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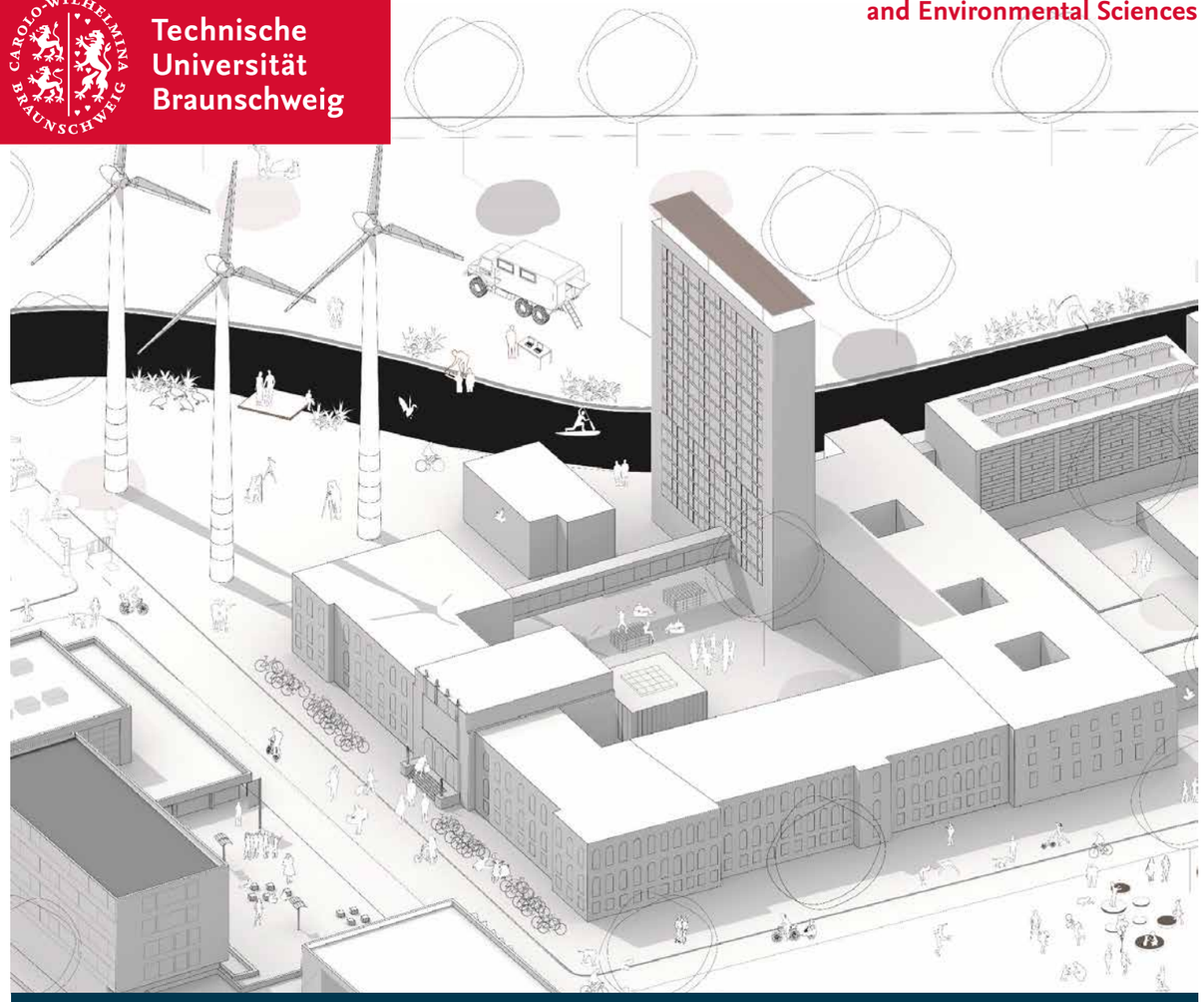
Technische Universität Braunschweig

Faculty
of Architecture, Civil Engineering
and Environmental Sciences



RESEARCH AND TEACHING

**Faculty of Architecture,
Civil Engineering and Environmental Sciences**

Foreword of the Dean

Dear Reader,

meeting the world's most pressing challenges requires a holistic approach that transcends disciplinary boundaries. At the Department of Architecture, Civil Engineering, and Environmental Sciences of Technische Universität Braunschweig, we bring together key disciplines to shape future cities, infrastructure, and environments. Our approach is multi-disciplinary and considers key factors such as efficiency, safety, environmentally sustainable living, health, social welfare, mobility, sustainability, and digitalization. In both our research and teaching endeavors, we rely on an interdisciplinary and collaborative approach to foster innovative solutions.

RESEARCH AND TEACHING provides a comprehensive overview of the research and teaching focus of each institute and division. For those interested in learning more about our current research activities, we offer a curated list of important publications. Additionally, we provide information on the career trajectories of our professors and the institutions supporting their research efforts.

For students, RESEARCH AND TEACHING presents our diverse range of subjects to study, including opportunities to write both bachelor's and master's theses or work as a student assistant. Additionally, many of our topics provide research opportunities for those interested in pursuing a PhD in their chosen field.

For our customers and research partners, we showcase our active research areas and state-of-the-art lab infrastructure. This serves as an excellent starting point for potential collaboration and future research projects.

Our aim with RESEARCH AND TEACHING is to pique your curiosity. Rather than clustering contributions by subject area, we have intentionally presented each professor's key areas of activity. As our research extends well beyond Germany, we have provided all articles in English.

We hope that you find RESEARCH AND TEACHING both informative and engaging, and that it inspires you to delve deeper into the exciting research taking place within our department.

Prof. Dr. Klaus Thiele
University Professor and Dean of the Department

Technische Universität Braunschweig

Faculty of Architecture, Civil Engineering and Environmental Sciences

Architecture

Civil Engineering and Environmental Sciences

Short Portrait Technische Universität Braunschweig

Carolo-Wilhelmina

Technische Universität Braunschweig Carolo-Wilhelmina is the academic focal point of Braunschweig, the City of Science, which in turn is at the heart of one of Europe's most active research regions. With more than 20,000 students and 3,500 staff members, we are the largest Institute of Technology in Northern Germany. Our campus is the ideal size for a university: our vast spectrum of teaching and research activities enjoy the use of state-of-the-art facilities while offering an intimate atmosphere at the same time. The Central Campus is located on the banks of the Oker River, walking distance from Braunschweig's city centre.

Our core disciplines include a comprehensive engineering branch and a strong natural sciences branch, closely linked with business sciences, social sciences, humanities and educational sciences. Our strategic research fields are mobility, infections and active agents, city of the future and metrology, which are interlinked through numerous overarching topics.

The name Carolo-Wilhelmina stems from the founding fathers of Technische Universität Braunschweig, Dukes Carl and Wilhelm von Braunschweig-Lüneburg. In 1745, Carl founded the Collegium Carolinum, thus becoming the first in Germany to lay the foundations for a technical university. Among the first students was mathematician Carl Friedrich Gauß.

Nec aspera terrent. Adversities shall not deter us – this motto of the founders of our university still serves as our maxim.

Taken from: Short Profile, TU Braunschweig 2018

With its 250,000 residents, Braunschweig is the largest city between Hanover and Berlin, making it the region's focal point, both throughout history and the present. Today, the Lion City is characterized by its rich history, its continuous development as a dynamic economic and commercial hub, its diverse and attractive cultural life, and its many-faceted research and science landscape.

Active research region

Braunschweig is not only one of the most active research regions in Europe; according to European Union statistics, it is also one of Europe's top investment regions in terms of spending on research and development. German economics magazine »Wirtschaftswoche« has also placed Braunschweig at the top of a ranking of business-friendly cities. TU Braunschweig plays a substantial part in this as it serves as a vital engine for the region. Our students are able to take part in projects at the facilities of our cooperation partners, for example at the Helmholtz Centres and Fraunhofer Institutes, and at federal research facilities and museums. Here they gain hands-on experience in biotechnology and environmental technology, automotive technology, aerospace technology, information and communications technology, measurement technology and microelectronics, as well as in humanities and education.

Transfers: What does it take to turn a good idea into a successful business concept? Technology transfers help to bring our research results to the economy, give support to business founders, and protect inventions through patenting. Under the roof of the Innovationsgesellschaft iTUBS (TU Braunschweig's innovation company), various specialized technology transfer centres aim to provide access to TU Braunschweig's research potential for commercial use, including for small and mid-sized enterprises.

Transparency and solid foundations: As a technical university, we seek open exchanges with the economy and society. In doing so, we also retain our independence. We feel an obligation towards a public, scientific and ethical discourse about the work that we do and uphold the rules of good scientific practice.

RESEARCH AND TEACHING AT TU BRAUNSCHWEIG

Study at the cutting edge of science: Our courses are guided by our research and impart broad, in-depth fundamentals, as well as offering diverse possibilities for individual specialisation. We let our students experience what it is like to put their own thoughts and results into practice, to research and develop projects on their own. For this reason we try to shape our degree courses around up-to-date research topics from an early stage.

Take interdisciplinary courses such as Environmental Science or Biochemical and Pharmaceutical Engineering, Transportation Engineering, Sustainable Energy Engineering and Biotechnology, or classic subjects from the fields of engineering, natural sciences, humanities and social sciences: our curriculum aims to interlink the various individual fields of study. Many courses of study are developed and realised in conjunction with neighbouring research institutes, such as the Metrology and Analytics course that is unique in Germany and is offered in cooperation with the German metrology institute PTB.

Master's degree: Our goal is that our bachelor's graduates continue to study at the master's level. Here the focus is even stronger: all our master's programmes are research-oriented and provide the necessary skill sets for management positions and international careers in research, development and business management.

Awards for exceptional teaching: We strive to continuously improve the quality of our teaching through student participation and by encouraging innovation in teaching. The best courses are awarded the »LehrLeo« teaching prize.

Open University: We open up new possibilities by offering students the chance to study without the »Abitur« certificate. We also practice knowledge transfers through research-oriented further education, especially in the field of mobility.

One point of contact for all your informational needs: matriculation, course guidance and CareerService – the Study Service Centre provides all the information and guidance you may need.

Technische Universität Braunschweig is part of the TU9 group of leading Institutes of Technology in Germany, and for each of its core disciplines, the engineering subjects, it ranks among the top 9 universities in Germany.

International

Our profile is international: TU Braunschweig is a cosmopolitan university. We cooperate closely with universities in the European Union, the USA, Canada, South America, China and Japan. Through the ERASMUS programme, we have student exchange partnerships with more than 200 universities in Europe.

One third of all our students spend part of their studies outside of Germany.
Dual degrees with US, French, Brazilian and Chinese universities qualify our graduates for the international job market. Student exchange, research projects and internships in foreign countries allow them to gain invaluable international experience. The various language courses on offer at our Language Centre prepare them for their stay abroad and for future careers in international environments.

International students are an important part of our academic community. Our campus is truly diverse: 3,000 students from more than 100 countries are currently studying and researching at TU Braunschweig. The excellent support provided by the International Office, the City of Braunschweig and the Peer Student Programme ensure that international students feel at home at our university.

In terms of research, our international orientation is just as self-evident. A considerable number of international scientists teach and conduct research at TU Braunschweig.

TU BRAUNSCHWEIG HISTORY

1745: The Collegium Carolinum is established, a new type of educational institution between secondary school and university, where mathematical/technical subjects are taught alongside humanities and fine arts.

1878: The polytechnical school is renamed Herzogliche Technische Hochschule Carolo-Wilhelmina (TH).

1900: The TH is accredited to award doctorates.

1933: Political alignment of the TH: the institution loses nearly 20% of its academic staff during the early period of the Nazi regime.

1945: Despite 70% of the institution being destroyed, the TH resumes lectures. It is the first German technical university to do so.

1968: After the establishment of a department for humanities and social sciences, the TH is renamed Technische Universität or TU Braunschweig (Institute of Technology).

1995: Under the slogan »Project Future«, TU Braunschweig celebrates its 250th anniversary.

2003: Establishment of the Centre for Humanities and Social Sciences at the Northern campus.

2006: Creation of TU9, an association of the nine leading German Institutes of Technology.

2007: Braunschweig is named the »City of Science 2007«.

2007: Foundation of the Automotive Research Centre Niedersachsen (NFF).

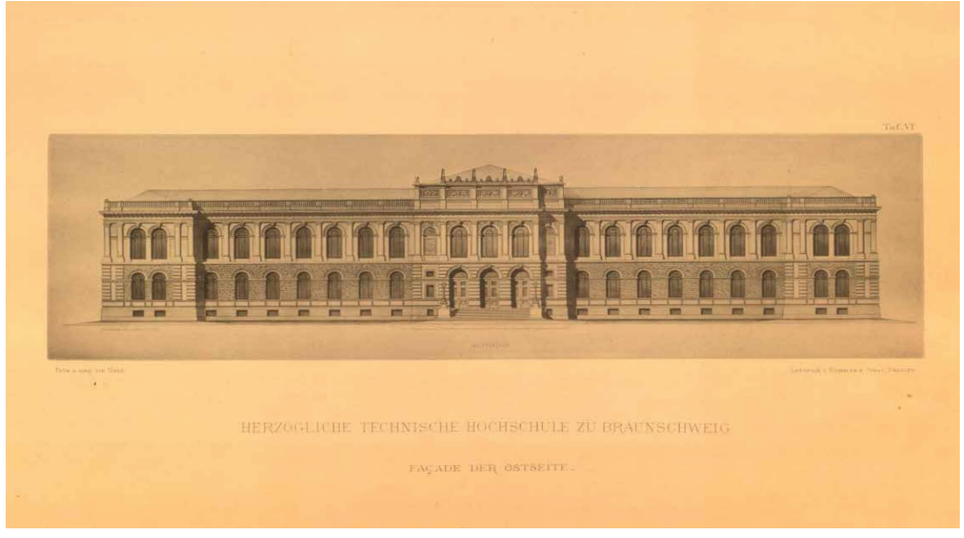
2009: Foundation of the Aeronautics Research Centre Niedersachsen (NFL).

2009: Creation of the Braunschweig Integrated Centre of Systems Biology (BRICS).

2016: Completion of the Open Hybrid LabFactory research campus.

2017: Relocation to the new Centre for Pharmaceutical Process Engineering (PVZ).

2017: Record high of 20.116 students



TU Braunschweig Figures

Study programmes:
- 34 bachelor's programmess and state examination courses (for undergraduates)
- 41 master's programmes

Students:
16,809 in the 2022/23 winter semester, including:
- 7,009 female
- 3,294 international students
- from 119 countries
- 2937 in faculty 3, 1.278 female

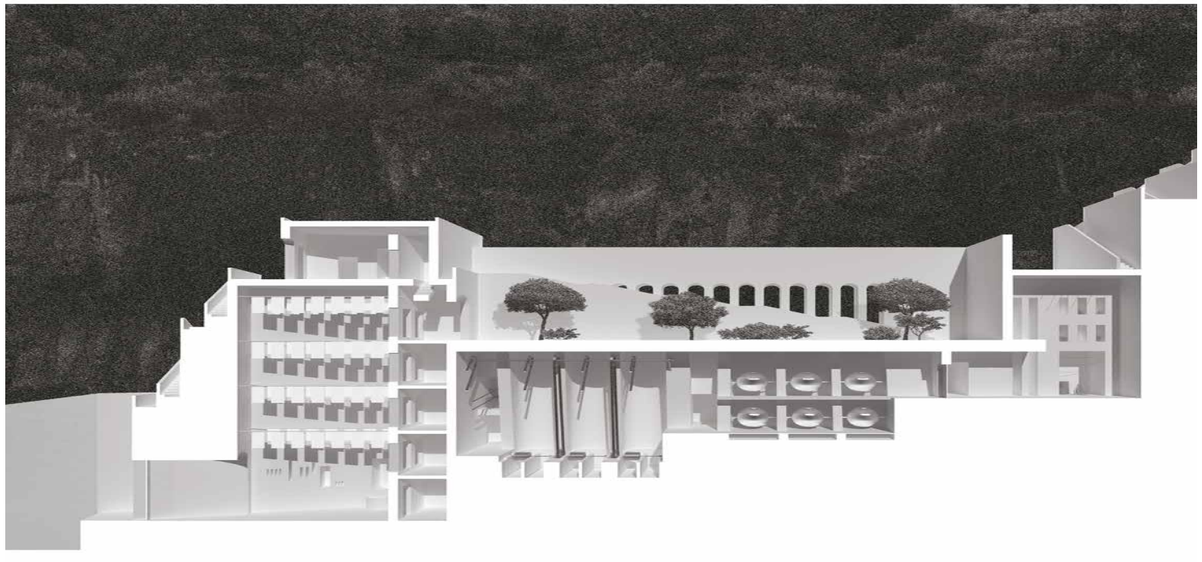
Graduates:
- 3,353

Doctorates:
- 303

Staff:
3,834 university employees (1,624 female, 2,110 male), including externally funded employees:
- 242 professors
- 2,088 academic staff
- 1,415 technical and administrative staff
- 89 trainees
- plus 416 adjunct lecturers
- plus 1,946 student assistants

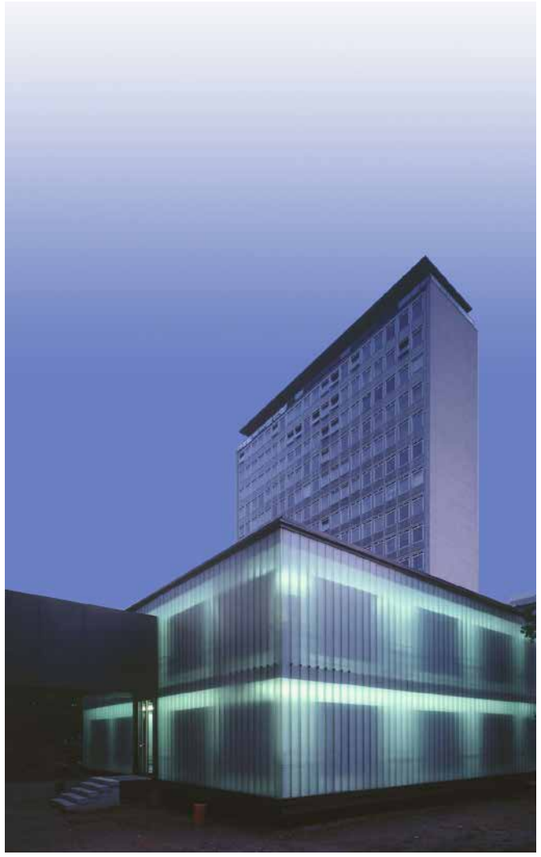
Budget:
393 million € of overall budget, including:
- 123,6 million € in external funding

Faculty of Architecture, Civil Engineering and Environmental Sciences



Our degree programmes:

- **Architecture**
- **Civil Engineering**
- **Industrial and Civil Engineering**
- **Environmental Engineering**
- **Environmental Sciences**
- **Computational Sciences in Engineering**
- **Transportation Engineering**



Architecture (BSc. and MSc.)

The Bachelor's degree programme in Architecture offers a basic education in six semesters and provides you with an overview of the professional field of architecture. The degree programme is divided into six areas of competence:

- Cultural and historical knowledge
- Representation and design
- Design and construction
- City and landscapeArchitectural design
- Professionalisation

The Master's programme in Architecture offers students the greatest freedom to organise their studies according to their own professional interests. The Master's students choose their design projects and work as well as their other subjects according to their interests. Our students get to know architecture in Germany and far beyond during excursions. Excursions abroad with a well-organised programme of visits and designs on site take you to Italy, Iceland, Japan, Brazil or India, for example.

The use of new media plays an important role in architecture. From the very beginning, our students are familiar with digital media as well as analogue techniques. They have access to various facilities such as the model-making workshop; laser cutters, 3D printers and virtual reality labs are all part of this.

The architecture pavilion of the TU Braunschweig is the central location for a wide range of events of the study programme. Presentations, regular exhibitions, semester kick-offs and the graduation ceremony take place here.

The TU Braunschweig is one of the most renowned schools of architecture in Germany. The "Braunschweig School" is characterised by its focus on architectural design. You learn to design architectural forms and spaces constructively and functionally. In addition to the lectures, fortnightly lectures on works by outstanding international architects in the series "Architectural Positions" are an essential part of the training.

A special feature of the Braunschweig architecture programme are the drawing rooms with several hundred workstations. Here students advise each other on drafts and exercises and support each other during busy phases. The mutual exchange of ideas, knowledge and techniques complements the university teaching. This communicative interaction is one of the best experiences during your studies. It is not uncommon for architectural firms to emerge from the collaboration in the drawing rooms.

Civil Engineering (BSc. and MSc.)

The Civil Engineering degree programme at the TU Braunschweig is particularly characterised by its broad structure. The study plan stipulates that subjects from each area of the engineering specialisations must be taken. The Bachelor's degree programme in Civil Engineering covers the following areas:

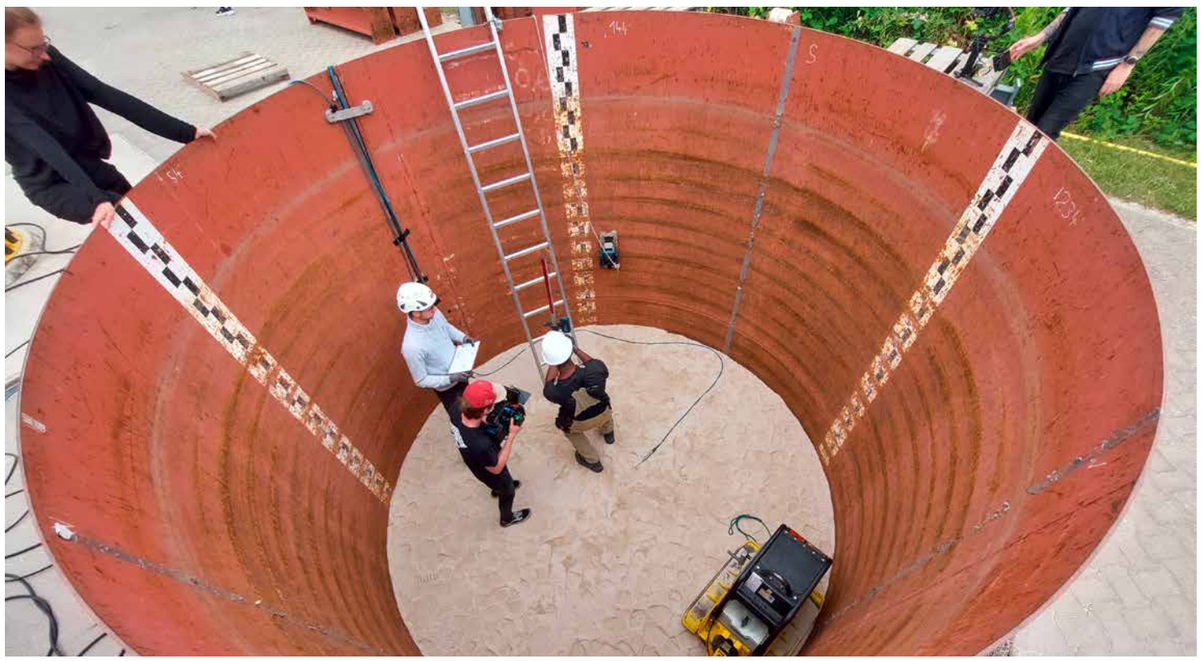
- Cultural and historical knowledge
- Representation and design
- Mathematical-scientific basics, including the modules engineering mathematics and technical mechanics.
- Engineering fundamentals, this area includes the modules building construction, building materials science, building economics, building statics, geotechnics, etc.
- Engineering science specialisation in the areas of structural engineering, water and environment, transport and infrastructure, computational engineering
- Cross-curricular content, including courses outside of civil engineering, e.g. languages and general business studies
- Bachelor thesis

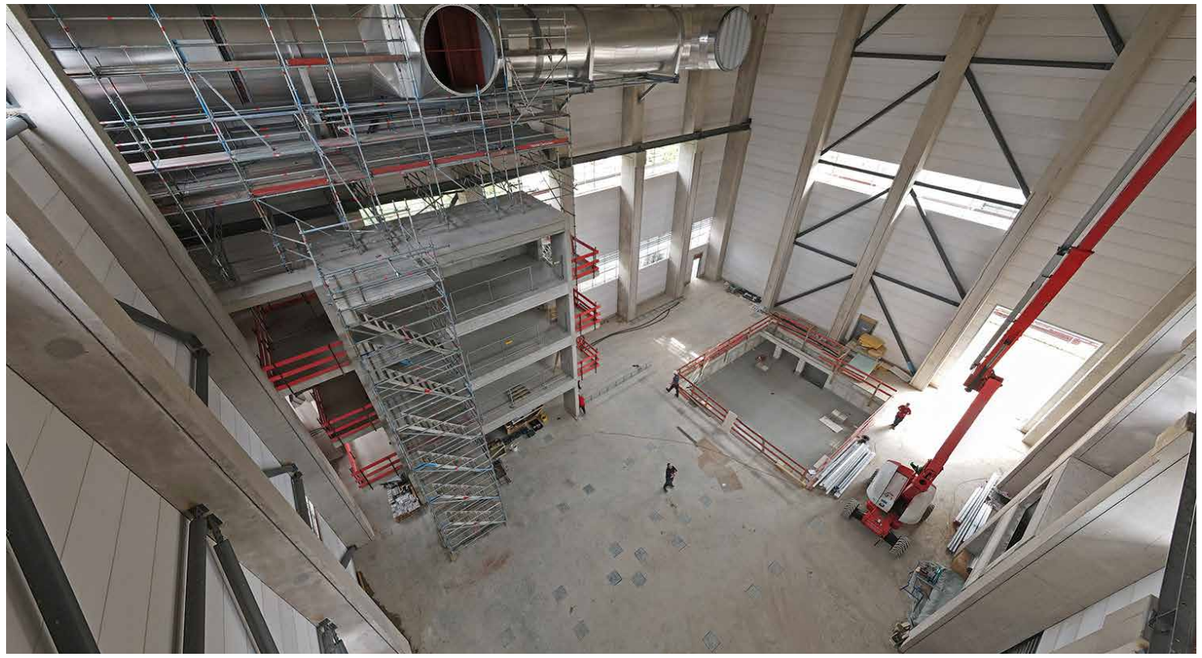
With the "Braunschweig Model", the civil engineering programme at the TU Braunschweig offers students a broad-based basic education in the Bachelor's programme. With the comprehensive options in the Master's programme, we train our students to become specialists within one subject area or generalists with basic knowledge from several areas of specialisation.

In the Master's programme, our students can choose from 22 specialisation subjects. Those who want to cover the breadth of civil engineering study three completely different subjects, because companies and engineering offices are always looking for employees who can be used in a variety of ways with a broad portfolio. Those who are interested in a specific area of civil engineering are also in the right place at the TU Braunschweig and simply specialise in three thematically related subjects, such as solid construction, steel construction and statics.

You can choose from the following specialisation subjects: Waste management | Construction and project management | Building materials technology | Building preservation | Fire protection | Geotechnics | Timber construction | Hydrology, Water Management and Water Protection | Coastal Engineering and Maritime Engineering | Infrastructure and real estate management | Engineering Geodesy | Engineering Mechanics | Solid Construction | Public Transport | Computer-aided Modelling | Urban Water Management | Guided traffic | Steel construction | Statics | Road engineering | Traffic and urban planning | Hydraulic engineering

As with all degree programmes, there is the possibility of a doctorate.





Industrial and Civil Engineering (BSc. and MSc.)

"Construction" has long since ceased to be limited to constructing buildings, roads, bridges, underground railway lines and railway tracks, or ensuring water supply and sewage disposal. Buildings, industrial plants, railway stations, airport terminals, traffic routes, etc. are now offered as "complete packages" - from planning and construction to commissioning and use.

Turnkey construction, leasing models, building management and public-private partnerships additionally require dealing with questions of financing, sale, operation and maintenance of buildings. Buildings and facilities are managed by construction companies for the entire duration of their existence. This requires professionals who have both the basic knowledge of civil engineering and business administration.

The Bachelor's degree programme in Industrial Engineering/Construction combines the classical contents of civil engineering, such as planning, dimensioning and operation, with knowledge from the field of economics, including the handling of financial resources and the management methods of a controlling system. In four semesters, our students acquire scientific and methodological know-how that prepares them for demanding tasks. The Master's programme is divided into specialisations in civil engineering and economics as well as the integration area.

At TU Braunschweig, our students simultaneously get to know the worlds of civil engineering and economics. They benefit from the wide range of civil engineering courses, which cover all areas from structural engineering to hydraulic engineering to lane-guided traffic. In the same semester, they study the basics of business administration and civil law together with other industrial engineers. A new professorship in infrastructure planning and management has been created especially for the industrial engineers.

Even during their studies, our students benefit from the interdisciplinarity of their future careers, as they attend lectures and exercises in various disciplines.

Environmental Engineering (BSc. and MSc.)

The daily news shows the need for environmental engineers on the labour market very clearly. Natural disasters and climate change, endangered nuclear waste repositories, disturbed ecosystems and shortages of raw materials with an increasing world population are just a few examples of the relevance of environmental engineering.

The solutions to these problems must be sustainable and should protect and preserve our world. Environmental engineers are concerned with

- Transport and Infrastructure
- Supply Locks, dams and wind and hydroelectric power plants
- Renewable energy sources (sun, wind, water, biomass)
- flood protection
- Reduction of emissions, immissions and noise
- Drinking water supply and wastewater treatment
- Sewage treatment plants
- Landfills and contaminated sites
- recycling

In the bachelor's degree programme in environmental engineering, we teach our students the professional and sustainable use of important resources such as energy, water, soil, building materials, etc.

Building on the basics from the Bachelor's programme and geared to their own interests, our students can further deepen their knowledge in the Master's programme in order to start their careers as well-trained specialists.

The following specialisations are available in the Master's programme in Environmental Engineering:

- Soil conservation and geotechnics
- Energy Engineering
- Environmental Sustainability and Life Cycle Engineering
- Public Transport
- Environmental Monitoring
- Environment- and resource-friendly construction
- Transport and Infrastructure
- Supply and waste management

Environmental Sciences (BSc. and MSc.)

Environmental scientists work primarily in teams with engineers against the progressive destruction, pollution and restriction of the natural basis of life for humans, fauna and flora. They are able to anticipate and assess potential problems related to human use. The Environmental Sciences degree programme appeals to all those who are interested in the interrelationships within an ecosystem and the interaction between humans and nature.

At the TU Braunschweig, the Environmental Sciences degree programme is not a mass operation. The manageable number of about 50 first-year students per year ensures small groups, intensive contact with the teaching staff and thus excellent supervision. A special feature is the broad range of courses in the field of modelling processes and interrelationships in ecosystems.

Furthermore, the TU Braunschweig is characterised by a wide range of research and experimental facilities as well as cooperation with, among others, the Federal Research Institute for Rural Areas, Forests and Fisheries and the Federal Research Institute for Cultivated Plants for practically oriented projects or theses.

The bachelor's programme provides our students with knowledge and qualifications for the sustainable solution of environmental problems in the areas of soil, water and atmosphere. It provides them with the basis for direct career entry or further Master's studies.

Building on the basics from the Bachelor's degree and your interests, you can further specialise our students in the Master's degree with the following specialisations:

- Applied hydrology and water management
- Atmosphere and boundary layer processes
- Biodiversity
- Soil and land use management
- Pollutant monitoring and modelling
- Environmental (geo)chemistry and ecotoxicology

Transportation Engineering (BSc. and MSc.)

Transport engineering studies cover the systems of road transport, rail transport and aviation. Traffic engineering offers exciting tasks and career prospects in very different fields of work: from urban and regional planning, planning and construction of vehicles and traffic facilities to the development of new traffic management methods.

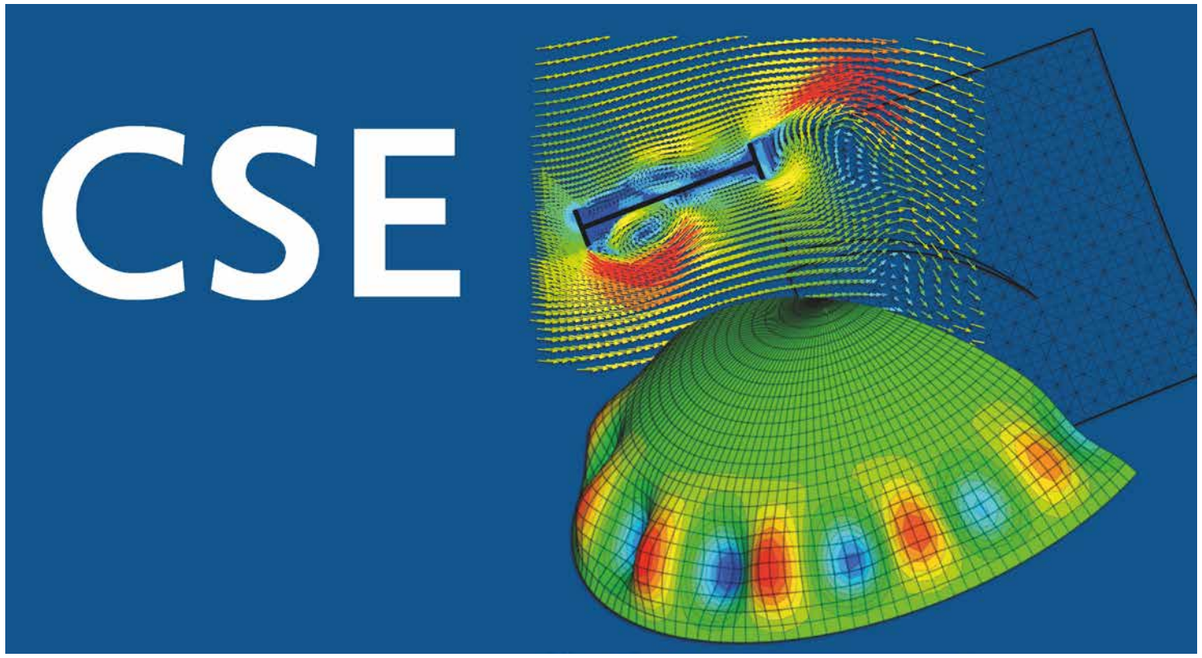
The Bachelor's degree programme in Traffic Engineering includes:

- Mathematical basics and computer science with the modules Engineering Mathematics and Programming.
- Engineering fundamentals such as technical mechanics, control engineering and electrical engineering
- Fundamentals of transport science, including modules on railway construction, road construction, public transport and transport and urban planning
- Economics and Social Sciences
- Architecture and economics, including the modules Production & Logistics, Economics and Mobility, Space & Architecture, among others
- Professionalisation: which includes, among others, the module CAD and the specialised internship

The TU Braunschweig could not be better chosen as the location for the interdisciplinary degree programme in transport engineering. The region's economy is strongly characterised by transport-related companies, but also by public institutions in the transport sector (e.g. Federal Aviation Authority, DLR, research airport). The region is quite rightly described as a transport competence region.

In addition, the TU Braunschweig:

- An interdisciplinary degree programme (intersections of mechanical engineering, civil engineering and economics).
- An opportunity for a double degree: through exchange programmes with the Université de Technologie de Compiègne (UTC) you can obtain a French Diplôme d'Ingénieur in addition to the German Master's degree
- A strong network with companies in the region



Computational Sciences in Engineering (Msc.)

Computational Sciences in Engineering (CSE) is an interdisciplinary, research oriented, international, and bilingual Master's degree programme at the TU Braunschweig.

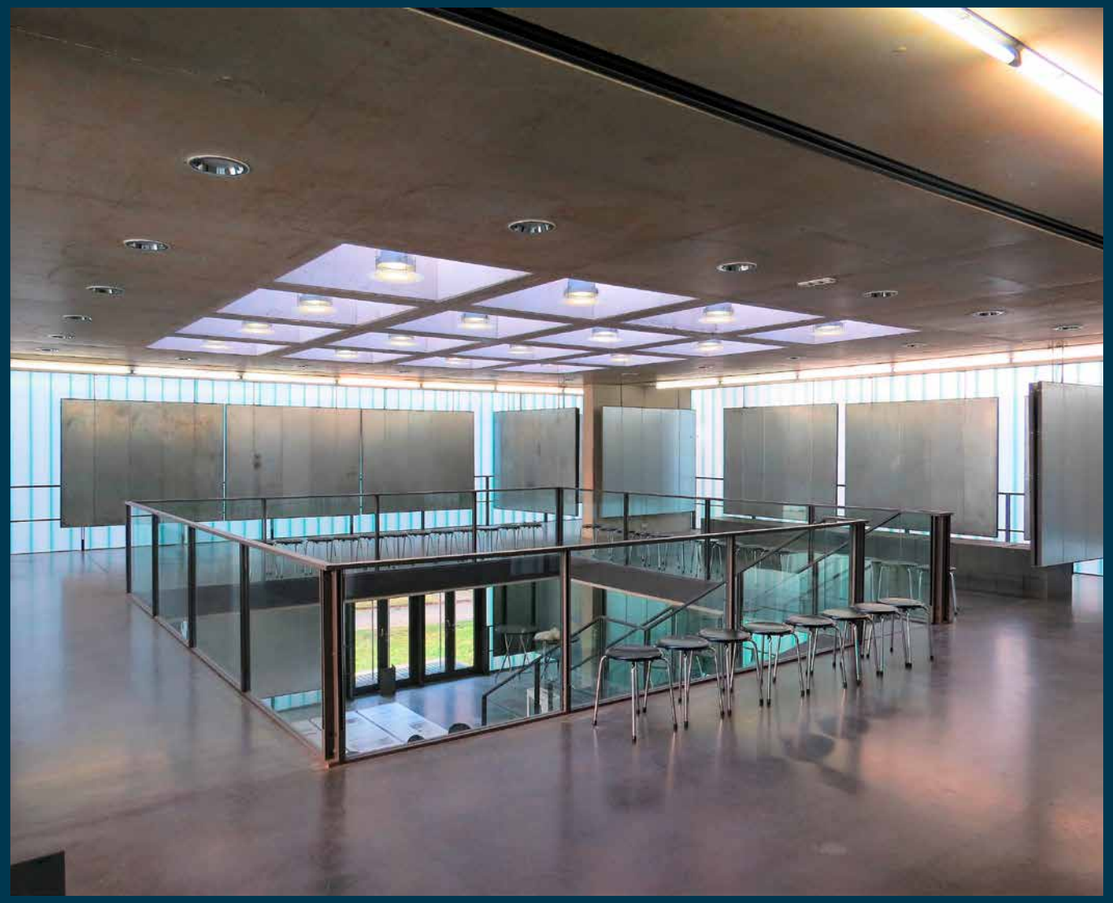
There are 4 directions of study within the CSE master's programme: Civil, Electrical and Mechanical Engineering and Mathematics.

CSE is a combination of engineering sciences, mathematics and applied computer sciences. Students will develop mathematical models for physical processes such as occur in various branches of engineering sciences. They will solve specific problems regarding physical modelling, mathematical description as well as numerical simulation and performing and evaluating complex numerical analyses of engineering processes.

Because of the international focus of CSE, our students find themselves in a multicultural environment.

CSE graduates are able to apply this knowledge both in developing new approaches and in improving existing technologies. They are able to plan and work on sub-projects in increasingly interdisciplinary project teams and successfully present the results.

The CSE master's programme enables graduates to carry out independent research as part of doctoral studies in civil, mechanical or electrical engineering, or in mathematics.



Architecture

GTAS | Institute for History and Theory of Architecture and the City

Mission Statement

In the face of epochal urban transformations and growing socio-spatial inequalities, architecture – as a field, discipline, and profession – will need to reconfigure long-established and habitual ways of doing, practices, mechanisms as well as operations. Tackling this directly through the development of transformative narratives is at the core of our work.

RESEARCH

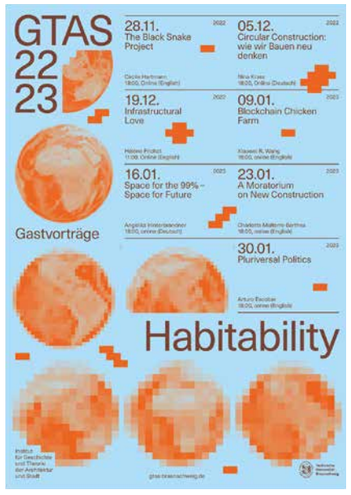
The Institute for History and Theory of Architecture and the City investigates, analyses, and documents the political-economic conditions and ethical demands placed on architecture and architects in the context of climate breakdown.

We regard the making visible and thus the understanding of decision-making structures as an essential, if not indispensable, instrument for negotiable, transformative and emancipatory (re)productions of space.

This is important because other ways of doing only become conceivable when questions of privilege, interest or power are exposed, and their distinct layers revealed. The much-discussed right to the city, for example, can only be realised when the very systems that produce architectural projects and objects become the focus of investigation.

This critical-reflective point of departure for the Institute is anchored in teaching and research through the exploration of historical lines of flight. It is situated in interdisciplinary discussions and the identification of trans-local concerns, so that contemporary issues such as migration, housing, and agency are framed and embedded in broader debates.

We position ourselves and our approaches firmly against the modernist fragmentation and abstraction of knowledge. In doing so, we are concerned with drawing attention to and investigating complex machines or apparitions of practices and the subsequent configuration of other trajectories and imaginaries.



This side: Extracurricular lecture series; Design: A Gesture Of, 2022.

Playing 'Lift Me Up' – a student project that develops a critical understanding of vacant shops and properties in Braunschweig; Design: Marlon Dina, Jonas Fangmann und Büsra Topallar, 2021.

Opposite side: Engaging with ecological and social conditions of making cities; Field trip to Marseille, 2022.

Photo credits: GTAS (3), Simone Fürst/TU Braunschweig (1)

GTAS | Prof. Dr. Tatjana Schneider

Researcher's Career

- since 2022: Vice President for International and Regional Relations, TU Braunschweig
- since 2018: Full Professor for Architectural Theory, TU Braunschweig
- 2004–2018: Senior Lecturer, The University of Sheffield
- Guest Professor Hafencity University, Hamburg; Adjunct Faculty: IUAV, Venice; Nanjing University; CEPT University, Ahmedabad
- Co-Founder of the Workers' Cooperative Glasgow Letters on Architecture and Space (G.L.A.S) and the research Cluster AGENCY

Funding

AHRC, BMBF, BMI, British Academy, British Council, DAAD, DFG, ESRC / Horizon 2020, Kulturstiftung des Bundes, MWK

TEACHING

The guiding idea of our teaching formats is to reveal the complexity and 'messiness' of the spaces in which and for which architects design, through the collaboration of diverse professional competencies and associated methodological approaches.

We believe it is essential to navigate this complexity and make it visible as a dense network of practices, imaginaries, privileges, interests, and power relations in order to prepare for sustainable and lasting change. In doing so, it is important for us not only to make references to current events and social developments but also their path dependencies. We also question hegemonic constructs and their validity, to find out where seemingly universally valid judgments and evaluations come from, how and by whom they are produced, and what – often less apparent – alternatives already exist. The approaches are always processual, research-based, and problem-oriented, and are thus intended to contribute to the reconfiguration as well as ethical expansion of the profession and discipline of architecture.

Publications

- Bader, Markus, George Kafka, Tatjana Schneider, and Rosario Talevi, editors. *Making Futures.* Leipzig: Spector Books, 2022.
- Endres, Elisabeth, Gabriele G. Kiefer, Folke Köbberling, and Tatjana Schneider, editors. *Reallabor Hagenmarkt.* Braunschweig: TU Braunschweig, 2022.
- Feireiss, Lukas, Tatjana Schneider, and TheGreenEyl. *Living the City. Of Cities, People and Stories.* Leipzig: Spector Books, 2020.
- Schneider, Tatjana. „Agency". In *connectedness. An Incomplete Encyclopedia of the Anthropocene*, edited by Marianne Krogh, 36–39. Copenhagen: Strandberg, 2020.
- Schneider, Tatjana. „Plädoyer für das Durcheinander". In *Architekturkultur*, edited by Alexander Gutzmer and Stefan Höglmaier, 116–31. München: Callwey, 2019.
- Schneider, Tatjana. „What If ... or Toward a Progressive Understanding of Socially Engaged Architecture". In *The Routledge Companion to Architecture and Social Engagement*, edited by Farhan Karim, 3–13. New York & London: Routledge, 2018.
- Awan, Nishat, Tatjana Schneider, and Jeremy Till. *Spatial Agency. Other Ways of Doing Architecture.* London & New York: Routledge, 2011.
- Kossak, Florian, Doina Petrescu, Renata Tyszczuk, Tatjana Schneider and Stephen Walker, editors. *Agency. Working With Uncertain Architectures.* London: Routledge, 2009.
- Schneider, Tatjana, and Jeremy Till. *Flexible Housing.* London: Architectural Press, 2007.

Contact

Technische Universität Braunschweig
GTAS | Institute for History and Theory of Architecture and the City
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IAD | Institute of Architectural Design

Mission Statement

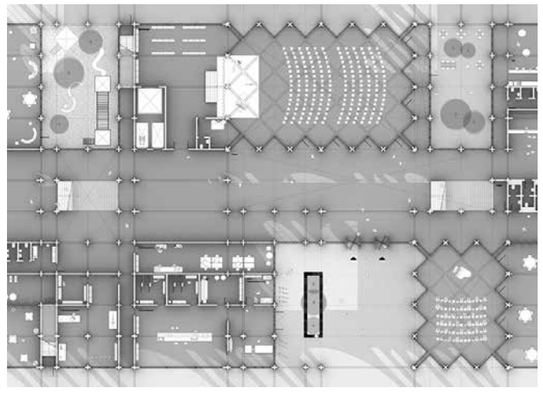
The relevance of an architectural project arises from the meaningful interaction of a conceptual structural-spatial idea and the manifold connection to the contextual fields of influence.

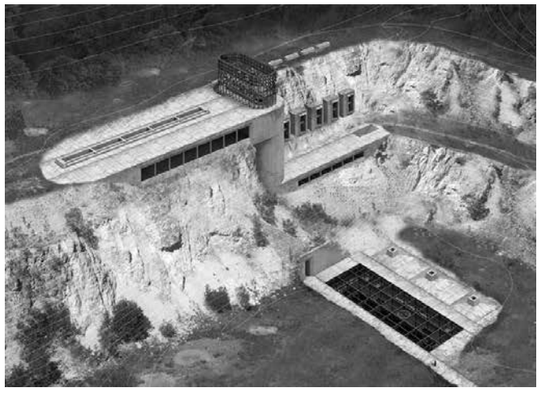
RESEARCH

Design-Based Research
In the generalist discipline of architectural design, research can only ever be an exploration of aspects and sub-areas within the complex field of influence of architectural decisions. Thus, the work of our institute as well as the work of my office deals with the question of the balance between autonomous and contextual aspects and their influence on decisions within an architectural design process. While the autonomous aspects of architecture - structure, space, construction - seek references in the existing architectural fundus and are first of all to be thought free of concrete building tasks. Contextual influences are fed by the peculiarities of the place and its history, but also by the social and cultural environment of a project. The relevance of an architectural project arises from the meaningful interaction of a conceptual structural-spatial idea and the manifold connection to the contextual fields of influence.

Lecture Series
IAD curates the Department of Architecture's lecture series ‚Architekturpositionen', featuring both renowned architects and emerging talents. Professionals present their thinking and acting as architects, the design strategies, work and applied research of their offices. Thus, students not only get to know exciting architectural projects and gain insights into their realization. They also learn what professionalism means in the field of architecture. Lecturers and tutors can match their teaching and research with architectural practice. With about five guest lectures per semester, since 2012 we have welcomed more than 100 architects, such as Stéphanie Bru, Max Dudler, Antón García-Abril, Jeannette Kuo, Jean-Philippe Vassal, Tatiana Bilbao.

Autonomy and Alliance
Student projects by Lara Kellner, Jonas Höltke and Edwald Dederer, Tiana Hilker





IAD | Prof. Volker Staab

Researcher's Career

- since 2012 Professorship at TU Braunschweig and Head of the Institute of Architectural Design
- 2011 Großer BDA Preis (Grand Prix of the Association of German Architects)
- 2008 'Bundesverdienstkreuz am Bande' (Cross of the Order of Merit of the Federal Republic of Germany)
- 2008-2009 Guest professorship at Akademie der Bildenden Künste Stuttgart (Acadamy of Fine Arts)
- since 2005 Member of the Academy of Arts Berlin
- 2005-2007 Guest professorship at FH Münster (University of Applied Arts)
- 2002-2004 Guest professorship at TU Berlin (Institute of Technology)
- 1996 Founding of Staab Architekten together with Alfred Nieuwenhuizen
- 1991 Founding of own office
- 1991 Diploma in Architecture at ETH Zürich

TEACHING

Programmatics
IAD is primarily concerned with the design of buildings.
The focus is on the search for design strategies that take into consideration the complex boundary conditions of architecture and contemporary techniques, while still keeping an emphasis on conceptual sharpness in the design process.
The inner logic of an architectural construct as well as the processing of contextual influences and social issues play an essential role. The discourse is determined by the question of the relevance of an architectural form.
In the Bachelor's programme, implications of architectural design such as idea, context, programme, structure and atmosphere are addressed in exercises and projects of increasing complexity. In two parallel Master's studios, we look for an architecture that is open to different uses but specific in terms of the spatial quality, expression and atmosphere of a building and its relationship to its context - one studio starts from the development of a structural object that changes through confrontation with a site, the other develops architectural concepts as a distillate of the social and historical influences of a place.

Publications

- Staab Architekten. Verwandte Unikate (Affinity of unique specimens, monographic study), Hatje Cantz 2016
- Staab Architekten. Arbeiten Works (monographic study), Junius Verlag 2016

Essays and Works among others in:

- Ingenieurbaukunst 2022 (The art of engineering), Ernst & Sohn 2021
- Bauhaus 100. Sites of Modernism, Hatje Cantz 2019
- My Bauhaus – Mein Bauhaus. 100 Architekten zum 100. Geburtstag eines Mythos | 100 Architects on the 100th Anniversary of a Myth, Edition Detail 2018
- Jüdische Lebenswelten in Regensburg (Worlds of Jews), Friedrich Pustet Verlag 2017
- Grundrissfibel Museumsbauten (Primer of museum floor plans), Edition Hochparterre 2017
- Reduce Reuse Recycle (The German pavilion at Venice Biennale), Hatje Cantz 2012

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IAK | Institute for Architecture-Related Art

Mission Statement

Artistic work as we understand it is process oriented and never primarily determined by its use. Our goal is to foster dialogue and collaborative models of working. We work 1:1 with many different, often recycled materials, establishing knowledge about methods of artistic design and form-finding. We encourage critical thinking and questioning of predefined structures via artistic reflection.

RESEARCH

Public Space
How do we define public space and what rights and obligations follow as a consequence of our perception? Public space in the cities today is beset by a growing number of cars and the expanding infrastructure to support the automobile lifestyle, by the permanent pressure to consume and the increasing surveillance of public or semi-public spaces. Through artistic work - interventions, installations, site specific constructions as well as performative and collaborative works - we seek to deepen our knowledge of public space and instigate new alternative models of co-habitation and collective appropriation.

Mobility
We believe that mobility begins in our heads and by experimenting with shifting views and standpoints, we aim to expand the willingness for creative thinking. While walking (or biking) heightens the sensitivity towards our surroundings, driving a car does not. Therefore we work to design and construct new structures and vehicles for non-motorised transportation by reconstructing and recycling materials gained from automobile waste with the aim to strengthen sustainable forms of mobility.

Resources
We explore the artistic and constructional qualities of a variety of materials. It is our firm conviction that it is not necessary to buy material to work with, but that there are significant resources to be gained from what is generally considered to be trash and of no use to others. Most working materials we obtain from our immediate surrounding. Through our daily artistic practice as well as in more extensive collaborative works, we develop the manual skills needed to work with many different materials, learning how to reuse and recycle. The possibilities lying within the material inspire the design and the acquisition of the work material becomes part of the exploration process.

Waste land
Free and unused space is an invaluable resource in times of growing cities and an increasing world population. We understand waste land or uninvested land as a creative resource and explore possibilities for creating new shared space through site specific work. Urban waste land is mostly a symptom of economic crises and transformation processes. At the IAK we value the yet undefined space as possible exit point of a cultural refreshment of a city. Because of unclear ownership, uninvested spaces are open to informal use and as green areas it has the potential to become areas of urban retreat, often being land left to nature and with spontaneous wild growth; spots where nature has re-defined space.

IAK | Prof. Folke Köbberling

Researcher's Career

- Full Professor for Architecture-Related Art, TU Braunschweig
- Visiting Professor, University of Applied Arts, Vienna/Austria
- Visiting Professor, Art Center College of Design, Pasadena/USA
- Lecturer, University of Fine Arts UDK, Berlin
- Associated Professor, Leibniz Universität, Hannover
- Member of the Commission for Art in Public Space, Lower Austria
- Working grant, Canada Council, Vancouver/Canada
- Artist in residence, Villa Serpentara/ Akademie der Künste, Olevano/Ital
- Working grant, Stiftung Kunstfonds Bonn

Co-operations since 2017

- Felix-Nussbaum-Haus, Osnabrück
- ALBA Braunschweig GmbH
- KHiB - Bergen National Academy of the Arts, Bergen, Norway (now UiB, Bergen)

TEACHING

A design process, be it in art or architecture, typically begins with a layout, a concept, a sketch or a design from which a form is developed. At the IAK design takes a starting point in the material, its qualities and possibilities, while form develops as a consequence of the practical and manual work process. We teach and work as site specific as possible. The surrounding forest, the city of Braunschweig, the museums and cultural institutions nearby, the resources at hand, provide a basis for our investigative and experimental practices. In art, in making art, the process is a goal in itself, much more than a predefined result. The useful often hides within the erroneous and is to be found on detours or by coincidence. It is our goal to train perception to a heightened sensitivity towards our urban and natural surroundings and their visual and creative potentials.
Most steps of the artistic practice taught at the IAK are collaborative, making communicative skills and knowledge about art practice an essential element of our teaching. We strongly believe in the possibility of sound but critical thinking deriving from artistic practice and we encourage dialogue and verbalised reflection as an integrated part of our daily teaching. Lectures and workshops by renowned artists and art practitioners complement the practical and theoretical courses offered by Professor Folke Köbberling and her team.

Publications

- Köbberling, Folke: Full Stop, Edition Metzel, München 2017
- The Games Are Open, Folke Köbberling and Martin Kaltwasser. Texts by Barbara Holub and Barbara Cole. Edited by Lorna Brown, Vancouver 2016
- Kaltwasser, Martin/Köbberling, Folke (ed.): Hold it! The Art & Architecture of Public Space: Bricolage Resistance Resources Aesthetics, jovis Verlag, Berlin 2009
- Kaltwasser, Martin/Köbberling, Folke (ed.): Ressource Stadt - City as a Resource. One man's trash is another man's treasure, jovis Verlag, Berlin 2006
- Becker, Jochen/Burbaum, Claudia/Kaltwasser, Martin/Köbberling, Folke /Lanz, Stephan/Reichard, Katja: learning from *, NGBK (ed.) b_books, vice versa, Berlin 2003
- Köbberling, Folke: Tagesfiliale Köbberling Elektronik, Goldrausch Künstlerinnenprojekt, Berlin 2003

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IB | Institute of Building History

Mission Statement

Building History provides an immense source of knowledge on the transformations within our societies. The true value of historic buildings lies not in their beauty or by conveying a feeling of identity. They document how people lived, where they were governed, how they practised their religious beliefs etc., and are thus a historic source in their own right.

RESEARCH

Thanks to a diverse team of researchers from various stages in their careers and with a wide field of interests, the IB is active in the broad research field of building history and building archaeology.

Building Archaeology of the Ancient World
We explore the architecture of the ancient world, gaining knowledge through building archaeology, interdisciplinary cooperation, and cultural exchange. Architectural remains are scrutinized and documented by surveying, drawing, describing, etc. Only this enables assessment, virtual reconstruction and interpretation.
In cooperation with the WWU Münster, the IB is involved in the archaeological exploration of Doliche, a Roman city in southeastern Turkey, particularly of its centrally located temple. In Egypt, we are taking a look at the temple of Philae, the Necropolis in Tuna el-Gebel and the city of Hermopolis. Additionally, the IB is part of a summer school there in cooperation with the LMU Munich, HAWK Hildesheim, RPM Hildesheim, and the University of Minia.

Rural Buildings in Lower Saxony
The exploration of significant rural buildings in Lower Saxony is a contribution to local history and heritage conservation by the IB. The region has, e.g., a rich history of rural Romanesque churches, the study of which has so far led to an exhibition and a monograph in 2022. Furthermore, Lucklum, a historic knight's estate, is the focal point of the faculty's interdisciplinary research. This complex, which dates back to the Romanesque period, is being explored utilizing the disciplines of archaeology, civil engineering, and building archaeology.

Epistemic History
The history of knowledge and science is a rich field for building historians, competent to establish how historic architects operated. Especially from the Renaissance on, this research includes not only built, but also written sources, sketches, plans etc. The IB has published about the work of Michelangelo and Giuliano da Sangallo, as well as on the research of Jean-Baptiste Lepère and Georg Erbkam, who were 19th century architects as well as building archaeologists.

Local Modern Architecture
The Braunschweiger Schule, highly influential in post-war Germany, originated at the TU Braunschweig. Thus, the TU offers a good vantage point for exploring 20th century architecture. When the TU chemistry building was cleared for demolition, the intricate mosaic spanning the full height of its northern staircase was fatally threatened. As a notable example of modern art-in-architecture, the mosaic was documented using SFM, hoping to digitally preserve it. A 1930's experimental plant for testing reinforced concrete for structural air protection was unearthed by the IAK in 2021. IB documented the finding in the Querumer Forest (Braunschweig) using photogrammetry. We plan to continue exploring the area and its history on an interdisciplinary basis at the TU Braunschweig.

This page: The team of the IB at the finding at Querumer Forst (U. Fauerbach/TU Braunschweig)

Opposite page: Students surveying a historic building on site (A. Wiesbeck-Klein/TU Braunschweig)

IB | Prof. Dr. phil. Ulrike Fauerbach

Researcher's Career

- Since 2021: Full Professor of Building History
- 2016–2021: Professor of the History of Architecture and Construction, University of Applied Science OTH Regensburg
- 2013–2015 Senior Research Fellow, Eidgenössische Technische Hochschule Zürich
- 2006–2012 Senior Research Fellow, German Archaeological Institute Cairo
- 2006 Scholarship at the Max Planck Institute for the History of Science, Berlin
- 2005 Doctoral degree from the University of Bamberg on The Great Pylon of the Horus Temple in Edfu, Egypt
- Member of the DFG Research Training Group Kunstwissenschaft–Bauforschung–Denkmalpflege (University of Bamberg/ TU Berlin). The thesis was awarded the Hans-Löwel-Preis

Funding
DAAD, DFG, MPI

TEACHING

We teach students how to analyse historic architecture in its manifold contexts of cultural and social history, technical development, theoretical outlook, climate, and topography. A broad overview is given in a two-term lecture course that presents examples from the Neolithic to the end of the 19th century, focusing on the Mediterranean. The experience of hands-on material studies can be gained in an intensive workshop week by surveying and researching historic buildings on site, as well as by studying written and visual sources. On these foundations, which are laid during the first two semesters, students can then choose from a range of topics for in-depth study of building history. These could comprise a survey of a medieval village church, researching publications on ancient Egyptian temples, recording the building construction of an industrial building from the early modern era, etc. During the course, students interpret their research results and convey the gained knowledge to others by e.g. writing a paper, re-editing a Wikipedia entry, making an architectural model, and so forth.
These achievements will enable students to help preserve the built heritage and to transfer their analysis into the architectural discourse.

Publications

- Bauch, Julian, Schulz-Lehnfeld, Gunnar und Thies, Harmen: Romanische Dorfkirchen in der Region Braunschweig, Berlin 2022.
- Fauerbach, Ulrike: Schrittmaß. Die Arbeitsweise des Bauforschers Georg Erbkam in Ägypten und Nubien 1842–1845, in Bußmann, Richard et al (Hg.): Spuren der Altägyptischen Gesellschaft. Festschrift für Stephan J. Seidlmayer, Berlin / Boston 2023, S. 369-384. doi.org/10.1515/9783110761665-022
- Fauerbach, Ulrike: Von islamischer Architektursprache fasziniert – James Wild, in Grallert, Silke und Helmbold-Doyé, Jana (Hg.): Abenteuer am Nil. Preußen und die Ägyptologie 1842–45. Begleitbuch zur Ausstellung vom 15.10.2022–07.03.2023 im Neuen Museum Berlin, Berlin 2022, S. 134–140.
- Fauerbach, Ulrike: Georg Erbkams Vermessungsmethoden, in: ibid., S. 167–172.
- Fauerbach, Ulrike: Das Wirken von Georg Erbkam als Architekt und Bauforscher, in: ibid., S. 224–229.
- Fauerbach, Ulrike und Putz, Andreas: « Bauforschung » Today: Current Tendencies in Building Archaeology in Germany', in Sapin, Christian et al (Hg.): Archéologie du bâti. Aujourd'hui et demain, Dijon 2022. https://books.openedition.org/artehis/26352.
- Fauerbach, Ulrike: Description de l'Égypte. Ein Monument der Drucktechnik, in Hassler, Uta (Hg.): Polychromie und Wissen, München 2019, S. 126–149.

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Bet Tfila - Research Unit for Jewish Architecture

Mission Statement

The Bet Tfila – Research Unit for Jewish Architecture – is dedicated to researching and communicating Jewish cultural, especially built heritage, in Europe and beyond. Through our international and interdisciplinary projects, Bet Tfila scholars contribute to the development of social awareness of Jewish heritage, thus combating anti-Semitism, by conducting and publishing its in-depth research on selected topics.

RESEARCH

The built heritage of Jewish communities in Europe is viewed controversially. As the architecture of a minority, it is often overlooked, misunderstood and thus endangered, both in the past and today. Our work at the Bet Tfila – Research Unit is aimed at documenting, researching, critically assessing and communicating this heritage in all its facets. As Jewish communities were highly mobile and globally connected from antiquity on, this work must be considered in a wider international context. Beyond the aspects of architectural history, the social, cultural and political significance of Jewish built heritage needs to be considered: what constitutes Jewish architecture? who designs it, who builds it? What is the significance of architecture for Jewish communities, how is it received by non-Jewish societies? What is the role of destroyed and preserved Jewish buildings within the discourses surrounding the memory of the Holocaust, from both Jewish and non-Jewish perspectives? How do societies, bereft of their Jewish citizens, deal with the "orphaned" heritage, how do contemporary Jewish communities position themselves in relation to it?

Since the foundation of the Bet Tfila – Research Unit in 2000, its groups at the TU Braunschweig and at the Center for Jewish Art of the Hebrew University of Jerusalem have been working in interdisciplinary and international project cooperations. Within the DFG priority program "Jewish Cultural Heritage", which began its work in 2022, we are represented by two projects and also by Ulrich Knufinke in the coordinating program committee. Doctoral and postdoctoral researchers work on the documentation of Jewish buildings: Zuzanna Światowy's project deals with former synagogues in Poland, their protection, re-use and reception by Jews and non-Jewish society. In a further project, Mirko Przystawik explores architecture and text as constituting "sites" of Jewish self-understanding and cultural heritage. Katrin Keßler examines Jewish cemeteries with regard to anti-Semitism and their role in memorial culture.

The Bet Tfila – Research Unit publishes its research results in two scientific series, as well as in books and numerous articles. Since 2007, we have organised a series of international congresses on Jewish Architecture with our partner institutions, most recently in 2022 on "Jewish Topographies" with contributions from all over the world.
We address the interested public with our lectures at the TU Braunschweig and in more than 20 exhibitions of our collection of wooden models of reconstructed synagogues.

Photos:

This page: Model of the villa of Galka Scheyer, LA art collector and socialite, built by students after scrutinizing hundreds of photos (M. Przystawik, 2022)

Opposite page: Synagogue in Lengnau/Switzerland (U. Knufinke, 2017)

Bet Tfila | Prof. Dr. phil. Ulrike Fauerbach

Formation of the Research Unit

- 2000: Foundation of the Bet Tfila – Research Unit for Jewish Architecture at the TU Braunschweig and the Center for Jewish Art in Jerusalem; Directors: Harmen H. Thies (Braunschweig), Aliza Cohen-Mushlin (Jerusalem)
- Since 2007: five International Congresses on Jewish Architecture
- 2014: new director: Alexander von Kienlin
- 2015: foundation of the Jewish Cultural Heritage Network
- Since 2021: new director: Ulrike Fauerbach, scientific director: Ulrich Knufinke
- 2021: DFG priority program "Jewish Cultural Heritage", Ulrich Knufinke member of the program committee

Funding
German Research Foundation (DFG), Federal Ministry of Education and Research (BMBF), Lower Saxony Ministry of Science and Culture (MWK), Alfried Krupp von Bohlen und Halbach-Stiftung, German Israeli Foundation and others

TEACHING

The Bet Tfila – Research Unit regularly offers seminars for Bachelor and Master students to provide an insight into Jewish cultural heritage and also enable participants to learn building documentation, the critical analysis of historical sources as well as to become well-versed concerning reconstructions of destroyed buildings. The topics and tasks of the courses are related to ongoing research projects, so that students acquire in-depth knowledge of scholarly work and experience how their results contribute to scientific knowledge.

Currently, the Bet Tfila – Research Unit is establishing an interdisciplinary, cross-university "Jewish Cultural Heritage Studies Network" in cooperation with other institutions. It will offer our students a wide range of courses from various disciplines to a broad methodological and thematic spectrum. We understand Jewish heritage as exemplary for having both material and immaterial aspects which are inseparable from each other and can only have a future as a living legacy.

Publications

- Keßler, Katrin, Andreas Brämer, Ulrich Knufinke and Miriam Rürup (eds.): Wandernde Objekte des Jüdischen. Braunschweig 2022.
- Berghahn, Cord Friedrich, Mirko Przystawik, Ulrich Knufinke and Katrin Keßler (eds.): Israel Jacobson (1768-1828). Studien zu Leben, Werk und Wirkung. Göttingen 2022.
- Keßler, Katrin, Sarah M. Ross, Barbara Staudinger and Lea Weik (eds.): Jewish Life and Culture in Germany after 1945. Sacred Spaces, Objects and Musical Traditions. Berlin, Boston 2022.
- Keßler Katrin (ed.): Galka Scheyer – A Jewish Woman in International Art Business, Petersberg 2022.
- Brämer, Andreas, Katrin Keßler, Ulrich Knufinke and Mirko Przystawik (eds.): Jewish Architects – Jewish Architecture?, Petersberg 2021.
- Keßler, Katrin; Ulrich Knufinke, Alexander von Kienlin and Annette Weber (eds.): Synagogue and Museum, Petersberg 2018.
- Brämer, Andreas, Mirko Przystawik and Harmen H. Thies (eds.): Reform Judaism and Architecture, Petersberg 2016.
- Keßler, Katrin and Alexander von Kienlin (eds.): Jewish Architecture – New Sources and Approaches, Petersberg 2015.

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IBEA | Institute for Building Climatology and Energy of Architecture

Mission Statement

The IBEA teaches and researches at the interface of passive and active building components in architecture. The aim of our applied building research is to develop strategies for districts and buildings that create sustainable living space with robust construction methods, simple low-tech systems and holistic approaches.

RESEARCH

Energy systems
Buildings and their functionality and operational performance are closely linked to the energy and supply infrastructure systems they are embedded in. Therefore, one of the Institute's research focuses and interest lies on the analysis, design and optimization of energy systems in buildings as well as on urban levels. With rising shares of renewable energies, also innovative storage opportunities like hydrogen become more important and are investigated to meet the challenges of volatility and decentralization. Ultimately questions of appropriate sustainability metrics in the building sector and their development are subject of research.

Low Tech / High Tech
The low-tech approach is a response to the increasing demands on building and comfort for users in recent decades, which have often been met with complex and component-rich building technology. While the term low-tech is often misunderstood as no-tech one of the institutes main interests is to research not only how much technology a building and its users need but also how active and passive compounds can collaborate to archive holistic building strategies for durable and sustainable buildings.

Materials
The building physics of a building is often considered separately from the materials used, since it is not uncommon for energy considerations to use only one characteristic value in the form of thermal conductivity to assess the thermal quality. However, by exploiting the passive potential of alternative natural building materials, it is possible to achieve not only thermal improvements but also optimization in the area of indoor humidity in combination with reduced climate effectiveness. In this context, layer-reduced constructions respective the effort of refinement of the materials used, are in the focus of minimizing ecological burdens and furthermore increasing resource and energy efficiency, as well as the possibility of reuse and recycling .

Living Lab
The real laboratory as an experiment enables the interaction between planners, builders and users with the object of investigation and links social and scientific learning and reflection processes. We do not collect specific knowledge under abstract laboratory conditions, but abstract knowledge under specific conditions of use. Thereby we consider the conception and production as well as the monitoring/ measurement as part of the Living Lab and as a source for insights and knowledge.

At the IBEA institute we installed various self-constructed clay walls equipped with different water-based systems for heating and cooling our rooms. The passive contribution to the preservation of the indoor climate by means of clay building materials is measured.

IBEA | Prof. Dipl.-Ing. Elisabeth Endres, BDA

Researcher's Career

- Member of Managing board at Hausladen Engineering LTD
- Member of the Advisory Board of HafenCity GmbH, LDR Berlin and Climate Advisory Board of the State Capital Munich
- EuroTec Fellow at DTU Kopenhagen, Center for Indoor Environment and Energy
- Scientific Assistant at Institute of Building Technology and Climate Responsive Design, TU Munich
- Teaching Fellow at Universidad Técnica Federico Santa Maria, Chile
- International workshops with Tsinghua University, Beijing and UTA University in Quito
- Scientific Assistant at Institute of Building Climatology and Building Services, TU Munich
- Member of DGNB, BDA, Bundesstiftung Baukultur, Aktiv+ e.V.
- Study of architecture at TU Kaiserslautern and TU Munich

Funding
BBSR Forschungsförderung ZukunftBau, Bingo Umweltstiftung, Deutsche Bundestiftung Umwelt, DBU, FNR, GEWOFAG, RECUN, BMWK

TEACHING

Increasing requirements on building performance for the energy efficiency and the development of methods brings a high complexity in the processes of planning and construction as well as for the users in operation. Therefore, the research area of the institute analyses the development of general solutions in architecture and urban planning that need to be carried out in order to achieve the necessary climate targets by implementation of recyclable constructions and the reducing of technical complexity.

Our aim is to teach the students the basics of building physics and technical building equipment as well as holistic thinking for integral planning in order to apply them in drafts and student research projects. Some of the research questions are explored through the use of digital tools as well as through 1:1 experiments in the institute's laboratory and in the urban context in collaboration with students. The range of courses can be taken up by students of architecture and environmental engineering.

Publications

- Endres, E., "Hightech versus Lowtech oder einfach robust? ", in: Bundesinstitut für Bau-, Stadt- und Raumforschung (BBSR) im Bundesamt für Bauwesen und Raumordnung (BBR) (ed.), Lowtech im Gebäudebereich, ISBN 978-3-87994-300-5, 2020.
- Endres, E., Franke, L., Sen Dong, M., Neubert, L., "Parameters to design Low-Tech Strategies", in: PowerSkin Conference Proceedings, TU Delft/TUM (ed.), ISBN 978-94-6366-125-6, 2019.
- Santucci, D., Tucci, F., Endres, E., Hausladen, G., "Smart urban districts: Dynamic energy systems for synergic interactions between building and city", in TECHNE - Journal of Technology for Architecture and Environment, (1), 92-102, 2018.
- Endres, E., Santucci, D., Tucci, F., Battisti, A., "Energie: Bedrohung oder Chance für die Europäische Stadtlandschaft? Energia: occasione o minaccia per il paesaggio urbano europeo? ", TUM (ed.) ISBN: 9783941370685, 2015.
- Endres, E., Hausladen, G., "Lowtech ist die neue Hightech", in: architese01/2015 Swiss Performance 15, ISBN 978-3-03862-224-6, 2015.
- Hausladen, G., Endres, E., 2012. "Zukünftige Energiekonzepte für Gebäude und Stadtquartiere", Rundgespräche der Kommission für Ökologie, Bd.41 "Die Zukunft der Energieversorgung", S. 63-71, Verlag Dr. Friedrich Pfeil München, 2012.

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IBEA Gender.Ing. | Gendered and intersectional aspects of technology and space

Mission Statement

Technology and space, though seemingly "neutral" and "for all", are socially constructed and inherently intertwined with cultural understandings of gender roles and relations. We work at the intersection of Social Sciences, especially Gender Studies, and various fields of Engineering with the overall aim to disclose, discuss and deepen our knowledge on the interdependencies of society and its inequalities on the one hand and spatial structures, technical artefacts as well as engineering, design and planning processes on the other. Ultimately, we aim to contribute to a more reflective and less discriminatory academia and society.

RESEARCH

Gender-sensitive planning and the reconciliation of care work and paid work
Everybody cares and is cared for – the spatial structures of our cities, however, are not designed to meet the needs of people giving or receiving care. Many have their origins in a fordist functional separation of space that does not accommodate the highly complex and time-consuming everyday geographies of care. Within this field, we are especially interested in researching the possibilities and impossibilities of reconciling paid employment and care in newly planned suburban residential areas. We advocate for new ways of collaborating between institutions on a variety of scales and sectors with the aim to foster gender equality and develop partnerships that prioritise and strategically include care into spatial planning and urban/regional economics. We are part of a DFG-funded research cluster on "New Suburbanisms" coordinated at the University of Kassel.

Spatial and environmental justice
Environmental and resource protection, adaptation to climate change and social as well as gender justice are closely intertwined. Environmental impacts are unevenly distributed, as are recreational opportunities, especially in densely populated areas. In a research project completed in 2021 on the significance of residential green spaces for families and children during the Covid 19 pandemic, we have shown that attractively designed and stimulating open spaces strengthen children and, to a certain extent, balance out their parents' financial and time resources. In the future, we plan to investigate more broadly the impact of the design and distribution of infrastructure on society and its most vulnerable groups.

Communication and participation processes in engineering, architecture and urban planning
Communication between engineers and the users of their products is important in all areas of engineering – from building equipment to renewable energies, from public transport to apps and digital devices – and improves the acceptance and usability of engineering products. In recent years, participatory processes such as citizen science have gained significance. Still, certain groups of people – those with care responsibilities, but also children and young people, people with disabilities, with limited language skills or from non-academic backgrounds – are often underrepresented in these processes. Researching and evaluating gender-sensitive and intersectionally informed means of communication and participation that contribute to the quality of engineering research are therefore particularly important to us.

IBEA | Prof. Dr. Henriette Bertram

Researcher's Career

- Assistant Professor for gendered and intersectional aspects of technology and space at TU Braunschweig
- Post-Doc researcher and coordinator of research cluster "New Suburbanisms", Universität Kassel
- Lecturer in Social Sciences, Georg-August-Universität Göttingen
- PhD in Urban Planning at Universität Kassel
- Researcher and lecturer at the Chairs of Urban and Regional Economics and Urban Renewal and Planning Theory at Universität Kassel
- Erasmus exchange programme, Universidad Complutense de Madrid
- Degree in Cultural Sciences, Europa-Universität Frankfurt (Oder)
- Voluntary Service at Centre for Global Education, Belfast

Funding
DFG, British Academy/Alexander von Humboldt Foundation, Federal State of Hesse

TEACHING

In teaching, we aim to encourage students to think independently and to develop their own questions about the interrelatedness of society and the respective engineering fields. Learning content is geared towards specific real-life, social or design-related issues that complement students' professional skills and has a relevance for their personal development as well as their future employment. We emphasise the practise of writing in order to develop ideas, strengthen argumentation skills and focused communication. Our teaching is based on students' prior knowledge and their degree background and informed by our own and other scholars' recent research. A recurring teaching format is the seminar "Gendered aspects of technology and engineering" that is open to students of all engineering degree programmes. We work closely with Faculties 4 (Mechanical Engineering) and 5 (Electrical Engineering, Information Technology, Physics) of TU Braunschweig.

Publications

- Bertram, Henriette (2024, forthcoming): Gendersensible Planung in aktuellen Stadterweiterungsprojekten – Vereinbarkeit von Erwerbs- und Sorgearbeit jetzt auch in Suburbia? In: Altrock, Uwe/Bertram, Henriette/Krüger, Arvid (Eds.): Stadterweiterung in Zeiten der Reurbanisierung – Neue Suburbanität? Transcript.
- Bertram, Henriette (2023): Planning Gender-Inclusive Cities: Tactical and Strategic Support for the Reconciliation of Paid Work and Care Work. In: Čamprag, Nebojša/Uğur, Lauren/Suri, Anshika (Eds.): Rethinking Urban Transformations. A New Paradigm for Inclusive Cities; pp. 169-186.
- Bertram, Henriette/Hennecke, Stefanie/Münderlein, Daniel/Niesen, Johanna (2022): Children's outdoor play and leisure time during the first weeks of the Covid-19 pandemic. In: Sharp, Briony; Finkel, Rebecca; Dashper, Katherine (Hrsg.): Transformations and Transgressions: Explorations of 'Restricted' Leisure during COVID-19. London: Routledge.
- Bertram, Henriette/Hennecke, Stefanie/Million, Angela/Niesen, Johanna: Basteln, Matschen, Toben während der „Corona-Krise": Die Bedeutung von wohnungsnahem Freiraum für Kinder und Familien während der Frühphase der Pandemie. In: sub\urban Zeitschrift für kritische Stadtforschung.
- Bertram, Henriette (2017): Schattenorte in Belfast. Stadterneuerung nach dem Karfreitagsabkommen. Bielefeld: Transcript.

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IDAS | Institute for Design and Architectural Strategies

Mission Statement

Architectural Design is creative exploration. It requires the observation and evaluation of the environment and its history in order to develop strategies for mastering current and future challenges. It requires the empathatic understanding of the collective as well as the courage of the individual to develop architectural strategies in the search for alternative ecological, functional, formal, technical, artistic and cultural possibilities.

RESEARCH

Hortitecture
This term refers to the exploration of synergies between architecture and plant material in order to understand their impact on the environment and architectural design. We have established a network of international experts, including architects, artists, biologists, and ecologists, and have hosted a series of symposia at the Technical University of Braunschweig. We aim through these multidisciplinary exchanges, we aim to encourage critical reflection, enhance knowledge transfer, and expand expertise in implementing these synergies into architectural design.

Reet reloaded
Thatch construction, which utilizes the reed plant as a primary element, has a long history in any region where this plant grows near shallow water. This has resulted in a strong interdependence between architecture and ecology in these areas. Our research explores new ways to interpret and utilize this traditional material, examining its formal and technical capabilities, cultural-historical significance, and ecological potential. We have organized workshops to design case study architecture for slow tourism, for example, compostable cabins in the dunes.

Existing building as the resource
architectural design is no longer based on „tabula rasa thinking“ of modernism, rather it is challenged by impacts of the climate crisis and the abundance of sealed surfaces created by buildings and infrastructure. The role of architects is to balance the problems and potentials of existing buildings. The strategies here are varied: existing building structures are expanded, reconnected and reprogrammed through addition, superimposition, displacement and penetration. Our challenge as architects - beyond design and supervision of construction as a service - is to present ideas that activate and connect program and people. Pro-active moderation requires a high level of architectural expertise and the sensitivity to understand buildings as a cultural and material resource.

Building Knowledge
Schools are vital institutions for any society, serving not only as places for knowledge transfer, but also for experimentation and communication. School buildings significantly influence students' perceptions of the built and natural world. In an era of digital transformation, it becomes increasingly important to have physical spaces that provide sensory experiences and foster social interaction and communication. Our design studios focus on the creative exploration of school buildings, in collaboration with the Department of School Pedagogy and General Didactics. School buildings initiate the relationship to architecture - they shape the life of future generations.

IDAS | Prof. Almut Grüntuch-Ernst

Researcher's Career

- Member of the Academy of Arts Berlin since 2016
- Professor at TU Braunschweig, Head of the Institute of Design and Architectural Strategies since 2011
- Consultant to the City of Munich 2010-15
- Commissioner of the German Contribution for the Venice Biennale, 2006
- Grüntuch Ernst Architects, Berlin - office with Armand Grüntuch since 1991
- Assistant teacher at Hochschule der Künste, Berlin 1993-97
- Architectural Association, London (DAAD-Scholarship) 1989-90
- Internship Alsop & Lyall, London 1988-89
- Architecture and Urban Development at Universität Stuttgart 1985-91

TEACHING

A wide spectrum of design studios addresses future challenges that permeate the entire teaching and research program. Our aim is to engage students in the complex and contradictory nature of future challenges while enabling them to use architectural design as a method of materializing a project and actively promoting optimism. We base the studio work on observations and video documentations, lectures, readings and references in order to discuss criteria for the design work. We organize workshops, invite interdisciplinary experts and build up a direct connection with possible future clients in order to enable students to present ideas and projects beyond the academic framework. We have established an international network with partnering universities for the purpose of collaborative studio work in order to address global challenges and understand intercultural perspectives.

Publications

- Grüntuch-Ernst, Almut; Grüntuch, Armand (Hg.): Wilmina; DISTANZ, Berlin 2022
- Grüntuch Ernst Architects - Based in Berlin, Protagonisti Series of Books,Editions de l'Arca International, Monaco 2019
- Grüntuch-Ernst, Almut; IDAS TU Braunschweig (Hg.): Hortitecture – The Power of Architecture and Plants, Jovis, Berlin 2018
- Ruby, Ilka; Ruby, Andreas (Hg.): Grüntuch Ernst Architekten – Dialoge/Dialogues, DISTANZ, Berlin 2013
- Grüntuch-Ernst, Almut; Grüntuch, Armand (Hg.): Arch+ 180 – Convertible City, Exhibition catalogue for the German pavilion - Venice Biennale 2006, ARCH+, Berlin 2006
- Feireiss, Kristin; Commerell, Hans-Jürgen (Hg.): Grüntuch Ernst Architekten – Urban Upgrade, Strategies of urban densification, Exhibition catalogue, Aedes, Berlin 2006
- Feireiss, Kristin (Hg.): Grüntuch Ernst Architects – Points of Access, Prestel Verlag 2004

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IEB | Institute of Building Design

Mission Statement

Designing is a constant tightrope walk between intuition and knowledge, a creative process ranging from integral consideration to individual interpretation. Reducing it to a rational planning process and limiting it to the comprehensible is bound to fail, since designing is always an artistic process as well.

RESEARCH

IEB
We are a group of people who are on the road together. On the road to discover something new time and again. It is the secret of the arts to always start all over again and again. We do have many questions and a few answers. But most of all, we experience, how teaching at TU Braunschweig is a source of great joy and energy in our daily lives. The joy in architecture is our reason for gatherings and festivities. Through conversations, workshops, travels, guest lectures and moments that speak into our lives, we provide space for creativity. We are learning from each other.
We love people!

Symposia
We consider architecture as an interdisciplinary art, which thrives not only through its own insights, but rather by the collective gain of knowledge through the exchange of new perspectives. Within the framework of symposia as „convivial gatherings“, we want to face the responsibility of our work together. We aim to learn from each other, and with each other.

Research
We are concerned with the creation of new, innovative and demand-oriented housing models as a contemporary response to social developments. The shift away from the classic family model toward more single-person households due to demographic change, but also changing lifestyles, confront us with new challenges.
How did we use to live? How are we living now? How do we want to live in the future? Is it possible to integrate architectural research and practice? What are contemporary typological solutions that address changing living situations? Our seminars, in-depth studies and research projects focus on questions like these.

Travels
To really understand and study architecture, traveling is essential. Excursions and field trips are an important additional part of the design courses. We consider ourselves to be architectural nomads. Always in search of our roots. We may study architecture at universities. We certainly acquire knowledge there, but being an architect is above all a question of seeing and imagining. It is a matter of attentively searching and „nomadically“ going through life.

IEB | Prof. Dan Schürch

Researcher's Career

- Architect FH / REG A; Member SIA, BSA, BDA NRW and Architekten-kammer Hamburg
- since 2020 Full Professor at TU Braunschweig, Head of the Institute for Building Design (IEB)
- since 2007 Duplex Architekten, Zu-rich / Düsseldorf / Hamburg / Paris
- 2007-2009 Research Assistant with Prof. Markus Peter, in the field of construction and design, at ETHZ
- 2001-2007 Work with Marcel Meili, Markus Peter Architekten, Zurich
- 2000 Internship at DRFTWD, Amsterdam
- 1997-2001 Architectural Studies at Technikum Winterthur
- 1992-1996 Apprenticeship as a Structural Draughtsman at H.R. Berger, Zurich

TEACHING

Drafting means searching, thinking and making. With the aim to discover something new by working on models and sketches, processes are triggered and things become visible that, without visual support, would remain hidden. In our work at the Institute for Design and Building Design we focus in the drafting of buildings which ever typology it might be. Beginning in the third semester, the spectrum extends through initial design exercises, standing drafts and various design formats to the master's thesis.

Lectures
Complementary to our design courses, we offer various additional learning opportunities. These are e.g. lectures that complement the teaching and take place in an informal setting, both in terms of time and location.
These so called „Learning Lunches“ take place during the lunch break in a relaxed atmosphere. In collaboration with invited guest lecturers from a variety of disciplines, a wide range of topics are addressed throughout each semester.

Publications

- innen nah am fenster tag, Editor: Anne Kaestle, Dan Schürch, Graficdesign: Ludovic Balland, Typography Cabinet, Basel, 164 pages, 16 x 24 cm, Own publishing house, 2015, ISBN 978-3-86859-454-6
- Duplex Architects – Rethinking Housing, Editor: Ludovic Balland, Nele Dechmann, Authors: Hubertus Adam, Marc Angélil, Nele Dechmann, Anne Kaestle, Andreas Ruby, Caspar Schärer, Dan Schürch, Philip Ursprung, Niklas Maak, Günther Vogt, Language: English, German, 416 pages, 23 x 30 cm, Park Books, 2021. ISBN D 978-3-03860-229-3, ISBN EN 978-3-03860-230-9

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IEX | Institute for Experimental Architecture

Mission Statement

The Institute for Experimental Architecture sees itself as a laboratory where students can explore and apply new ideas and experimental approaches to design tasks in order to find solutions to today's social, spatiotemporal, economic and environmental problems and challenges.

RESEARCH

Introduction in Designing:
In the first year of study, five supervised exercises lasting several weeks are worked on. Under the headings of manifesto, composition, genius loci, spatial sequence and light spaces, these initially focus on partial aspects of design. These are finally brought together in a small building design. In this way, students are introduced to the complex field of design from different angles. By working on and presenting the exercises, they will also learn initial drawing, model building and presentation techniques.

Introduction in Drawing:
In the form of weekly lectures and exercises, students are introduced to the basic skills of freehand drawing, sketching, and descriptive geometry, in addition to the theoretical and historical foundations of drawing in architecture. Techniques of building and architectural analysis are practiced, which can be used to break down a building into its architectural elements. Using the drawing and representation techniques practiced, analytical, interpretive drawings can be produced. Through repetition and analog production in different modes of representation and scales, students train their two- and three-dimensional imagination.

Lecture Series:
The lecture series "Architektonisches Denken im 20. und 21. Jahrhundert" introduces important persons, works and positions of architectural production of the last 125 years. It is a compulsory part of Introduction in Designing. During the lecture, the students draw along the photographs and drawings shown in the form of speedsketches.

IEX | Prof. Berthold Penkhues

Researcher's Career

- Member: Architektenkammer Hessen AKH, Nr. 10508 since 1989, Bund Deutscher Architekten, BDA, Deutscher Werkbund, DWB
- Since 1994 Full-Professor, Technische Universität Braunschweig, Director IEX Institute for Experimental Architecture
- 1989 –1994 Assistant Prof., University Kassel, Department of Architecture
- Since 1989 PENKHUES ARCHITECTS, Kassel
- 1986 – 1989, Design- Architect Frank O. Gehry, Los Angeles
- 1985 DAAD scholarship for the US of America
- 1985 California Fellowship (Scholarship from the State of California)
- 1984 - 1986 University of California, Los Angeles, UCLA, Master of Architecture, M Arch
- 1980 Internship Office Prof. Josef Kleihues, Dülmen/Rorup, Germany
- 1976 – 1984 University Kassel: Diplom- Ingenieur in Architecture, Dipl.-Ing. 1981, Diplom- Ingenieur in Urban Design, Dipl.-Ing. 1984

TEACHING

We understand architecture in its genesis, its direct experience and in its theoretical reception as manifoldly determined and determining. Accordingly, design logic does not exist for us as a rigid set of rules, but as a complex system in the field of tension between technical knowledge, historical contexts, sociological factors, personal experiences and aesthetic intentions. In the concrete formulation of our task, we therefore distance ourselves from a pure "theory of form". Rather, the development of individually defined approaches to architectural work is the focus of our teaching. Starting from simple observations up to detailed analyses of everyday or special phenomena, the students develop a personal positioning in space and time, which are to be connected with the functional requirements and aesthetic objectives and to be communicated with adequate means of expression.

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IKE | Institute of Construction Design, Industrial and Healthcare Building

Mission Statement

The IKE regards itself as a think tank that places emphasis on the exploration and implementation of innovative methods, technologies and theories in architecture at all scales. Dedicated research groups along with a network of specialists exchange ideas on building the framework for the interdisciplinary research activities of the institute, focusing on the fields of industrial and healthcare building.

RESEARCH

Industrial Building
Head of research: Michael Bucherer
The IIKE holds core expertise in investigating typological and constructive aspects of industrial and functional building, as well as industrial construction. Recently, focus has been placed on the increasingly complex requirements and influential factors of industrial building. In several research projects, the institute has successfully collaborated on research partnerships with specialists from the fields of plant design, city planning, business management and building services engineering, as well as key players from the private sector. In this way the institute is able to offer expert advice to the industry.

Urban Factory: This interdisciplinary research project investigates the symbiosis of cities and industrial production under the aspect of resource efficiency. It aims to develop an innovative, interactive knowledge base that can be used by all key players involved in maximizing integration potentials.
OI BAU: The initiation of planning requirements for complex building projects is analyzed and tools are developed that determine the decisions in the early phases of design.

Architecture for Health
Head of research: Dr. Wolfgang Sunder, Jan Holzhausen
The biggest challenge in the health sector is to achieve a balance between the best possible medical care and associated costs. The aspect of hospital construction has been identified to play a key role in establishing an equilibrium. The transfer of highly efficient planning and construction methods utilized in everything from industrial buildings to health care buildings is another research focus of the institute.
In various research projects related to this matter, the IIKE has researched ways to optimize the planning process, to develop new building structures and to provide a higher level of infection protection in hospitals. Successful collaborations with hospital operators and healthcare companies have been established in the process, working jointly on various innovative research projects, research contracts and reports.

HYBAU: The aim of this research project is to optimize construction types, from materials to methods in construction, as well as functional processes, in order to create a safer hospital environment under the aspect of hygiene.
KARMIN: Investigations on the influence of architecture and design on the occurrence of infections, design and construction of a two-bed room in the normal care as a prototype.
HYFLY: Effective strategies to control and manage pathways of pathogens in aviation, development of infection-safe mastering and acute planning of airports.
EKOS: Development of a new concept of an insolation unit to ensure the medical care of life-threatening diseases in hospitals.
BIPROC: Development of a classification system for structural infection prevention based on new epidemiological studies.

This side: Pandemic Research Center, design: Reuven Zweigel 2017

Opposite side: ME Transit, Erin Nies 2017

IKE | Prof. Carsten Roth

Researcher's Career

- Member of the Freie Akademie der Künste in Hamburg
- Visiting professor for Design at the Universität Kassel
- Leader of his own studio in Hamburg
- Fulbright scholarship at Virginia Polytechnic Institute in Blacksburg and Alexandria/USA
- Study of architecture at the Academy of Fine arts in Vienna
- Study of architecture at Technische Universität Braunschweig

Funding
BBSR, BMBF, BMWI

TEACHING

As one of three institutes at German architecture faculties that engage in industrial building, the Institute for Industrial Building and Constructive Design (IIKE) of university professor Mag. Arch. M. Arch. Carsten Roth holds core expertise regarding urbanistic, typological and structural key aspects of industrial building and industrial site development.

The institute places emphasis on the exploration and implementation of innovative methods, technologies and materials in industrial building and the prefabrication in building construction. The transfer of highly efficient planning and construction methods utilized in industrial building to health care buildings is another research focus.

For both, research and teaching, the institute maintains long-standing cooperations with partners in the industry. Research partnerships in the fields of plant design, city planning, business management and building services engineering enable the IIKE to develop and execute various research projects based on interdisciplinary collaboration.

Publications

- Roth C, Dombrowski U, Fisch N, Holzhausen J, Knöfler P, Riechel C, Sunder W: Zukunft.Klinik.Bau. Strategische Planung von Krankenhäusern. Springer Vieweg Verlag Wiesbaden, 1. Auflage 2015, 212 Seiten
- BBSR Zukunft Bauen: Forschung für die Praxis, Band 13, Bauliche Hygiene im Klinikbau, Bonn, Februar 2018, S.54-69
- Roth C, Dombrowski U, Sunder W, Riechel C (2013): Zukunftsfähige Gebäudestrukturen und Planungsorganisation von Krankenhäusern. In: Das Krankenhaus 2013, 2, S. 170-174
- Sunder W, Holzhausen J, Dreßler I, Stiller A (2016): Bauliche Hygiene: Mit Architektur und Design gegen multiresistente Erreger. In: das Krankenhaus 108 (12), S. 1130–1132
- Juraschek M, Bucherer M, Schnabel F, Hoffschröer H, Vossen B, Kreuz F, Thiede S, Herrmann C (2018): Urban Factories and Their Potential Contribution to the Sustainable Development of Cities. In: The 25th CIRP Conference on Life Cycle Engineering, Procedia CIRP, 69, S. 72–77

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IKON | Institute for Construction

Mission Statement

Building construction examines all architectural actions from the perspective of their moment of realization. It is evident that without innovations in architectural construction the buildings of the future will remain impossible to create. This is the point where practice, learning and research have to collectively reposition themselves in order to recalibrate structural design processes. In the shift from the doable to the desirable, already in the development process the solution lies in cooperatively combining the experimental, the fundamental and the digital with ecological ideals so that a meaningful whole emerges.

RESEARCH

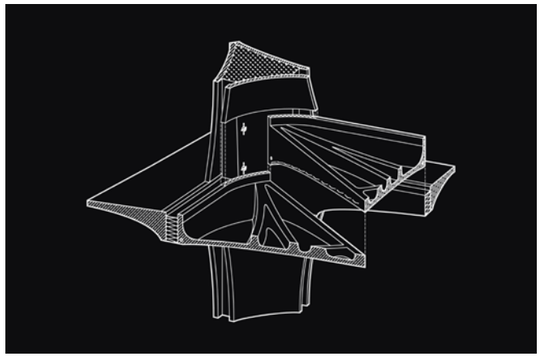
Designing in a contemporary manner means using the criteria of planetary boundaries as a basis for the conception of an architectural project. We have to understand the complex processes behind the production of a construction and their effects on our environment. At the Institute of Construction / IKON, we address research topics dealing with new methods for responsible design and their influence on our architectural language.

Constructive Disobedience
Constructive Disobedience focuses on methods for constructive experimentation and knowledge production through singular and particular architectural projects. A conference in September 2022 invited architects, engineers, manufacturers and craftspeople to present a specific insight into their constructive experiments and to engage in exchange. The aim is to find instructions for action - dispositivi - on how we can enable constructive experimentation from the core of the profession, understand it methodically, establish it as design research and thus bring it into recognition academically and on the building site.

Birch Bark Building Material
The temporary pavilion in Weimar - realized by Prof. Blocksdorf in 2021 - serves as an epistemic artefact for the investigation of the physical properties of birch bark as a building material. Monitoring results allow the development of new construction typologies with bark materials. Birch bark performs functions such as moisture regulation, sealing or weather protection.

Breathable Constructions
Breathable Constructions aim to explore the potential of the hygrothermal properties of ecological building materials. Based on an analysis of the building stock in Germany, strategies for the transformation and supplementation are developed and constructive alternatives to conventional construction methods are identified. The interaction of structural and building climate parameters is the focus of the considerations.

Explorative Teaching & Additive Manufacturing
Explorative teaching breaks with common and standardized design teaching methods. It promotes the interaction of technology and design and transfers individual technical inventions into a coherent architectural construct. In cooperation with the Institute of Structural Design, ITE, design methods on additive manufacturing were investigated and led to the production of collaborative demonstrators for the AMC TRR 277 research project. Explorative teaching will be integrated in upcoming design studios, searching for a new symbiosis of ecological materials and digital fabrication.



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IKON | Prof. Helga Blocksdorf

Researcher's Career

- since 2021 Full Professor and Director of the Institute for Construction / IKON
- 2022 International Conference Constructive Disobedience at TU Braunschweig in collaboration with Katharina Benjamin and Matthias Ballestrem
- 2021 Guest Professor for Constructive Design at Bauhaus-University Weimar
- since 2019 PHD-candidate
- program for design-based doctorates (PEP) at Technische Universität Berlin
- 2013 Founder of Helga Blocksdorf / Architektur, Berlin
- 2007 - 2012 Scientific Assistant at the Chair for Design and Construction, Prof. Ute Frank, TU Berlin

TEACHING

IKON prepares the knowledge base for the materialization of a responsible architecture. In "Building Construction I & II", "Architecture & Construction" and "Constructive Project", methods, concepts and skills for constructive design are taught in the first 5 semesters of the Bachelor program. Master's programs, on the other hand, focus on developing new perspectives on architectural solutions, such as explorative design. The studios intend to transform the classical design method in favor of a material- and fabrication-oriented approach that leads to true sustainable architectural conceptions.

Publications

- Blocksdorf, H.; Dörfler K.; Hack N. (Hrsg.), (2023). From Additive Manufacturing to Architecture, TU Braunschweig.
- Blocksdorf, H.; Barckhausen, S.; Beilby, R. (Hrsg.), (2023). PERSONÆ - Konstruktive Charaktere im analytischen Licht zeitgenössischer Entwurfskriterien, TU Braunschweig, Institut für Baukonstruktion.
- Blocksdorf, H. (2023). Kommentar in Ballestrem, M. (Hrsg.); Gasperoni, L. (Hrsg.), Epistemic Artefacts – a Dialogical Reflection on Design Research in Architecture, AADR, Spurbuchverlag. B
- Blocksdorf, H., Barckhausen, S., Beilby, R. (Hrsg.), (2021). IN SITU EX SITU – eine grafische Analyse zwischen Konstruktionsprozess und Ausdrucksform, TU Braunschweig, Institut für Baukonstruktion.
- Blocksdorf, H. (Hrsg.) (2021). Winter 20/21 – Über die Textilität von Brettsperrholz, Bauhaus-Universität Weimar, Fachgebiet für Konstruktives Entwerfen.
- Blocksdorf, H. (Hrsg.) (2012). adreizehn 2008-10, TU Berlin, Fachgebiet Entwerfen und Baukonstruktion.
- Blocksdorf, H. (Hrsg.) (2011). EKLAT - Entwerfen und Konstruieren in Lehre, Anwendung und Theorie, TU Berlin, Fachgebiet Entwerfen und Baukonstruktion.
- Blocksdorf, H. (Hrsg.) (2008). adreizehn 2007-08, TU Berlin, Fachgebiet Entwerfen und Baukonstruktion.

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ILA | Institute of Landscape Architecture

Mission Statement

Landscape architecture is a unique non-verbal communication medium for conducting dialogues about our built and natural environment. Designing characteristic places capable of endowing identities is one of the central duties of (landscape) architecture intending to offer viable and aesthetically appealing places in which people can live. We have to discuss new points of reference and models for tomorrow's open spaces.

RESEARCH

Recombinations: Developing landscape hybrids with an antithetical leitmotif as an expression of total creation which is linked to the idea of nature – this is the main focus of our landscape architectural work. We do research on the hybridization of space and atmosphere and develop interfaces between productive and reproductive spaces.

Sustainable Chile: We maintain partnerships with Chilean universities to discuss and develop tools and approaches for sustainable urban developments in South American contexts at all urban scales from object to citywide concepts.

Urban Biodiversity: The flora and fauna of Central European cities has long received little attention; nature was sought after outside the cities, in the countryside or in distant regions of the world. We focus on urban contexts and develop structures for wildlife architectures and analyze requirements for evolving habitat structures.

City of the Future: Whether it be climate change, social inequality or scarcity of resources – the challenges facing our society are great. We are part of the new strategic research project at our university discussing and developing principles and models of sustainable urban development.

Landscape for Architects: The design of landscapes requires a holistic approach but also in- depth specialist knowledge. In teaching and publications, however, the perspective of the generalist and concrete aspects of design are often neglected. "Landscape for Architects" is a design manual that is as comprehensive as it is practical and as holistic in its concept as it is lucid in detail. It presents a series of "questions" illustrated by abstract schematic drawings along with "answers" in the form of analytical drawings of case studies that aim to inspire creative reflection and exploration in the reader's own design process.

This side: Landscape for Architects – The 5 trilingual volumes – Building, Landscape, Park, Qualities, Use – together compromise more than 1000 pages.

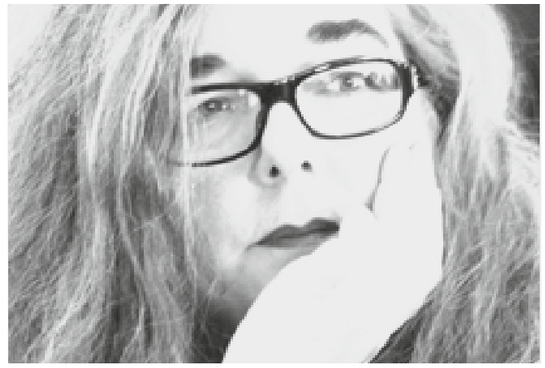
Opposite side: Exhibition view „Eins.Getrennt.Vereint" St. Thomas-Church, Berlin.

ILA | Prof. Gabriele G. Kiefer

Researcher's Career

- 2015-2013, Dean of the Faculty of Architecture at the TU Braunschweig
- 2013-2008, Member of urban advisory council City of Salzburg
- since 2012, Jury member for the Villa Massimo-Scholarships
- since 2008, Teaching in Valdivia and Santiago de Chile, Chile
- since 2002, Professor at the Technical University of Braunschweig, Institute of Landscape Architecture
- since 1990, internatonal juries and lectures activities
- 1989, Foundation of planning office BÜRO KIEFER
- 1992-1987, research associate at the TU Berlin , Department of landscape architecture
- 1987-1979, Studies at the Technical University of Berlin, Department of landscape architecture

Funding
DAAD, BUND, City of Braunschweig, BS | Energy, local municipalities



TEACHING

Most of our environment - landscape and city - consists of open space. Open or public space shape the image and atmosphere of a city just as much as its high-rise buildings. The clear boundary between the building and the outside space, between inside and outside, is becoming increasingly blurred. This interlocking creates hybrid spaces; the landscape is no longer just the space around the building, but the building increasingly becomes part of the landscape. In recent years, landscape architecture has increasingly turned out to be the engine of urban development. Today, no architectural and urban planning project can be carried out without open space planning. In order to sensitize architecture students to this, the focus of our teaching is not only on design projects but also on the analysis of existing projects. Knowledge of open space planning and the timeline of urban developments is therefore a necessary component of architectural teaching.

Publications

- Endres, E., Kiefer, G., Köbberling, F., Schneider, T.: Reallabor Hagenmarkt; TU Braunschweig; 2022
- Kiefer, G., Neubauer A.: Landscape for Architects I Landschaft für Architekten I Paisaje para arquitectos; Birkhäuser (Hrsg.); 2020
- Kiefer, G.: Armut, Ästhetik und Stadt.Architektur In: Grüne Reihe 117; Erich Fleischer Verlag (Hrsg.); 2017
- Kiefer, G.: Strategies for Optimizing Urban Resources - (Bio) Diversity of Public Space In: ISG Magazin; Internationales Städteforum in Graz (Hrsg.); 2016
- Kiefer, G.: Die Kehrseite der Schönheit – Die Vorstadt Salzburgs ist einer Kulturstadt nicht würdig In: ‚Frei Raum Szene Salzburg' Tagungsband, Magistrat Stadt Salzburg (Hrsg.); 2010
- Kiefer, G.: Wie Phönix aus der Asche In: Learning from Duisburg Nord; TU München, Prof. Udo Weilacher (Hrsg.); 2009
- Kiefer, G.: Stilisierte Leere und Möglichkeiten In: Architekturforum Zürich (Hrsg.): Garten des Poeten G59; 2009
- Kiefer, G.: Digital Presentations for Landscape Architecture Competitions In: Digital Design in Landscape Architecture 2008 - Proceedings at Anhalt University of Applied Sciences (Hrsg.); Verlag Wichmann; 2008
- Kiefer, G.; Schröder, T. (Hrsg.): Büro Kiefer – Recombinations; Ulmer Verlag; 2005

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IMD | Institute of Media and Design

Mission Statement | Exploring the information space

The Institute of Media and Design _IMD, deals with crossmedia interdependence of architectural design and new media processes. Engagement in architecture on computerbased information is at the center of the institute's profile. Due to proceeding mediatisation and digitalisation of nearly all aspects of living, architecture, too, will growingly have to cope with the process-related and inscenatorical dimensions of design spanning from simulation of any form of behavior, whether social or physical, up to conceiving virtual and hybrid worlds.

RESEARCH AND TEACHING

Research and proving in the field of computer-based methods take a key role, since digital media are especially capable of processing and organizing affluently growing amounts of information in egalitarian ways. The conventional, solely object-related, diagramming and hence also analysis of buildings owes its privileged position solely to the fact that dynamic aspects such as movement, climate, light, acoustics, varying usages and such are just planable to a certain extent. Computer programs do not only combine these aspects but complete each other vice versa.

During the design process information alters the output, which again changes the input. Thus, the design process is constantly subject to transformation. Diagramming of this process loses its representative function and becomes part of a serial time-space exploration. Integration of dynamic, alterable aspects demand new diagramming instruments which are to be ascertained and systemized. This incorporates two-dimensional notations, charts, scores etc. as well as three-dimensional models and four-dimensional 'time-based' simulations, animations, VR/AR scenarios and all imaginable hybrid modes.

IMD | Prof. Matthias Karch

Researcher's Career

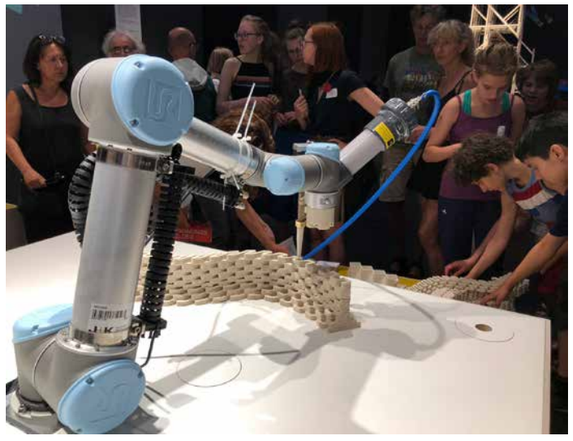
- Since 2003 Professor and Head of the IMD _Institute of Media and Design
- 1995-2003 Professor at the BAUHAUS in Dessau, University of Applied Sciences Dessau
- 1995 Founder and owner of OZA_Studio for Architecture and Scenography, Berlin
- Since 1990 about 80 Scenography and Stage Design realisations in Germany, Austria, Switzerland and USA
- 1987-90 Stage Design assistant at the Burgtheater Wien, Austria Coworkings with Luciano Damiani, Karl-Ernst Herrmann, Achim Freyer, Claus Peymann
- 1984-87 Study of Stage Design under Prof. Achim Freyer, University of Arts, Berlin
- 1983-84 Coworker architectural office of Hans Kollhoff and Arthur Ovaska, Berlin
- 1983 Diploma in Architecture, Technical University Berlin

Funding

BMWF, Stiftung TOPOGRAPHIE DES TERRORS Berlin, Stiftung DEUTSCHE KINEMATHEK Berlin, KISD Cologne, STO-Stiftung Essen, Braunschweigischer Hochschulbund, MEDIAN Kliniken, Berlin

The Institute's Teaching and Research topics are:

- Organisation and design of the information space
- Parametric and generative design processes
- Digital fabrication, digital manufacturing
- Robotics
- Interactive architecture and design
- Scenic spatial design, design of atmospheres
- Development of hybrid spaces, virtual realities, augmented realities
- Design of events (social, physical, statistical…)



Publications

- Bildhafte Räume, begehbare Bilder _Virtuelle Architekturen interdisziplinär Herausgeber:innen: Kassandra Nakas und Philipp Reinfeld, Architektur der Medien – Medien der Architektur, Band 2
- MIT WEIT GESCHLOSSENEN AUGEN _Virtuelle Realitäten entwerfen Herausgeber:innen: Carolin Höfler und Philipp Reinfeld, Architektur der Medien – Medien der Architektur, Band 1
- IMAGE-BASED ARCHITECTURE, Fotografie und Entwerfen Dr. Philipp Reinfeld, Wilhelm Fink Verlag, 2018, ISBN 978-3-7705-6316-6
- MARSCHORDNUNGEN, Das Reichsparteitagsgelände in Nürnberg / March Formations. The Nazi Party Rally Grounds in Nuremberg, Katalogband zur gleichnamigen Ausstellung / catalogue to the exhibition, hg. v. / ed. by Carolin Höfler and Matthias Karch, Berlin 2016, 180 S. ISBN 978-3-00-052654-1
- BIGGER THAN LIFE. Ken Adam's Film Design, hg. von Deutsche Kinemathek, Kerber Verlag 2014, 26,00 x 22,50 cm, 208 Seiten, 100 farbige und 93 s/w Abbildungen, Hardcover, Sprache: Deutsch. Texte u. a. von: Daniel Libeskind, Carolin Höfler, Matthias Karch. ISBN 978-3-7356-0027-1
- IN-FORM, Catalogue to the Exhibition of the Institute of Media Design of the Technische Universität Braunschweig, Braunschweig, raumLABOR at the University of Arts, 2012
- FORM UND ZEIT, Computerbasiertes Entwerfen in der Architektur, Prof. Dr. Carolin Höfler, Humboldt-Universität zu Berlin, 2011

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ISE | Institute of Urban Design

Mission Statement

Urban Design as we understand it is a balancing act between idealism and pragmatism, creativity and structure, future visions, and current needs. It is also a long-term process with a huge social, environmental, economic, and energetic impact. We therefore aim to create visions and designs für sustainable future cities.

RESEARCH

In our research projects we work together with cooperating municipalities and institutes as well as students to create visions and concepts for future-oriented urban design. Our focus lies on transformative research and experiment which closely relate to the local urban design practice and its challenges. In the past years ISE conducted transformative research projects on several urban areas, particularly on such aspects as design scenarios, energetic strategies, and participatory processes. Among our past projects is for instance the research on transformation of the TU campus in terms of sustainability and resilience, conducted in a cooperation with several institutes of the TU as well as external partners and founded by the Ministry of Economy and Energy (EnEff Campus). In cooperation with the municipality of Wolfsburg and with the support of the German Federal Environmental Foundation we explored urban transformation ideas of the local community and published a catalogue of urban transformation strategies (Zukunftsraum Wolfsburg).

In cooperation with the city of Braunschweig we contributed to the strategic development and participatory design of the area of the former industrial railway zone (BAHNSTADT). Another cooperation with the city of Braunschweig is the co-creative planning process for a new mixed-use area at and around the so-called Campus North (Campus Nord): Since 2016 we coordinate and codesign the experimental project “CoLiving Campus”, aiming to offer an urban platform for local innovation and to build bridges between science and the city.

ISE | Prof. Uwe Brederlau

Researcher’s Career

- CEO, Institute of Urban Design
- Chair, Johannes Göderitz Foundation
- Member of the Deutsche Akademie für Städtebau und Landesplanung (DASL)
- Member of the Deutscher Werkbund (DWB)
- Office BREDERLAU + HOLIK, Architecture and Urban Design, Braunschweig
- Full Professor for Urban Design since 2000
- Assistant Professor at the Institut für Städtebau, Wohnungswesen und Landesplanung, Leibniz Universität Hannover
- Office of Urban Design and Architecture, 1993-2010, Hannover
- Meisterschüler at the Hochschule für Bildende Künste (HBK) Braunschweig
- Study of Architecture at the Leibniz Universität Hannover

Funding
BMWi, DBU, BMBF

TEACHING

We aim to share our passion for urban design with architecture students because we understand buildings as parts of a large interconnected system that interact with their built, social, and natural environment. In his lectures, Prof. Brederlau discusses theoretical and historic background of urban design with bachelor students. We also run software and method-focused workshops in order to offer our students tools for a successful design process, starting from early semesters. In our design courses we work on development scenarios for urban areas and often cooperate with city municipalities in order to explore practice-oriented challenges. Through cooperation with urban design institutes from different universities and cities we take part in a student competition that allows a broader discourse and exchange for students in their advanced bachelor and master semesters (Johannes-Göderitz-Preis). In seminars we explore urban interventions, critical urbanism as well as planning instruments and methods. We regularly document the output of the design courses and seminars in digital and printed publications, which are partially available on our website as well in the institute and the university library.

Publications

- Brederlau, U., ISE - Institut für Städtebau und Entwurfsmethodik (Hrsg.) (2020): Grenzen des Bauens Folgen der Massenproduktion von Stadt und die Alternativen: Seminar 2019-20.
- Brederlau, U. Holik, F., Jureit, A., Lubahn, S., (Hrsg.) (2019): Zukunftsraum Wolfsburg. Strategien zur Umsetzung der Energiewende im städtischen Kontext.
- Brederlau, U-, ISE - Institut Für Städtebau Und Entwurfsmethodik (Hrsg.) (2018): CoLiving Campus – Johannes-Göderitz-Preis 2018.
- Brederlau, U., Jureit, A., Lubahn, S., Nestler, J. (2015): CAMPUS+STADT: Analysen, Strategien und Szenarien für die stadträumliche Entwicklung der Technischen Universität Braunschweig.

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ISU | Institute for Sustainable Urbanism

Mission Statement

‘Sustainable Urbanism.’ These two words represent the biggest challenge and the biggest hope of our generation. ISU explores, teaches, co-designs, engineers, and promotes all strata of sustainable development in the context of worldwide urbanisation. ISU is a think tank, design and research laboratory committed to promoting science and scholarship in an international, inter- and transdisciplinary setting.

RESEARCH

The Institute for Sustainable Urbanism (ISU) is researching and developing tools and strategies for more sustainable cities and communities. Its progressive ideas in linking architecture, urban design and planning to a multitude of other disciplines, such as environmental science, traffic engineering, politial science, psychology and data sciences, within the context of a common ground – sustainable cities and urban regions – has generated new holistic approaches towards a more science-based urban design. Extending the limits of its own discipline, ISU engages in multidisciplinary joint projects, gaining scientific and data-based knowledge of the complexity of the urban world and redefines the understanding how the structure, design and shape of the built environment is key towards sustainable urbanism.
With the Urban Digital Lab (ISU-uLAB) ISU builds up a state of the art competence center for multidisciplinary urban research. It uses the digital realm to transgress the disciplinary limits of architecture, urban design, and planning in its pursuit to transform and develop future cities.

ISU projects typically evolve around central research themes:
Space as Resource: Space is a valuable and limited resource that must be properly managed and used efficiently to optimal effect, just like other resources of limited supply. As we face what the United Nations call the Urban Age, this idea will become increasingly true and imperative.

City in Society: Cities are where people are and people meet. At the heart of good urban design is public space, accessible and open to multiple users and uses, connecting individuals, functions, and spaces, but increasingly also formats of democratic participation in developing cities and urban regions. Urban design, both formal and process-oriented, has a role in supporting sustainable lifestyles, such as by understanding users’ needs, providing environmentally friendly forms of mobility, or by enabling innovative recreational or economic activities.

Impossible Sites: Large, global-scale trends affect the local, urban-scale conditions. What was previously considered an uninhabitable or un-occupiable site, can, through a tilt in macropolitical, economic, environmental, or sociological forces, become again possible, and vice versa.
These forces produce particular observable and measureable phenomena that affect neighborhoods at the local scale, highlighting the inherent contradictions and excesses of globalisation and its neoliberal forces.

Urban-Rural Relations: Where the city stops, the country does not begin. Cities must be considered in a broader context, encompassing their larger footprints. Thus today cities must be managed in a context larger than their compact urban cores and downtown areas, but rather in terms of their hinterlands, water- and waste-sheds, their reaches of networks of transportation and human resources. Likewise, villages are not just remote, rural places, but also providers and consumers of various forms of urban capital. These new dynamics involve processes of proximity and distance between the city and the countryside.

ISU | Prof. Dr.-Ing. Vanessa M. Carlow

Researcher’s Career

- Architect and Planner, MAA, BDA
- since 2012: Full Professor; Head of the Institute for Sustainable Urbanism (ISU)
- since 2015: Co-speaker of ‘Future City’ research cluster of TU Braunschweig
- since 2014: CEO of Research Institute for Sustainable Urbanism RISU
- Visiting Professor: Cornell University, Architecture Art Planning AAP, Ithaca, USA (2017); Stuckeman School of Architecture, Pennsylvania State University, USA (2013)
- 2012: PhD at Royal Danish Academy of Fine Arts Copenhagen, Centre for Planning
- 2012: Founder of COBE Berlin GmbH
- 2005: Co-founder of COBE, Copenhagen, Denkmark
- 2003-2004: MA Urban Management at Erasmus University Rotterdam, University Copenhagen, Ca Foscari Venice, Antwerp University, Auton. University Barcelona
- 1995-2002: Study of architecture and urban design, Berlin & Delft

Funding: BMBF, AA, MWK, DAAD, public and local authorities, Alexander von Humboldt Foundation, Robert Bosch Foundation, VW Foundation, et al.

TEACHING

Architects and urban designers – in collaboration with specialists from a multitude of other disciplines – balance their individual creativity with manifold impacting interests to shape our built environment. In an ever more complex world, our profession needs to reflect on design strategies, considering other disciplines’ knowledge and perspectives, to develop sustainable future cities and liveable spaces for all.

An in-depth exploration of specific questions and current discourses is necessary in order to train students’ perception and understanding of complex processes embedded in urban development. In order to prepare students for the challenges of sustainable urban development, ISU has developed a series of innovative teaching formats that pursue a cooperative, multidisciplinary approach.

ISU follows the concept of integrating practice-oriented methods and cooperation into teaching. In the sense of problem-oriented teaching, we bring our students into contact with real-world questions, places and actors to foster a two-directional transfer of knowledge. ISU is using digital media and tools in pursuing the strong interdisciplinary integration of teaching and research.

Publications

- Carlow VM, Schmidt V, Neumann D, Mumm O. 2019 (forthcoming). Projektakademie Ländlicher Raum – ein kooperativer, inter- und transdisziplinärer Ansatz in der Städtebaulehre. In: Kauffeld S, Othmer J (eds.). Innovative Lehre. Heidelberg: Springer.
- Carlow VM. 2018 (forthcoming). Stadt für Alle. In: Pahl KA, Reuther I, Stubbe P, Tietz J (eds.). Potenzial Großsiedlung – Zukunftsbilder für die Neue Vahr. Berlin: Jovis, 118-133.
- Carlow VM. 2017. The transformation of the London Green Belt. In: Voigts E, Pleßke N. (eds.) 2017. Transforming Cities. Heidelberg: Winter a&e
- Carlow VM. 2017. Perspektiven einer wissensbasierten, kooperativen und offenen Stadtentwicklungspolitik. In: Bundesinstitut für Bau-, Stadt- und Raumforschung (BBSR) im BBR (ed.). 2017. Stadt im Fokus – 10 Jahre Nationale Stadtentwicklungspolitik. Bonn: BBSR.
- Neumann D, Sedrez M, Carlow VM. 2016. Scenarios for sustainable development of Lower Saxony. Metapolis. In: Schröder J, Carta M, Ferretti M, Lino B (eds.). 2016. Territories. Rural-Urban Strategies. Berlin: Jovis, 258-265.
- Carlow VM, ISU (ed.). 2016. Ruralism. The Future of Villages and Small Towns in an Urbanizing World. Berlin: Jovis.
- Carlow VM. 2016. LIMITS. Space as Resource. Berlin: Jovis.
- Carlow VM. 2015. Space as a resource: West Berlin’s impossible sites. In: Sustainable Development and Planning. WIT Press/ Computational Mechanics, 251–261.
- Carlow VM, Hong YW. 2015. Adapting design tools to produce site-specific solutions: three Projects. In: Wang F, Prominski M (eds.). Urbanization and Locality: Strengthening Identity and Sustainability by Site-specific Planning and Design. Heidelberg: Springer, 359-383.

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ITE | Institute of Structural Design

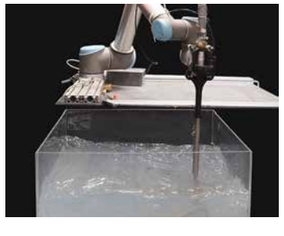
ITE | Prof. Dr. Norman Hack

Researcher's Career

- Since 2022: Professor for Digital Construction at the Institute of Structural Design, TU Braunschweig
- 2018-2022: Junior professor for Digital Building Fabrication at the Institute of Structural Design, TU Braunschweig
- 2018: PhD with distinction, Chair of Architecture and Digital Fabrication (Gramazio Kohler Research), ETH Zurich
- 2012-2014 Research assistant, Future Cities Laboratory, Singapore-ETH Centre for Global Environmental Sustainability, Singapore
- 2012: Master of Architecture with distinction, Architectural Association (AA), London
- 2009-2010: Architect in the Digital Technologies Group at Herzog & de Meuron, Basel
- 2009: Diploma in Architecture with distinction, Vienna Technical University, Vienna

TEACHING

Architects must reconsider their approach to design, planning, and construction in response to the global climate crisis. Construction alone contributes to 8% of the world's CO_2 emissions and consumes 35% of all materials used worldwide. Digital construction processes can help address these challenges by integrating interdisciplinary knowledge and facilitating seamless digital information flow from design to execution. Robotic manufacturing and additive manufacturing, in particular, have the potential to contribute to these efforts. The professorship in Digital Construction focuses on reducing resource consumption by adopting a circular approach facilitated through digital design and fabrication processes. The research-driven learning approach emphasizes comprehensive digital skills for navigating future architectural contexts. Physical experimentation on a 1:1 scale and interdisciplinary collaboration are key components of this approach, which emphasizes a practice-oriented, material, and design-oriented approach to teaching.



Shotcrete 3D printing for material-efficient reinforced concrete componentsfor its design and potential and material efficiency

Publications

- N. Hack, H. Kloft, Shotcrete 3D Printing Technology for the Fabrication of Slender Fully Reinforced Freeform Concrete Elements with High Surface Quality: A Real-Scale Demonstrator, 2nd RILEM International Conference on Concrete and Digital Fabrication, Eindhoven, 2020
- N. Hack, I. Dressler, L. Brohmann, S. Gantner, D. Lowke, H. Kloft, Injection 3D Concrete Printing: Basic Principles and Case Studies, Materials. (2020)
- N. Hack, K. Dörfler, A.N. Walzer, T. Wangler, J. Mata-Falcón, N. Kumar, J. Buchli, W. Kaufmann, R.J. Flatt, F. Gramazio, M. Kohler, Structural Stay-In-Place Formwork for Robotic In Situ Fabrication of Non-Standard Concrete Structures: A Real Scale Architectural Demonstrator, Automation in Construction. 115, 202
- I. Mai, L. Brohmann, N. Freund, S. Gantner, H.Kloft, D. Lowke, N. Hack, Large Particle 3D Concrete Printing—A Green and Viable Solution. Materials 2021, Vol. 14, Page 6125, 14(20), 6125 (2021)
- Y. Xiao, N.Khader, A. Vandenberg, D. Lowke, H. Kloft, N. Hack, Injection 3D Concrete Printing (I3DCP) Combined with Vector-Based 3D Graphic Statics. RILEM Bookseries, 37, 43–49 (2022)

Awards

2018: ETH Medal for outstanding Doctoral Theses
2017: Concrete Innovation Award 2017, Tromsø
2016: SwissTechnology Award 2016, Basel
2014: Best Paper Award CAADRIA 2014, Kyoto
2011: Europan 11, Winner for Skien and Porsgrunn
2010: DAAD Scholarship for Architectural Association, London

ITE | Prof. Dr.-Ing. Harald Kloft

Researcher's Career

- Since 2020: Spokesperson of the DFG-funded Collaborative Research Centre TRR 277 Additive Manufacturing in Construction (AMC)
- 2015-2017: Dean of the Faculty of Architecture, Civil Engineering and Environmental Sciences, TU Braunschweig
- Since 2011: University Professorship for Structural Design and Head of the Institute of Structural Design (ITE), Faculty of Architecture, Civil Engineering and Environmental Sciences, TU Braunschweig
- 2007-2009: University Professorship for Structural Design, Faculty of Architecture, TU Graz
- 2002-2011: University Professor for Structural Design and Construction, Faculty A/RU/BI, TU Kaiserslautern
- 2002-2019: Co-Founder and Managing Director of the engineering practice "Office for Structural Design" (osd), Frankfurt a. M
- Distinction 'Deutscher Ingenieurbaupreis 2016', Award for the ETA-Fabrik project (osd)
- Balthasar-Neumann-Prize' 2014, Award for the LAV-Archive Nordrhein-Westfalen (osd)

TEACHING

Structures are an essential part of all architecture. The up-to-date digital technologies in planning and manufacturing create new possibilities in the design of structures as well as in the range of materials and construction techniques. However, the basic knowledge of structural design and engineering theories remain valid, regardless of the technologies used. More than ever, the design of resource-minimised structures that can be utilised for a long time and whose components can ideally be de-constructed and re-used later is an important contribution to environmental sustainability and climate protection. At the Institute of Structural Design (ITE), the basics of load-bearing structures (TWL) as well as the materials-based design and construction principles (TWE) are taught in the bachelor's degree programme. In the so-called "Konstruktives Projekt", the structural design is addressed as an integral part of the architectural design. Here, the philosophy is that the structural design is a separate, but not an independent design task: a structural system cannot be designed without an architectural context! In addition to the obligatory courses, the material-oriented design of structures is taught in research-related seminars and design projects in the Bachelor's and Master's degree programmes.

Variety of structural design models within the teaching course TWE

Publications

- H. Kloft, L. P. Schmitz, C. Müller, V. Laghi, N. Babovic, "Experimental Application of Robotic Wire-and-Arc Additive Manufacturing Technique for Strengthening the I-Beam Profiles", in: buildings, 2023, 13, 366
- M. Eschenbach, A.-K. Wagner, L. Ledderose, T. Böhret, D. Wohlfeld, M. Gille-Sepehri, C. Kuhn, H. Kloft, O. Tessmann, "Matter as Met: Towards a Computational Workflow for Architectural Design with Reused Concrete Components," in: Towards Radical Regeneration – Design Modelling Symposium Berlin 2022 (C. Gengnagel, O. Baverel, G. Betti, M. Popescu, M. Ramsgaard Thomsen, J. Wurm (Ed.), Springer International Publishing, pp.442-455
- D. Lowke, A. Vandenberg, A. Pierre, A. Thomas, H. Kloft, N. Hack, "Injection 3D concrete printing in a carrier liquid - Underlying physics and applications to lightweight space frame structures," Cement and Concrete Composites, 2021, 104169, ISSN 0958-9465
- V. Mechtcherine, R. Buswell, H. Kloft, F. P. Bos, N. Hack, R. Wolfs, J. Sanjayane, B. Nematollahi, E. Ivaniuk, T. Neef, "Integrating reinforcement in digital fabrication with concrete: A review and classification framework," Cement and Concrete Composites, 2021, 103964
- A. Baghdadi, M. Heristchian, H. Kloft, "Connections placement optimization approach toward new prefabricated building systems," Engineering Structures, 2021, 111648
- M. Schweiker, E. Endres, J. Gosslar, N. Hack, L. Hildebrand, M. Creutz, A. Klinge, H. Kloft, U. Knaack, J. Mehnert, E. Roswag-Klinge, "Ten questions concerning the potential of digital production and new technologies for contemporary earthen constructions," in: Building and Environment, 2021, 108240
- H. Kloft, H.-W. Krauss, N. Hack, E. Herrmann, S. Neudecker, P. Varady, D. Lowke, "Influence of process parameters on the interlayer bond strength of concrete elements additive manufactured by Shotcrete 3D Printing (SC3DP)," in: Cement and Concrete Research, no. 134, 2020
- H. Kloft, J. Oechsler, F. Loccarini, J. Gosslar, C. Delille, Robotische Fabrikation von Bauteilen aus Stampflehm, in: Deutsche BauZeitschrift. (2019) Nr. 7/8, S. 54-59

ITE | Institute of Structural Design

Mission Statement

Our goal is to explore the latest digital design and construction technologies, including additive manufacturing, robotics and augmented reality to create a more sustainable and circular built environment. By reducing material consumption and waste, we aim to enable sustainable building practices while exploring the impact of these technologies on architectural and structural design.

RESEARCH

Using digital tools our research investigates three core aspects of sustainable construction: reduce, reuse, and recycle. We aim to develop innovative computational design and fabrication methods to reduce material consumption, increase efficiency, and minimize the environmental impact of the construction industry.

Reduce

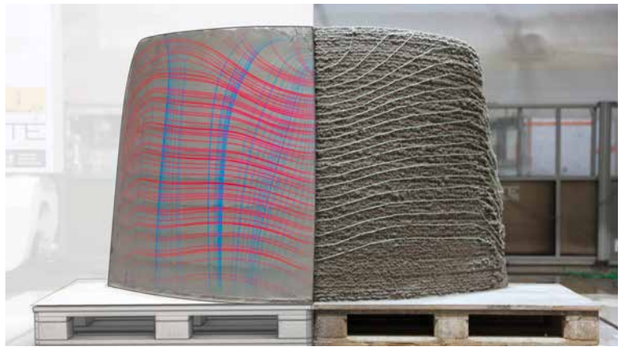
The "Reduce" focus area of research involves exploring data-driven and rule-based architectural design techniques, as well as artificial intelligence and evolutionary computation. The primary goal is to investigate new ways to design structures and buildings that use minimal building materials while still providing greater design flexibility. This area of research is supported by the development and testing of additive manufacturing techniques for construction on a 1:1 scale.

Reuse

The "Reuse" focus area aims on designing buildings for a circular economy, where components can be disassembled and reused. The architecture is designed for disassembly using durable and robust materials with reversible connections.

The research also includes digital pre-fabrication of components, mobile robotics, and augmented reality for in-situ assembly. We investigate hybrid structural systems and the use of salvaged as well as custom-printed parts. The research topics include integrative computational design frameworks, lightweight construction systems, digital fabrication of reusable components, robotic and augmented assembly strategies, structural and reversible connections, and digital databases.

Reduce: Through structural optimization and automated placement of fibre reinforcement the thickness of concrete elements can be significantly reduced



Reuse: Reinforced large-scale concrete components are digitally manufactured in a combinded process of SC3DP core printing, vertical cover layer printing and precise surface finishing by CNC milling

ITE | Institute of Structural Design

Team

Administration
Yonca Taube, Cecilia S. Ahumada, Meike Bährens

Researchers
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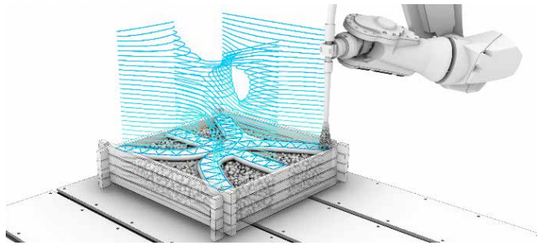
Additive Manufacturing with earthen materials
left: Sprayed Earth Additive Manufacturing; right: Robotic Rammed Earth

Recycle

The "Recycle" focus area aims to reduce the construction industry's waste production by upcycling construction waste into higher-grade construction products through digital fabrication. This research stream explores two strategies: additive manufacturing using materials like concrete, clay, plastic, metal, and glass, and robotic upcycling of building elements like bricks and timber using subtractive robotic fabrication techniques. Research topics include the development of new, higher-grade construction products, innovative fabrication techniques and process chains, and 3D scanning methods for precise geometric inspection. The focus area is closely linked to the other two focus areas, and primarily concerns materials and fabrication processeses.

Recycle: Large Particle 3D Printing: Using recycled aggregates and construction debris for upcycling into new construction elements



Recycle: Cutting of dry joint for reversible connections, applicable for salvaged as well as for newly printed structural elements

Research Projects (exclusive TRR 277 AMC projects)

- Rammed earth concrete: Combined, additive manufacturing of rammed earth and rammed concrete; Funding: BMBF
- ReMin - Joint project: Fertigteil2Punkto - Real-digital processchains for the extraction of installed concrete components forfurther use as finished components; Funding: BMBF
- WE! - GOLEHM: Mobile, robotic rammed earth: from laboratory to construction site production; Funding: BMBF
- Beyond 3D printing - A novel spatial printing technology for lightweight spaceframe concrete structures; Funding: VolkswagenStiftung
- Potential of additive manufacturing and performance in comparison to conventional in reinforced concrete construction; Funding: DBV - Deutscher Beton- und Bautechnik-Verein E.V.
- Next-generation additive manufacturing for material-efficient multi-storey buildings; Funding: BMBF
- Future Urban Coastlines – Individualized and Eco-Integrated Coastal Protection using Digital Technologies; Funding: DFG
- Large Particle 3D Concrete Printing Using Recycled Concrete Aggregates; Funding: BBSR
- Robot-supported production of recyclable wax formwork for sustainable geopolymer concrete components; Funding: BMBF

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AMC | Collaborative Research Center TRR 277 Additive Manufacturing in Construction

Mission Statement

The Collaborative Research Center Transregio 277 Additive Manufacturing in Construction (AMC) aims with its basic research to significantly shape the digitalization of construction. Within the levels of components, processes and materials, the AMC researches resource- and energy-efficient as well as sustainable, recyclable and digital construction. Through innovative 3D printing methods, materials, processes and optimized design are completely rethought.

RESEARCH

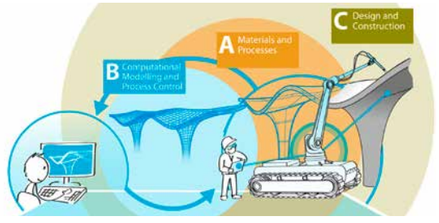
The AMC TRR 277 aims to examine Additive Manufacturing (AM) (3D printing) as a novel digital manufacturing technology for the construction industry in an interdisciplinary, cross-location research project. The two universities TU Braunschweig and TU Munich, pursue the novel manufacturing approach for the construction industry. Additive manufacturing can develop into a key technology for the digitalization of the construction industry. Complex research questions on materials, process engineering, control, modelling, design and construction are being investigated holistically by scientists from the fields of architecture, civil and mechanical engineering.

In Additive Manufacturing, the production of building components is achieved solely by a digitally controlled layer-by-layer material application, without mould making or forming processes. This approach represents a paradigm shift to the manual construction processes, which are characterised by traditional, predominantly craft-based techniques. As a result, productivity in the construction industry has stagnated for decades. In addition, these manual techniques foster a rather simple component design and thus inefficient use of materials.

Against the background of the enormous demand for resources in the construction industry, this methods of constructing contributes significantly to global CO_2 emissions.

The objective of the AMC is to explore the fundamentals for implementing Additive Manufacturing in Construction (AMC). Automated additive material application enables the construction of buildings with a high degree of design freedom and a resource-efficient use of materials. In order to fully exploit this potential, structural design, material behaviour and manufacturing processes must be fundamentally rethought and, above all, must interact.

Focus Areas A,B and C of the AMC and how they interact



TRR 277 AMC Summer School, Herrsching am Ammersee 2022

AMC | Collaborative Research Center TRR277 Additive Manufacturing in Construction

Funding
Funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) – since 2020 – Project number 414265976.

Spokesperson
Prof. Dr. Harald Kloft
Prof. Dr. Kathrin Dörfler

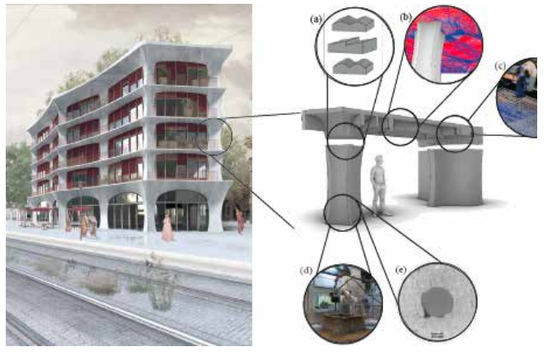
General Manager
Jeldrik Mainka

Administration
Cecilia S. Ahumada, Hastia Asadi, Meike Bährens, Yonca Taube, Janna Vollrath

RESEARCH BASED TEACHING

Additive manufacturing (AM) is an essential technology for the future of construction. To train and prepare students for the digitalized construction industry, topics of the TRR 277 AMC are incorporated into three teaching formats.
Firstly, the seminar “Applied Additive Manufacturing in Construction“, offered to students of architecture and civil engineering provided by ITE and iBMB consists of a theoretical and practical part, and teaches a fundamental knowledge of various additive manufacturing processes, materials development, testing and their practical application.
Secondly, the design course "From Additive Manufacturing to Architecture," investigated the impact of AM-methods as a design generator. In a joint design studio offered by TUM Professors Dörfler and Nagler as well as TUBS Professors Blocksdorf (IKON), Hack and Kloft (ITE) students develop AM-based housing projects in an urban context.
Thirdly, "Computational Design and Digital Fabrication," a cross-university seminar between TU Braunschweig, TU Munich and TU Delft included hybrid lectures in computational form finding, excursion to TU Delft and one-week robotic fabrication workshop at TU Braunschweig.

Shelltonics demonstrator: AM-section of building construction



AMC Focus Areas

- Focus Area A ‘Materials and Processes’ centres on the investigation of various materials and processes combinations for 3D-Printing. AM technologies include Particle-bed 3D printing techniques include selective cement activation (SCA), selective paste intrusion (SPI) for concrete, and selective laser melting (SLM) for steel which are being investigated. In terms of deposition techniques, extrusion 3D printing and shotcrete 3D printing for concrete, as well as wire and arc additive manufacturing (WAAM) for steel are being investigated.
- Focus Area B ‘Computational Modelling and Control’ considers the assigned digital feedback obtained by computational modelling and process control of all AM processes. The aim of focus area B is the development of novel models and efficient discretisation schemes for numerical simulation of material–process interactions relevant to additive manufacturing processes in construction.
- Focus Area C ‘Design and Construction‘ addresses the implementation of additive manufacturing in the process chain of design and construction. The interaction between digital models and physical objects connects the focus areas A and C. This focus area provides feedback to the A projects by investigating novel design techniques and structural optimisation as well as any information about building information modelling (BIM).

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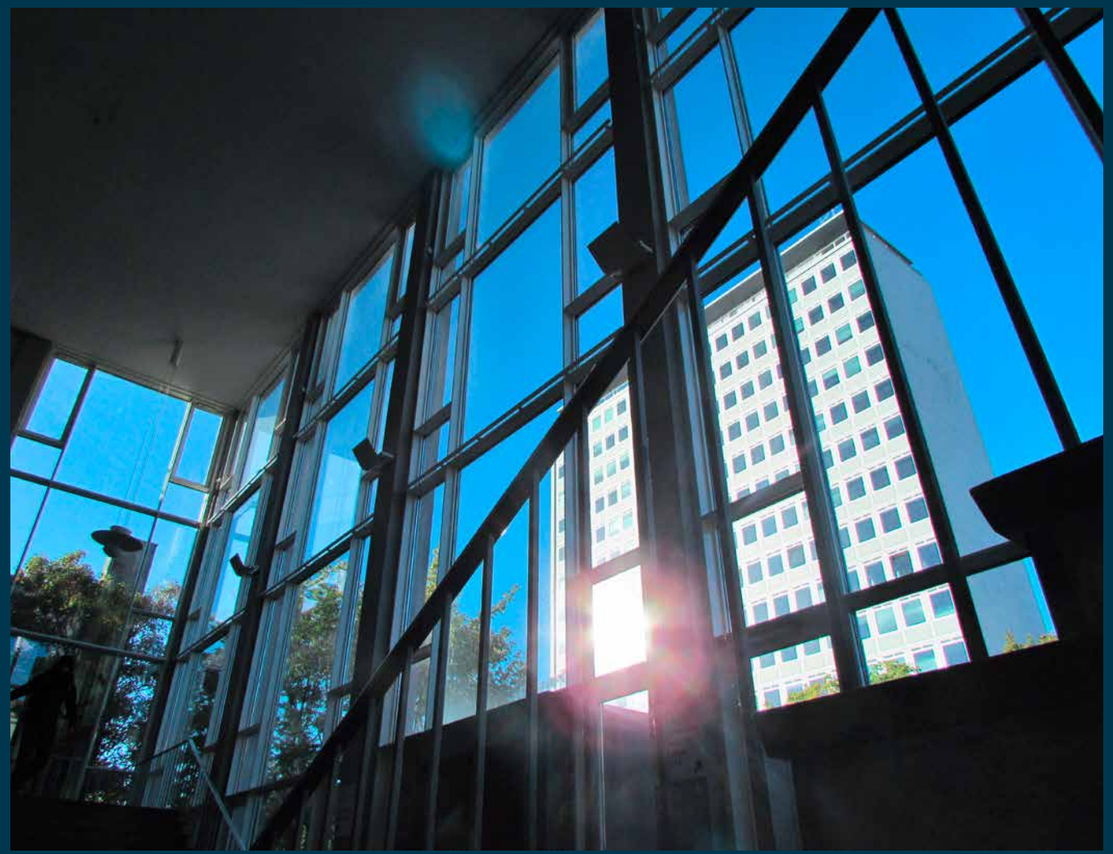


Civil Engineering and Environmental Sciences

IAM | Institute of Applied Mechanics

Mission Statement

We develop reliable and efficient computational methods that bridge the gap between length scales from nanometers to meters for solving multi-physics problems in conjunction with both 3D imaging and in-situ testing. Our activities span a broad range of applications, from porous media like concrete, rock, and soil, to cutting-edge energy storage materials.

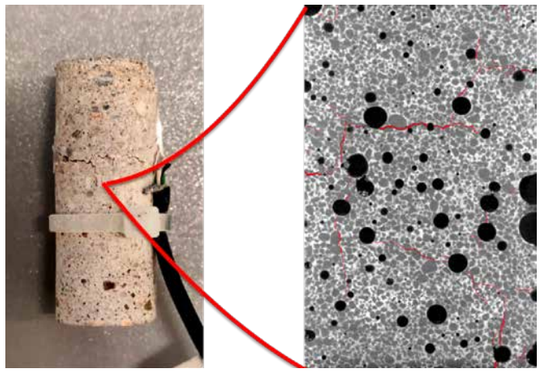
RESEARCH

At our institute, we are dedicated to developing advanced multi-physics models that enable us to describe and predict complex material properties. Our research is focused on developing strategies for solving multi-scale problems using cutting-edge techniques such as Computational Homogenization with Numerical Model Reduction. To support the accuracy of our models, we develop innovative setups for lab-experiments and combine 3D imaging using X-Ray Computed Tomography with in-situ testing.

Our applications of interest span a wide range of fields, from studying

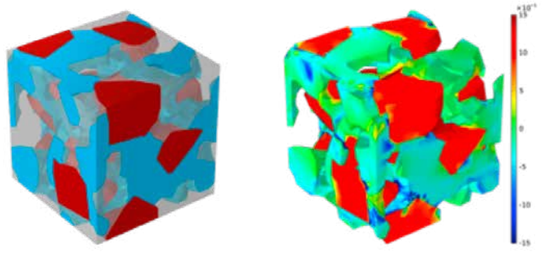
- transport and degradation processes in porous media such as concrete, porous rock, and soil, to
- process simulation of ShotCrete 3D Printing (SC3DP), as well as
- simulating coupled processes in batteries across multiple length scales.

Together with our collaboration partners, we are constantly exploring new avenues of research to tackle the most pressing challenges in engineering sciences, and our goal is to develop innovative solutions that will have a lasting impact on future research and industrial applications.



left: Crack propagation in concrete mortar after applying 16 freezing-thawing cycles.

below: Synthetic microstructure of a Li-ion battery cathode and volumetric expansion of LFP particles during battery charging.



IAM | Prof. Dr.-Ing. Ralf Jänicke

Researcher's Career

- Full professor in Applied Mechanics, TU Braunschweig, Germany
- Assoc. Prof. in Solid and Structural Mechanics, Chalmers University of Technology, Sweden
- Habiliation in Mechanics, Ruhr-Universität Bochum, Germany
- Elected as Junior Fellow of the North Rhine-Westphalian Academy of Sciences, Humanities, and the Arts
- Visiting Scholar, Chalmers University of Technology, Sweden
- Researcher at Institute of Computational Engineering, Ruhr-Universität Bochum, Germany
- Dr.-Ing. Saarland University, Germany
- Dipl.-Ing. In Materials Science, Saarland University, Germany

Funding: DFG, State Lower Saxony (MWK)

TEACHING

We aim to equip our students with the knowledge and skills necessary to succeed as engineers and researchers in their respective fields.

Our institute provides a diverse selection of courses tailored to Bachelor's and Master's level students in Civil and Environmental Engineering, Industrial Engineering, and the international Master's program in Computational Sciences in Engineering (CSE). Our course offerings include engineering mechanics, solid mechanics, computational mechanics, and related topics.

At the Bachelor's level, our courses serve as a foundation for future engineers. Students learn about engineering mechanics, including equilibrium principles, statics of rigid bodies, elastostatics, dynamics of rigid bodies, as well as concepts of computational methods and discretization techniques.

At the Master's level, we offer courses on both linear and nonlinear solid mechanics, providing students with an in-depth understanding of how to describe mechanical material behavior within a consistent mathematical framework. Additionally, we provide advanced courses on the Finite Element Method that equip our students to tackle nonlinear and coupled material behavior, multi-scale problems, and fracture propagation. To ensure a hands-on learning experience, all courses include computer labs.

Publications

- Tu, V., Larsson, F., Runesson, K., & Jänicke, R. (2023). Variationally consistent homogenization of electrochemical ion transport in a porous structural battery electrolyte. European Journal of Mechanics-A/Solids, 98, 104901.
- Ekre, F., Larsson, F., Runesson, K., & Jänicke, R. (2022). Numerical Model Reduction with error estimation for computational homogenization of non-linear consolidation. Computer Methods in Applied Mechanics and Engineering, 389, 114334.
- Bharali, R., Larsson, F., & Jänicke, R. (2021). Computational homogenisation of phase-field fracture. European Journal of Mechanics-A/Solids, 88, 104247.
- Pollmann, N., Larsson, F., Runesson, K., Lundgren, K., Zandi, K., & Jänicke, R. (2021). Modeling and computational homogenization of chloride diffusion in three-phase meso-scale concrete. Construction and Building Materials, 271, 121558.
- Kaessmair, S., Runesson, K., Steinmann, P., Jänicke, R., & Larsson, F. (2021). Variationally consistent computational homogenization of chemomechanical problems with stabilized weakly periodic boundary conditions. International Journal for Numerical Methods in Engineering, 122(22), 6429-6454.
- Jänicke, R., Larsson, F., & Runesson, K. (2020). A poro-viscoelastic substitute model of fine-scale poroelasticity obtained from homogenization and numerical model reduction. Computational Mechanics, 65(4), 1063-1083.

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IBB | Institute of Construction Engineering and Management

Mission Statement

The IBB combines a profound theoretical knowledge and practical experience concerning economical aspects of the construction industry as well as construction methods and management. Our goal is to integrate this competence in the fields of teaching, research and professional education. Hence, IBB regards itself as an institute in the interface of engineering and economic sciences.

RESEARCH

PS_EVA: The objective of this research project was to fully investigate and evaluate the experiences of building agencies with the use of external project managers for major building construction projects of the federal government. For this purpose data on the actual circumstances of the collaboration with external project managers as well as data on the contractual agreements were obtained in the form of a primary survey.

IHRaMoW: In order to contribute to the objective of low-cost housing construction, obstacles to the use of pre-fabricated room modules in housing construction were identified in the research project. The project was financially supported by the research initiative 'Zukunft Bau' of the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR).

OI+BAU: In cooperation with research partners from TU Braunschweig (IIM and IIKE) as well as partners from the private sector IBB analyzes and optimizes early project phases for the execution of complex construction projects. The project is financially supported by the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR) within the framework of the research initiative 'Zukunft Bau'.

Rima^{Bau}: Researchers from IBB support the working group 'risk management' that developed from the action program 'Reform Bundesbau' of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. The superior objective of the project is the development of an instruction manual for the risk management of building construction projects of the federal government.

IBB | Prof. Dr.-Ing. Patrick Schwerdtner

Researcher's Career

- Full Professor for Construction Engineering and Management, TU Braunschweig
- Partner of CEM Consultants®Prof. Wanninger + Comp. GmbH
- Head of Tender Division Major Projects, Bilfinger Hochbau GmbH, Frankfurt
- Visiting lecturer MBA Corporate Management Construction, FH Biberach
- Head of Contract Management, Bilfinger Hochbau GmbH
- PhD, TU Braunschweig
- Construction Manager, Bilfinger Hochbau GmbH, Frankfurt
- Dipl.-Ing. in Civil Engineering, TU Braunschweig
- Master of Science in Civil Engineering, Georgia Institute of Technology, Atlanta

Funding
BMUB, BBSR, HDB, Industry

TEACHING

The IBB imparts knowledge in Bachelor's and Master's programmes of Civil Engineering and Industrial Engineering with a specialisation in Civil Engineering as well as for interested students in the fields of Architecture and Environmental Engineering. The teaching concept of the IBB covers the phases of planning, organizing, process planning and execution of any construction project from a technological, economic and legal perspective. In addition to traditional methods and basic knowledge new technologies are integrated in the lectures, seminars and workshops (e.g. Building Information Modeling, Lean Construction and Industrial Production).

IBB has committed itself to convey skills and expertise that go beyond the requirements of later daily business and allow graduates to assert themselves in a constantly changing professional environment.

Publications

- Schwerdtner, P.; Kumlehn, F.: Anforderungen an baubetriebliche Bewertungen in Deutschland: Empfehlen sich Regelungsstandards für die Nachweisführung gestörter Bauabläufe? In: Verlag der Technischen Universität Graz (Hrsg.): Bauzeitermittlung im Soll, Sollte und IST: Beiträge zum Grazer Baubetriebs- und Bauwirtschaftssymposium vom 7. April 2017, S. 129 – 156
- Schwerdtner, P.: Risikomanagement im Bauwesen – eine kritische Bestandsaufnahme. In: Institut für Bauwirtschaft und Baubetrieb (Hrsg.): Risiken in Planung und Ausführung – Identifikation und Lösungsansätze: Beiträge zum Braunschweiger Baubetriebsseminar vom 17. Februar 2017. Schriftenreihe des IBB. Braunschweig: Institut für Bauwirtschaft und Baubetrieb (2017), Heft 61, S. 1-22
- Schwerdtner, P.: Berücksichtigung der Witterung bei der Angebotsbearbeitung. In: Institut für Bauwirtschaft und Baubetrieb (Hrsg.): Umgang mit Witterung bei Vertragsgestaltung und Baudurchführung: Beiträge zum Braunschweiger Baubetriebsseminar vom 26. Februar 2016. Schriftenreihe des IBB (2016), Heft 59, S. 45-62
- Schwerdtner, P.: Flexibel statt wasserdicht - Partnerschaftliches Vertragsmodell zur Einhaltung des geplanten Projektbudgets. In: Wanninger (Hrsg.): Die wirtschaftliche Seite des Bauens: Festschrift zum 60. Geburtstag von Professor Rainer Wanninger. Schriftenreihe des IBB (2010), Heft 50, S. 659-674
- Schwerdtner, P.: Anreizbasiertes Steuerungs- und Vergütungsmodell für Einzelvergaben im Hochbau (Dissertation). Schriftenreihe des IBB (2007), Heft 45

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IBHolz | Institute of Building Construction and Timber Structures

Mission Statement

The Institute of Building Construction and Timber Structures focuses on the investigation of spatial and planar structures from current and historical constructions. More challenges regard material behaviour, simulation of building physics and the preservation of existing structures.

RESEARCH

Research topics:

- Fatigue in Timber Structures
- Timber Adhesive Bonding
- Historic Timber Structures
- Building Conservation
- Roof Stacking
- Multi-Storey Timber Construction
- Renewable Resources
- Timber Frame Construction

Guide for Roof Stacking

This project is funded by the Forschungsinitiative ZukunftBau and aims for an extended addition of storeys to existing buildings in metropolitan areas by decreasing design efforts. Therefore a guideline is to be developed that provides the most important facts and parameters for designing and evaluating a Roof Stacking measure.

Development of a Loadbearing Theory for Timber Frame Constructions

In this project the development of an advanced shear field girder method in the plastic state of timber panel constructions is proposed. The advanced shear field girder method distinguishes from the basic model by considering joints in the ribs between all sheathing boards instead of continuous ribs. Hence, the model is reduced to a rigid body model with elastic-plastic bond and offers simple equations to measure the stress in the plastic state.

Fatigue Behaviour of Notches and Self-Tapping Fully Threaded Screws

This cooperation-project with the University of Stuttgart investigates the fatigue behaviour of notches and self-tapping fully threaded screws against the background of application as a connection in timber-concrete composite beams. Thus a safe and economic application regarding the relevant effects on fatigue is permitted. Especially shearing, extraction and the combination of both are reviewed and rules for dimensioning are deducted.

Investigation of the requirements and functional connection of components of ETICS

In this cooperation-project with Fraunhofer WKI the main physical properties of all components of an ETICS are determined and simulated in a numeric model. The numeric model shall be used to evolve single components according to the needed requirements.

IBHolz | Prof. Dr.-Ing. Mike Sieder

Researcher's Career

- Professor at TU Braunschweig, head of the Institute of Building Construction and Timber Stuctures
- Honorary professor at the TU München
- Interim professor at the Chair of Timber Structures and Building Construction, TU München
- Head of engineering of a company in the field of membrane structures and lightweight construction
- Authorised signatory and head of the department 'Building Physics' at the testing laboratory MFPA für das Bauwesen Leipzig GmbH
- Graduation: Dr.-Ing., Ruhr-Universität Bochum
- Scientific assistant at the Chair of Building Construction, Timber Structures and Building Physics, Ruhr-Universität Bochum
- Studies in civil engineering, Bauhaus-Universität Weimar

Funding
DFG, AiF, ZukunftBau (BBSR), DBU

TEACHING

The institute participates in the education of Industrial, Civil and Environmental engineers. In the bachelor's programme lectures on the subjects Building Construction, Form and Construction, Masonry Constructions, Building Physics and Timber Construction are held. In the master's programme, the focus on wooden constructions is consolidated with the subjects Timber Components and their Connections, Timber Structures, Design of Timber Structures, Prefabricated Timber Panel Constructions, CAD for Timber Structures, FEM for Timber Structures, Preservation of Wooden Buildings and Timber Adhesive Bonding. Following the contents of main lectures are listed. Other courses are part of modules contained in the main lectures, as specified in the underlying table.

BUILDING CONSTRUCTION I and II
Basic knowledge of the load-bearing capacity, serviceability and durability of constructions. Representations of structures. Technical terms and terminology. Dependence of form and construction, and influence on design.

MASONRY CONSTRUCTIONS
Behavior of masonry as construction material.
Verification of masonry constructions according to EC 6.

BUILDING PHYSICS
Basic knowledge of thermal insulation, moisture protection and sound insulation.

TIMBER CONSTRUCTION I
Design, calculation and evidence of simple timber constructions. For example a single-family house.

TIMBER COMPONENTS AND THEIR CONNECTIONS
Basic understanding of timber properties and their evidence: durability, load-bearing capacity and serviceability.

DESIGN OF TIMBER STRUCTURES
Design, calculation and evidence of small timber structures with increasing difficulty and complexity.

Publications and Patents

- Kessel, M. H.; Sieder, M.; Anheier, D.; Janßen, P. (2018): Floor panels with free edges - Extension of the shear field girder. In: G. Dill-Langer (Hrsg.), Timber: Bonds, Connections and Structures. Materialprüfungsanstalt (MPA) der Universität Stuttgart, pp. 271-288
- Sieder, M.; Niebuhr, P. (2018): Fatigue behaviour of CLT under in-plane shear loading. In: Brandner, R.; Tomasi, T.; Moosbrugger, T.; Serrano, E.; Dietsch. P. (Hrsg.): Properties, testing and design of cross laminated timber: A state-of-the-art report by COST Action FP1402 / WG 2, Shaker
- Sieder, M.; Niebuhr, P. (2017): Der Ermüdungsnachweis im Holzbau nach DIN EN 1995-2 Anhang A. In: Stahlbau, Holzbau und Verbundbau – Festschrift zum 60. Geburtstag von Univ.-Prof. Dr.-Ing. Ulrike Kuhlmann, pp. 333-340, Verlag Ernst & Sohn, Berlin
- Kessel, M. H.; Sieder, M.; Colling, F.; Janßen, P.: Erarbeitung eines Rechenverfahrens zur Berücksichtigung von freien Stößen bei der Bemessung von Deckenscheiben in Holztafelbauart (erweiterte Schubfeldtheorie). Abschlussbericht PraxisRegelnBau Nr. PRB-4.1 (2017), Initiative Praxisgerechte Regelwerke im Bauwesen e.V., Berlin (2017)
- Brandner, R.; Dietsch, P.; Dröscher, J.; Schulte-Wrede, M.; Sieder, M. (2017): Cross Laminated Timber (CLT) Diaphragms under Shear: Test Configuration, Properties and Design, Construction and Building Materials 147 (2017), pp. 312-327, Elsevier B.V., Amsterdam
- Kreuzinger, H.; Sieder, M.: Einfaches Prüfverfahren zur Bewertung der Schubfestigkeit von Kreuzlagenholz/ Brettsperrholz. In: Bautechnik 90 (2013) No. 5, pp. 314-316, Ernst & Sohn, Berlin

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iBMB | Institute of Building Materials, Concrete Construction and Fire Safety
Division of Building Materials

Mission Statement

Civil engineering structures need well-suited materials to fulfill their demands throughout their entire service life. Our mission is building materials research and teaching with special emphasis on cement based materials.

RESEARCH

Additive manufacturing for cement based materials
Automated additive manufacturing such as 3D printing or robot-assisted spraying of concrete is finding its way into construction industry. A central task in the development of these technologies is the optimal setting of the concrete formulation parameters such as the type and amount of the binder as well as additives, grain size, water content and optionally choice and dosage of further additives for controlling the rheological and setting properties. The concrete formulations have to meet the requirements regarding strength, density, density gradients, surface quality, dimensional accuracy and subsequent machinability resulting from very different applications.

Rheology
The prerequisite for the development of additive manufacturing technologies such as 3D printing or robot-assisted spraying of cement-based materials is the understanding of rheological fundamentals such as the knowledge of the flow and deformation behavior of multiscale cement-based materials. In the fresh state the cement-based materials are highly concentrated suspensions of predominantly inorganic particles in water. In addition to the wide range of particle sizes between about 100 nm and 30 µm and the high solids fraction up to 90%, a specific feature of these suspensions is the reactivity of cement and other binders. The aim is to gain a basic understanding of the relevant processes that shape the rheological properties of fresh materials. The key to this is a detailed understanding of the energetic and mechanical interaction of reactive and non-reactive particles and the aqueous phase.

Computed tomography
Strength and durability of cement-based materials are strongly influenced by the heterogeneous structure of the material. For closer investigations it is necessary to consider cement-based materials as heterogeneous material and to identify and characterize the reactive and non-reactive particles of the cementitious material. One of the most innovative technologies for detecting and describing the particle structure and for the characterisation of the particles inside cementitious materials is computed tomography, which can produce a three-dimensional scan of the material and the particles with high precision.

DBFL at ITE, Photo: ITE

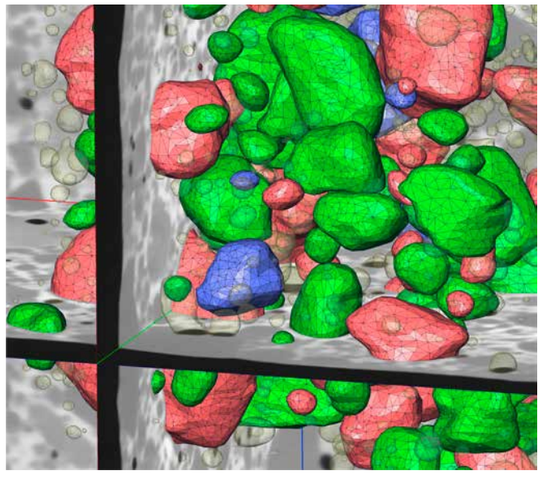
iBMB | Prof. Dr.-Ing. Dirk Lowke

Researcher's Career

- Professor of Building Materials, iBMB, TU Braunschweig
- Head of scientific division of the Civil Engineering Materials Testing Institute (MPA) Braunschweig
- Deputy chair of RILEM Technical Committee Digital Fabrication with cement-based materials
- Visiting research scholar, University of California Berkeley
- Head of concrete technology, Centre for Building Materials, TU München
- Research assistant at Centre for Building Materials, TU München
- Civil engineer, Hochtief building Dresden
- Dipl.-Ing. in civil engineering, TU Cottbus

TEACHING

Since the field of building material technology is large and changes rapidly, the fundamentals and methods have to replace facts in teaching. Essential fundamentals in the bachelor's programme for civil and environmental engineers as well as architects are the chemical and physical laws and relationships of the extraction, processing, binding, structure, states and properties of organic, metallic and mineral materials.
In the master's programme a specialisation to work and research areas in building material technology and building conservation is following, directed e.g. on chemical-physical damage mechanisms and their description in transport and reaction models or on material laws and their use in numerical simulations.



Publications

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- Lowke, D.: Thixotropy of SCC - A model describing the effect of particle packing and super-plasticizer adsorption on thixotropic structural build-up of the mortar phase based on interparticle interactions. Cement and Concrete Research 104(2018)2, pp. 94-104
- Lowke, D.; Gehlen, C.: The zeta potential of cement and additions in cementitious suspensions with high solid fraction. Cement and Concrete Research 95 (2017), pp. 195-204
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- Kränkel, T.; Lowke, D.; Gehlen, C.: Prediction of the creep behavior of bonded anchors until failure - A rheological approach. Construction & Building Materials 75 (2015) 1 , S. 458-464
- Stengel, T.; Lowke, D.; Mazanec, O.; Schießl, P; Gehlen, C.: UHPC mit alternativen Zusatzstoffen - Rheologie und Faserverbund. Beton - und Stahlbetonbau 106 (2011) 1, S.31 – 38

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iBMB | Institute of Building Materials, Concrete Construction and Fire Safety
Division of Concrete Construction

Mission Statement

The research at the Division of Concrete Construction aims at various aspects of construction, design, maintenance and strengthening of plain concrete as well as reinforced and prestressed concrete structures.

RESEARCH

Lightweight and Ecological Concrete Constructions:
The development of concrete constructions towards sustainability, energy efficiency and conservation of resources leads inevitably to shape- and material-optimized constructions. Within this research field, thin-walled components of UHPC and ultra-light, thin-walled, rod-shaped concrete hollow components are developed and tested. In order to simplify and industrialize the manufacturing process, thin-walled hollow components of previous research were produced within a spun concrete process.

Life-Cycle Engineering of Concrete Bridges:
Since existing road bridges have to carry increasing traffic loads, we develop alternative concepts for life-cycle investigations of existing bridge girders, focussing in particular on life-cycle phenomena such as cyclic load effects and fatigue. Beside experimental large-scale tests in our testing facilities, efficient numerical solutions and monitoring systems as well as mechanical models are developed.

Serviceability and Durability of Concrete Constructions:
Cracks in concrete have an important impact on the damage of the reinforcement due to corrosion and on maintaining the serviceability of concrete structures. In this regard, we are conducting tests on concrete beams and shell elements with conventional steel rebars as well as on components with alternative reinforcement forms such as micro-reinforcement and non-metallic rebars and grids. Our aim is to develop practical models and rules for crack width control.

Robust and Safe Concrete Constructions:
Nowadays, not only the ultimate load but also postfracture behavior and robustness are of high interest for reinforced concrete constructions. For this purpose, our research studies focus on robustness of structural components such as columns with large bar diameters and on columns made of UHPC and high-strength reinforcement.

iBMB | Prof. Dr.-Ing. Martin Empelmann

Researcher's Career

- Certifying Engineer for structural design
- Executive Director of the Civil Engineering Materials Testing Institute MPA Braunschweig
- University Full Professor for Concrete Construction at the TU Braunschweig
- Design Manager for Major International Projects, Hochtief Construction AG, Essen
- Award of the "Friedrich-Wilhelm Preis"
- Award of the "Borchers Plakette"
- Dr.-Ing. at the RWTH Aachen University, Institute of Structural Concrete
- Research Assistant at the Institute of Structural Concrete, RWTH Aachen University
- Award of the "Springorum-Denkmünze"
- Award of the "Hünnebeck-Preis"
- Study of Civil Engineering at the RWTH Aachen University, degree Dipl.-Ing.

Funding
DFG, BMWi, BMUB, PtJ, PRB, DIBt, DBV, BASt, DAfStb

TEACHING

Bachelor:
The aim of the bachelor courses is to prepare students to work as a structural engineer. Therefore, students get to know basic principles of the design and construction of reinforced concrete members, regarding the design for bending, shear and torsion at ultimate limit state as well as the control of cracking and deflection at serviceability limit state. Based on these principles, students gain the ability to design basic reinforced concrete elements like beams, slabs and columns. The bachelor courses are finalized in the bachelor's thesis, focusing the design and construction of a supporting structure of a high-rise building.

Master:
The master courses build upon the knowledge gained during the bachelor courses. Thus, further aspects of concrete construction in terms of sophisticated buildings, such as concrete bridges or industrial buildings, as well as advanced construction techniques, like prestressed concrete are discussed. Additionally, enhanced aspects of design and detailing as well as an outlook on innovations and applications in concrete constructions are part of the lectures. A new main focus is the integrated consideration of sustainability in all master courses. In addition to the structural assessment and rehabilitation of existing structures, this also includes resource conservation and CO_2 emission reduction. Finally, student research projects and master´s thesis deal with various topics either focused on advanced design and construction methods or dealing with current developments and research topics in the field of concrete construction.

Publications

- Matz, H.; Empelmann, M.: Butt Jointing of Prefabricated Concrete Columns. In: CivilEng 2022, 3(4), S. 1108-1125.
- Lanwer, J.-P.; Weigel, H.; Baghdadi, A.; Empelmann, M.; Kloft, H.: Jointing Principles in AMC - Part 1: Design and Preparation of Dry Joints. In: Applied Sciences 12 (2022), No. 9, 4138.
- Javidmehr, S.; Empelmann, M.: Shear Bond between Ultra-High Performance Fibre Reinforced Concrete Overlays and Normal Strength Concrete Substrates. In: Sustainability 2021, 13, 8229.
- Lanwer, J.-P.; Javidmehr, S.; Empelmann, M.: Statistical evaluation of compressive strength of ultra-high strength concrete. In: Beton- und Stahlbetonbau 116 (2021), Heft 6, S. 431-440.
- Empelmann, M.; Javidmehr, S.: Sustained load behaviour of normal-strength concrete. Beton- und Stahlbetonbau 115 (2020), Vol. 4, pp. 260-269.
- Empelmann, M.; Wichert, M.; Matz, H.: Splitting Failure of Grouted Joints between UHPC Segments. In: Bauingenieur 95 (2020), Heft 2, S. 55-63.
- Empelmann, M.; Matz, H.: Robustness of reinforced concrete columns. In: Beton- und Stahlbetonbau 114 (2019), Vol. 11, pp. 837-846.

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iBMB | Institute of Building Materials, Concrete Construction and Fire Safety **Division of Fire Safety**

Mission Statement

The focus of our work is the development of fire-safe buildings. Therefore we combine experimental research as well as numerical modelling in the field of structural fire engineering and fire dynamics.

RESEARCH

Research of fire propagation and heat release of combustible substances
We investigate experimentally the pyrolysis, fire propagation and development of pollutants during real fires. The experimental results will be used for further development and validation of numerical models for fire propagation and evacuation.

Fire behavior of renewable building materials
Lightweight construction and usage of renewable materials ensure sustainable buildings. With regard to the fire protection lightweight constructions rapidly heat up, renewable materials are combustible. We examine suitable constructions and protective materials to achieve the protection objectives sustainability as well as fire safety.

Fire behavior of facade systems
A rapid fire propagation through facades can make a fire uncontrollable. Combustible substances in the facade system have to be protected through appropriate measures. The before mentioned measures are researched through experimental and numerical examinations.

Natural fires and safety concepts for fire safety design
The examination of the influencing parameters and the development of natural fires and their modelling as well as the development of a safety concept comprising the design approach is a research area.

High-temperature behavior of concrete elements
The loss of strength of high-performance concrete and ultra-high-performance concrete at higher temperatures is progressing faster than normal concrete and the tendency of spalling increases. We perform basic studies on thermal and thermomechanical behavior of high- and ultra-high-performance concrete. Also, the material behavior during the cooling phase of fire, which is not been widely studied, is the subject of research at iBMB.

iBMB | Prof. Dr.-Ing. Jochen Zehfuß

Researcher's Career

- Professor of Fire Safety, iBMB, TU Braunschweig
- Head of scientific division of the Civil Engineering Materials Testing Institute (MPA) Braunschweig
- Convenor of DIN standard committee for Fire Safety Engineering
- Member of CEN Project Team New Items in EN 1992-1-2
- Member of Executive Committee German Fire Protection Association (GFPA)
- Inspection Engineer for Fire Protection
- Member of management and shareholder of hhpberlin fire safety engineers
- PhD at TU Braunschweig, Department of Civil Engineering
- Research assistant at Institute for Building Materials, Concrete Structures and Fire Safety, TU Braunschweig
- Study of Civil Engineering at TU Braunschweig, degree Dipl.-Ing.

Funding
DFG, BMBF, BMWi, AiF, BMEL, DIBt, industry

TEACHING

We teach the basic knowledge of Fire Safety for the bachelor education of civil engineering, architecture and environmental engineering. For master of civil engineering we offer advanced courses in the field of Fire Safety and Structural Reliability:

Fundamentals of Fire Protection
Prescriptive Fire Safety Design and Passive Fire Protection
Based Fire Fighting and Active Fire Protection

Fire Safety Engineering Methods
Fire Dynamics and Human Behavior in Fire
Structural Fire Engineering

Special Subjects of Fire Safety
Seminar Modelling Fire Simulations and Egress Analysis
Seminar Modelling Structural Fire Behavior
Fire Protection of Existing Buildings
Disaster Control
Fire Safety Design of Special Buildings
Seminar Fire Protection

Structural Reliability
Reliability
Evaluation of Reliability of Existing Buildings
Risk Analysis

Publications

- Zehfuß, J.; Northe, C.; Riese, O.: An investigation of the fire behavior of ETICS facades with polystyrene under fire loads of different size and location. In: Fire and Materials (2018).
- Zehfuß, J.; Felix, D.: Prestressed precast concrete floors in the event of fire. In: CPI - Concrete Plant International. ad-media Verlag Cologne. (2017), S. 128-137.
- Zehfuß, J.; Riese, O.; Northe, C.; Küppers, J.: Experimentelle und numerische Erkenntnisse zum Brandverhalten von WDVS-Fassaden auf Polystyrol-Basis. In: Bauingenieur 90 (2015), S. 567-574.
- Zehfuß, J.; Siemon, M.: Numerische Analyse brandbeanspruchter Stützen aus ultrahochfestem Beton (UHPC). In: Bautechnik 92 (2015), Heft 5, S.335-345.
- Zehfuß, J.; Riese, O.: Anwendung von Brandsimulationsmodellen für die Berechnung der thermischen Einwirkungen im Brandfall und der Rauchableitung. In: Fouad, N. (Hrsg.): Bauphysik Kalender 2015. Verlag Ernst & Sohn, Berlin.
- Zehfuß, J.; Klinzmann, C.; Paliga, K.: Performance-Based Fire Safety Design of Special Structures in Germany. In: Journal of Structural Fire Engineering 5 (2014), no. 2 (June), S.125-134.
- Richter, E.; Zehfuß, J.; Kampmeier, B.: Entwicklung vereinfachter Materialgesetze in Form von temperaturabhängigen Spannungs-Dehnungslinien für ultrahochfesten Beton. In: Bauphysik 35 (2013), Heft 5, S. 303-322.
- Zehfuß, J.; Hosser, D.: A parametric natural fire model for the structural fire design of multi-storey buildings. In: Fire Safety Journal 42 (2007), S. 115-126.

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iBMB | Institute of Building Materials, Concrete Construction and Fire Safety
Division of Organic and Wood-based Materials

Mission Statement

Our mission is to study and characterize organic materials used in construction including: combination of organic and inorganic materials, development of new experimental methods and techniques for material and interface.

RESEARCH

Fraunhofer Center for Light and Environmentally-Friendly Structures: The newly established Center focuses on use of plant-fiber based materials in construction and optimization of their use with regard to their function in a complex system. The Center brings together the university fundamental research with the application-oriented research and development pursued by Fraunhofer WKI. Graduate and undergraduate students and the Department of Civil and Environmental Engineering and Architecture together with Fraunhofer WKI scientists address various topics ranging from development of new construction materials to their ageing. A new Fraunhofer WKI research facility at the TU Braunschweig Campus opened in 2021.

Ageing of wood as a construction material: All structural materials age and the ageing is associated with change of relevant properties. The understanding of ageing at atomic scale is critical for design on materials for future as well as in assessment of existing structures. We are using environmental atomic force microscopy and other advanced techniques to study effects of various ageing parameters such as temperature or alkalic environment on properties on lignocellulosic materials (plant-based) and we use wood as a model material.

Timber guard rails: Here we develop a new generation of the guardrails that combine the environmental performance with structural one. The challenge is to sustain vehicle impact and at the same time provide sufficient durability of a biodegradable material.

Hybrid construction materials with renewable resources (with Apl. Prof Libo Yan): We combine concrete with natural fibers and fabric made of natural fibers (plant-based) and timber to create new hybrid construction materials and components. We study their structural behavior, creep, durability and fire resistance and develop new analytical and design models.

Industrial research and research with small and medium enterprises (SMEs): The Division of Organic and Wood-Based Materials conducts engineering industrial research that entails durability and fatigue tests of adhesives under realistic effects in the form of dynamic loads with simultaneous exposure to solvent (e.g. cleaning agents). In addition, methods for automated bonding of components are developed. Number of projects addressing development of composite-reinforced guardrail systems, inorganic foams, and fire-resistant foams are underway. Furthermore, the group conducts experimental failure analyses of materials and connections in construction as well as in mechanical systems.

iBMB | Prof. Dr.-Ing. Bohumil Kasal

Researcher's Career

- MS, PhD, Oregon State University, USA
- MS, Virginia Tech, USA
- Licenced professional engineer (P.Eng)
- Professor of Organic and Wood-based Materials, TU Braunschweig and
- Director of the Fraunhofer Wilhelm-Klauditz-Institut, WKI, Braunschweig (2010-present)
- Member of the DFG Graduate College focused on ageing of structural materials
- Hankin Chair of Residential Building Construction at the Pennsylvania State, University and a Director of the Pennsylvania Housing Research Center (2005 to 2010)
- Professor at the Department of Wood and Paper Science at the North Carolina State University in Raleigh (1993 - 2005)
- Honorary Research Fellow at the University of Bristol (2007 - 2012)
- Honorary Research Associate at the University of New Brunswick, Canada (2004-2014)
- Professor at the Czech Technical University in Prague
- Professorship at the North Carolina State University (associate faculty status)
- Fulbright Scholar

Funding
EU and German funding agencies, industry

TEACHING

Our teaching portfolio focuses on organic materials (plant-based and synthetic) as relevant to the civil and mechanical enfineering applications. We emphasize the material science aspects and the courses taught include

- Renewable and wood-based materials in civil engineering
- Plant-based natural fiber reinforcements in construction
- Plastics in construction and architecture
- Polymer materials
- In-situ assesment of timber
- Protection and repair of structures

Publications

- Li, J., Kasal, B. The immediate and short-term degradation of the wood surface in a cement environment measured by AFM. Mater Struct 55, 179 (2022). https://doi.org/10.1617/s11527-022-01988-8
- Yan L., Kasal B., Huang L. 2016. A review of recent research on the use of cellulosic fibres, their fibre fabric reinforced cementitious, geo-polymer and polymer composites in civil engineering. Composites Part B: Engineering (Elsevier) 2016; 92:94-132.
- Kasal, B., Friebel, S., Gunschera, J., Salthammer, T., Schirp, A., Schwab, H. and Thole, V. 2015. Wood-Based Materials. Ullmann's Encyclopedia of Industrial Chemistry. 1–56. Wiley-VCH Verlag GmbH & Co. KGaA. DOI: 10.1002/14356007.r28_r01.pub2
- Kasal, B., Guindos, P., Polocoser, T., Heiduschke, A., Urushadze, S., and Pospisil, S. 2014. Heavy Laminated Timber Frame with Rigid Three- Dimensional Beam-to-Column Connections. ASCE Journal of Performance of Constructed Facilities, Vol. 28, No. 6.
- Kasal, B., and R. Blass. 2013. Experimental and analytical investigation of crack development in composite reinforced laminated arch. Journal of Materials and Structures. Vol. 46, Issue 1-2, 173-180. DOI 10.1617/s11527- 012-9892-4
- Kasal, B., Tannert, T. (Editors). 2011. In situ assessment of structural timber. RILEM State of the Art Reports, Vol. 7. Springer Verlag. ISBN: 978-94-007-0559-3. 124 p.
- Kasal, B. and Anthony, R.W. (2004), Advances in in situ evaluation of timber structures. Prog. Struct. Engng Mater., 6: 94-103. https://doi.org/10.1002/pse.170

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iBMB | Institute for Building Materials, Solid Construction and Fire Safety **| Division of Organic and Wood-Based Construction Materials**

Mission Statement

We are devoted to developing an designing future environmentally-friendly construction and building materials and structures with lower carbon footprint from construction and building demolition and agricultural wastes.

RESEARCH

Application of Construction and Agricultural Wastes in Infrastructure: Our group is one of the leading german institutes to utilize agricultural waste, i.e. plant-based natural fibres and their reinforced polymer composites, for infrastructure application. Our research covers material characterisation, structural design and numerical simulation of natural fibre reinforced composite materials and the application of these materials to replace synthetic fibre reinforced composite materials. Currently we are also focusing on reuse and recycle of construction and building demolition wastes.

Design and Modeling of Hybrid Structures in Infrastructure: We design, model and characterize hybrid structures combining fibre reinforced polymer (FRP) composite materials with conventional construction and building materials such as steel, concrete and timber to be light-weight and environmentally-friendly structures with high performance.

Crashworthiness Design of Composite Structures for Automotive Engineering: We develop, design and model crashworthy structures with lightweight and high strength composite materials for automotive engineering application. Currently we are using composite materials such as glass, basalt and flax FRP composites.

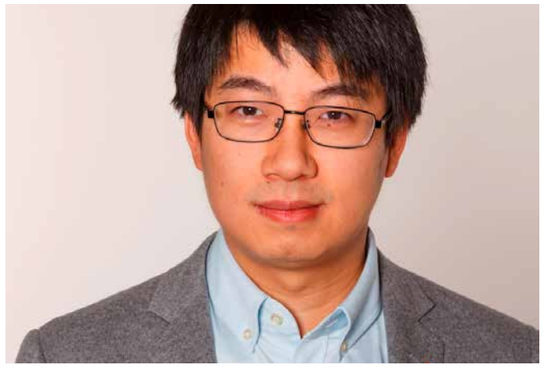
Ageing Investigation of Construction and Building Materials: We focus on the durability and ageing investigation of conventional and novel construction and building materials such as natural fibre, natural fibre reinforced polymer and natural fibre reinforced cementitious composites, concrete and recycled aggregate concrete. Currently we are studying the long-term durability of natural fibre and their fibre reinforced polymer and cementitious composites subjected to various accelerated environmental weathering conditions.

iBMB | Professor Dr. Libo Yan

Researcher's Career

- Assistant Professor of Department of Organic and Wood-based Construction Materials, iBMB, TU Braunschweig
- PhD in Civil Engineering, University of Auckland, New Zealand
- Master of Science in Structural Engineering from Cardiff University, United Kingdom
- Bachelor of Engineering in Civil Engineering from Chongqing University, China
- Recipient of several international/ national awards, such as International Institute for FRP in Construction (IIFC) Best PhD Thesis Award (2016), Vice-Chancellor's Prize for Best Doctoral Thesis (2014) from University of Auckland, Chinese Government Award for Outstanding Self-financed Student Abroad from China Scholarship Council (2014)

Funding
BMBF, BMEL, DFG



Publications and Patents

- Huang L, Zhang C, Yan L, Kasal B. Flexural Behavior of U-shape FRP Profile-RC Composite Beams with Inner GFRP Tube Confinement at Concrete Compression Zone. Composite Structures 2018; 184: 674-687.
- Yan LB, Wang B, Kasal B. Can Plant-Based Natural Flax Replace Basalt and E-Glass for Fiber-Reinforced Polymer Tubular Energy Absorbers? A Comparative Study on Quasi-Static Axial Crushing. Frontiers in Materials 2018; 4, 42. https://doi.org/10.3389/fmats.2017.00042
- Yan B, Huang L, Yan LB, Gao C, Kasal B. Behavior of flax FRP tube encased recycled aggregate concrete with clay brick aggregate. Construction and Building Materials (Elesvier) 2017;136:265-276.
- Huang L, Xun X, Yan LB, Kasal B. Impact behavior of concrete columns confined by both GFRP tube and steel spiral reinforcement. Construction and Building Materials 2017; 131:438-448
- Yan LB, Kasal B, Huang L. A review of recent research on the use of cellulosic fibres, their fibre fabric reinforced cementitious, geo-polymer and polymer composites in civil engineering. Composites Part B: Engineering (Elesvier) 2016;92:94-132.

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IfEV | Institute of Railway Systems Engineering and Traffic Safety

Mission Statement

In many parts of the world, there is a growing demand for rail transportation. Our mission is to provide excellent expertise in railway operations and signalling to support the revitalisation and modernisation of railway systems wordwide. A key element of this is international knowledge transfer.

RESEARCH

Centralisation: A main challenge is the change from rail traffic control by locally staffed control stations to operation control centres with a very high degree of centralisation. Beside new control technologies, there is a need for new operating rules and procedures that are designed for highly centralised control. A key element of this are efficient procedures for degraded-mode operations.

Interoperability: For historical reasons, the national railway systems differ significantly in their control systems, operating rules, and procedures. An important step to overcome these differences is international knowledge transfer and comparative analysis of technologies and procedures.

Human Factors: Safe and efficient operation is closely connected with the design of user interfaces in control centres and locomotive cabs. So, human factors in these areas have become a key element of our research. Typical research questions are the evaluation of situation awareness and the optimum design of the user interfaces for safe and efficient rail traffic control.

Digitalisation and Automation: These two megatrends will have a major impact on the way railway operation is controlled. In our research, we concentrate on the operational constraints that must be handled to implement digital control and driverless train operations.

This Side: Train driving simulator in the Virtual Railway Operations Laboratory (Bildautor: Pachl)

Other Side: Cutout from a train control user interface in the Virtual Railway Operations Laboratory

IfEV | Prof. Dr.-Ing. Jörn Pachl

Researcher's Career

- University professor and head of the Institute of Railway Systems Engineering and Traffic Safety
- Dr.-Ing. at TU Braunschweig, external candidate
- Project manager at German Railways
- Research assistant at the Institute of Traffic Safety at the Dresden College of Transportation
- Study of Transportation Engineering at the Dresden College of Transportation, degree Dipl.-Ing.

Funding
Industry, government authorities, DAAD

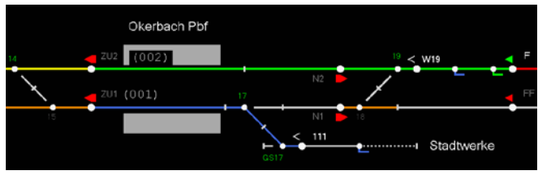
TEACHING

Railway Operations: Our lectures on railway operations cover the evaluation of operational capacity, computer-based scheduling of train operations, and the procedures of dispatching and train control.

Railway Signalling: The signalling lectures concentrate on the signalling principles, i.e., the operational functions of signalling systems. This includes block systems, interlocking systems, automatic train protection, and level crossing control.

Laboratory Session: A key teaching facility is the Virtual Railway Operations Laboratory. In this laboratory, railway traffic is simulated in a virtual network controlled by distributed control stations. The control stations are equipped with user interfaces as used in real control centres. Several networks including samples from foreign railways and light rail systems can be simulated. In addition to the network control simulation, the laboratory also has a locomotive cab simulator, which is based on a real locomotive interior.

International Teaching: Due to the big share of international students we offer specific lectures on international railway operations. In addition, external lectures are provided as a visiting professor or invited lecturer in several countries inside and outside Europe.



Publications

- Pachl, J.: Systemtechnik des Schienenverkehrs - Bahnbetrieb planen, steuern und sichern. 11th ed., Springer Vieweg, Wiesbaden 2022
- Pachl, J.: Railway Operation and Control. 3rd ed., VTD Rail Publishing, Mountlake Terrace (USA) 2014
- Pachl, J.: Railway Operation Processes. in: Theeg, G.; Vlasenko, S. (editors): Railway Signalling & Interlocking – International Compendium. 2nd ed., PMC Media, Bingen 2017, pp. 39-60
- Hansen, I. A.; Pachl, J. (editors): Railway Timetabling & Operations. 2nd ed., Eurailpress Hamburg 2014
- Pachl, J.: Besonderheiten ausländischer Eisenbahnbetriebsverfahren: Grundbegriffe – Stellwerksfunktionen – Signalsysteme. Springer essentials, Springer Vieweg, Wiesbaden 2016

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IGG | Institute for Geomechanics and Geotechnics

Mission Statement

Geotechnics, the modern term for Foundation Engineering and Soil Mechanics, is an essential part of Civil Engineering, present in each engineering project. Due to the fact that all constructions are in interaction with the subsoil, the knowledge about the soil behavior and the soil-structure interaction is crucial. The complexity of the naturally-formed underground requires continuing research.

RESEARCH

Offshore Wind Energy: Offshore wind energy is an important factor in the field of renewable energy. Due to the lack of construction experience, intensive research in the field of horizontal and vertical bearing capacity of the foundation structures (mainly pile foundations) is carried out. Furthermore, another research field came up as a consequence of hydro sound emission during the installation process of these pile foundations. Impact pile driving causes acoustic waves in the water which injure marine mammals such as porpoises. The development and optimisation of noise mitigation systems and the new method for installation of large piles through vibration are important research tasks. And not forget the huge scope of work to decommissioning these piles. For this purpose, various in situ measurements were carried out followed by large-model scale tests at our test site.

Deep geological disposal of radioactive waste: What is the most suitable host rock for deep geological disposal? Which deep repository safety level is safe enough? How could monitoring data help to take the decision of retrieval? To answer these questions from a geotechnical point of view, intensive research regarding stress-strain and creep behavior of rock salt for geological repositories of radioactive waste are carried out. In order to test the long term safety requirement, the constitutive model TUBSsalt was developed, which is capable of considering the different phases of creep and failure of rock salt. Furthermore, different concepts for deep geological disposal of HLW with retrievability provisions and near field monitoring during the operational phase are being developed for some host rocks such as: rock salt, clay, claystone and crystalline hard rock.

This Side: Instrumentation inside a Monopile (Photo IGB)
Rock Salt after load test (Photo IGB)

Other Side: Tunneling Excursion (Photo R. Zech)

IGG | Prof. Dr.-Ing. Joachim Stahlmann

Researcher's Career

- Full Professor and Head of the Institute of Foundation Engineering and Soil Mechanics, Department of Civil Engineering at Technische Universität Braunschweig
- Functions in private enterprises: Engineer in charge, Project manager, Head of branch office, Unit manager in geotechnics and underground openings
- Dr.-Ing. at RWTH Aachen
- Research Assistant at Institute of Foundation Engineering, Soil Mechanics, Rock Mechanics and Water Way Construction, RWTH Aachen
- Study of Civil engineering (Dipl.-Ing.) at the Technische Universität Braunschweig

Funding
BMBF, BMWi, BMUB, DFG, Industry

TEACHING

Bachelor: The aim of the two bachelor lectures is to teach students the basics of geotechnics. In soil mechanics they learn the basics of soil structure, description and classification as well as stress deformation behaviour in the continuum. Settlement calculations, the effect of water in the soil and earth pressure provide the basis for the verification of stability. In foundation engineering, the basic knowledge is applied to geotechnical methods and the students learn to calculate foundation methods, piles, excavation pit constructions, stability of earth dams and dewatering measures, among other things. Interested students can also choose the tunnel construction module.

Master: The aim is to deepen and expand the basic knowledge gained in the bachelor's programme:
Participation is compulsory for

- Theoretical and experimental soil and rock mechanics
- Foundation and rock engineering and dynamics in geotechnics

Additional modules are available:

- Subsurface excavation construction with tunneling excursion
- Deep geological repositories
- Numerical simulations and field measurements in geotechnics

Publications

- Epkenhans, I.; Mintzlaff, V.; Fachinger, S.; Wacker, S.; Daumlechner, E.; Stahlmann, J.: Flat-bedded rock salt – a mechanical anisotropic material? In: de Bresser, J. (Hrsg.). The mechanical behavior of salt X: Proceedings of the 10th Conference on the Mechanical Behavior of Salt (SALTMECH X), ISBN: 978-1-0032-9580-8, Utrecht, S. 153-167, 2022
- Hinzmann, N.; Lehn, P.; Gattermann, J.: Large-scale model investigation for monopile decommissioning of offshore wind turbines – vibratory pile extraction, Proceedings of the 3rd International Offshore Wind Technical Conference, IOWTC2021-Virtual Conference 16.-17. February, Boston, USA, https://doi.org/10.1115/IOWTC2021-3539, 2021
- Hinzmann, N.; Lehn, P.; Gattermann, J.: Large-Scale Tests with hydraulic and pneumatic overpressure for monopile decommissioning of offshore wind turbines Proceedings of the 39th International Conference on Ocean, Offshore and Arctic Engineering, OMAE2020- Virtual Conference 3.-7. August, Fort Lauderdale, USA, https://doi.org/10.1115/OMAE2020-18775, 2020
- Stein, P.; Hinzmann, N.; Gattermann, J.: Scale Model Investigations on Vibro Pile Driving, Proceedings of the 37th International Conference on Ocean, Offshore and Arctic Engineering, OMAE 2018, June 17-22 2018, Madrid, Spain
- Mintzlaff, V.; Leon Vargas, R.; Epkenhans, I.; Stahlmann, J.: Requirements for Geotechnical Monitoring of deep geological repositories with retrievability; Hocke-Bergler, Kuppler, Hassel und Smeddinck (Hg.): Technical Monitoring and Long-Term Governance. 1. Edition, 2019

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IGeo | Institute of Geosystems and Bioindication

Mission Statement

Sustainable use of our environment, especially water resources, depends on a thorough understanding of the processes that shape and alter our habitats. We focus on the interactions between climate, environmental dynamics and humans on different time scales and are especially interested in the regional expression of global climate change in Europe, the Tibetan Plateau, the Himalaya, Arabia and the Americas.

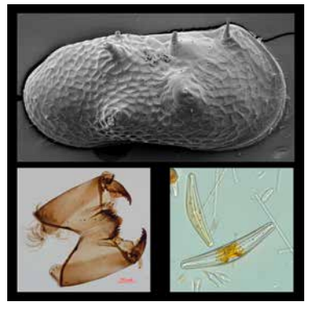
RESEARCH

Water quality assessment:
Our team uses aquatic organisms such as diatoms, ostracods and chironomids as bioindicators together with chemical, physical and nutrient parameters from waters to assess human impact in both urban and remote, pristine regions.

Assessment of the regional impact of global climate change and humans: Using lake sediments from climatically sensitive regions we evaluate how climate change has altered the regional hydrological cycles and the water supply to landscapes, especially aquatic ecosystems, and how these systems were affected by landuse. Currently, we are running projects using this approach in the high-altitude mountains of Nepal and Tibet, at lakes in Southern Germany, Italy, Saudi Arabia, Guatemala and Mexico.

Long-term reconstruction of environmental change:
As member in several international continental scientific drilling program (ICDP) projects we have established an interdisciplinary network of international partners to recover long sediment cores from large lakes reaching back several hundred thousand years in time. This allows us to detect changes in long-term environmental evolution, discover patterns of natural climate variability and frequency of climate extremes, as well as to search for causes for changes in biodiversity, human activities and dispersal.

Furthermore, our team recently expanded into the field of paleogenetics which offers access to environmental information where no microfossil remains survive. In the project “Climate Change and Early Humans in the North” all these methods are being combined to an interdisciplinary approach studying the environment and its changes during the times Neanderthals were roaming Europe.
Our approaches contribute to develop concepts for environmental management and protection, especially under the aspects of future climate change and sustainable land use.



Above: Lake Tangra Yumco, Central Tibet, at an altitude of 4540 m a.s.l. and Gangdis Mountains

Right: Bioindicators: Ostracod valve, chironomid head capsule and diatoms from lake sediments

Opposite side: Sediment coring using the Hipercorig platform on Lake Constance, Germany.
Photos: N. Börner, A. Schwarz, A. Schwalb

IGeo | Prof. Dr. sc. Antje Schwalb

Researcher’s Career

- Chair Board of Trustees Federal Institute for Geosciences and Natural Resources (BGR)
- Member Selection Committee Alexander von Humboldt Foundation
- Member DFG Senate, Review Board Geology/Paleontology
- Professor for Geology and Geosystems, TU Braunschweig
- Dr. sc. habil., Universität Göttingen
- BMBF Junior Group Leader, Universität Heidelberg
- Scientific Coordinator, Helmholtz Centre Potsdam, GFZ
- DFG Research Fellow and Research Associate, Universität Göttingen
- Swiss NSF Research Fellow, University of Minnesota, and U.S. Geological Survey (USA)
- Dr. sc., Université de Neuchâtel (CH)
- Dipl.-Geol., Universität Göttingen

Funding
DFG, BMBF, State Lower Saxony/ Volkswagen Foundation, DAAD, Karl-Heinz Frenzen-Stiftung

TEACHING

Our interdisciplinary team offers lectures, seminars and practical field and lab trainings in Geosciences, Biology and Ecology for Bachelor and Master students in Environmental Sciences, Environmental Engineering and Civil Engineering. We focus on processes, feedbacks and interactions in the complex system of the atmosphere-biosphere-hydrosphere-lithosphere and use Earth’s history to gain understanding of the full range of natural climate variability.
Students are trained in the fields of (paleo-) climate research, (paleo-) limnology, bioindication, water quality assessment, paleogenetics and GIS. Our goal is to train process- and system-oriented comprehension and critical thinking. Students gain an in-depth understanding of the Earth’s System as a prerequisite for the assessment of human impact and environmental management.
Under consideration of future climate and ecosystem change, students develop concepts for water protection and nature conservation. We offer thesis topics both in applied as well as in basic research involving field and/or lab work and opportunities for cooperation with local authorities, national and international research institutions within the frame of interdisciplinary research projects.

Publications

- Anslan, S., Azizi Rad, M., Buckel, J., Echeverria Galindo, P, Kai, J., Kang, W., Keys, L., Maurischat, P., Nieberding, F., Reinosch, E., Tang, H., Vi Tran, T., Wang, Y., Schwalb, A., 2020. Reviews and syntheses: How do abiotic and biotic processes respond to climatic variations in the Nam Co catchment (Tibetan Plateau)? Biogeosciences 17, 1261–1279, DOI: 10.5194/bg-17-1261-2020
- Bauersachs, T., Russell, J.M., Evans, T.W., Schwalb, A., Schwark, L., 2021. A heterocyte glycolipid-based calibration to reconstruct past continental climate change. Nature Communications 12, 2406, DOI: 10.1038/s41467-021-22739-3
- Costa-Böddeker, S., Thuyên, L.X., Hoelzmann, P., de Stigter, H.C., van Gaever, P., Đu´ć Huy, H., Smol, J.P., Schwalb, A., 2020. Heavy metal pollution in a reforested mangrove ecosystem (Can Gio Biosphere Reserve, Southern Vietnam): Effects of natural and anthropogenic stressors over a thirty-year history. Science of the Total Environment 716, 137035. DOI: 10.1016/j.scitotenv.2020.137035
- Leder, D., Hermann, R., Hüls, M., Russo, G., Hoelzmann, P., Nielbock, R., Böhner, U., Lehmann, J., Meier, M., Schwalb, A., Tröller-Reimer, A., Koddenberg, T., Terberger, T., 2021. A 51,000-year-old engraved bone reveals Neanderthals’ capacity for symbolic behavior. Nature Ecology & Evolution, 5, pages 1273–1282, DOI: 10.1038/s41559-021-01487
- Pérez, L., Correa-Metrio, A., Cohuo, S., Macario Gonzáles, L., Echeverría-Galindo, P., Brenner, M., Curtis, J., Kutterolf, S., Stockhecke, M., Schenk, F., Bauersachs, T., Schwalb, A., 2021. Ecological turnover in neotropical freshwater and terrestrial communities during episodes of abrupt climate change. Quaternary Research, DOI:10.1017/qua.2020.124

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IGÖ | Institute of Geoecology | **Division of Climatology and Environmental Meteorology**

Mission Statement

Our group uses measurements and modelling to explore exchange processes of energy and mass between urban and non-built surfaces and the atmosphere. We study relationships between urban particle emission and meteorological influence to assess exposure variability of humans towards pollutants.

RESEARCH

Surface-atmosphere exchange and boundary layer processes: The atmospheric boundary layer is characterised by important exchange processes of energy, mass and pollutants between the surface and the atmosphere. These fluxes influence climate, the state of ecosystems or human well-being. We use the state-of-the-art eddy covariance technique to quantify exchange fluxes. The work in our group focuses on urban environments, but takes place also in natural ecosystems. Currently, we are studying exchange processes of heat, water and CO_2 between the urban atmosphere and green roofs as well as at a mountainous peatland site.

Urban Climatology: The climate of urban areas is significantly modified in comparison to nonbuilt urban surroundings. The urban heat island is the most well known phenomenon of urban climate effects. We are interested in studying modifications of near-surface climate processes in urban environments and in analysing the relationship with urban structure and morphology. Our research addresses basic aspects of urban climatology but also looks into applied questions, e.g. benefits and urban ecosystem services of green infrastructure (cf. Figure).

Air quality and Aerosol research: Pollutants that are emitted into the atmosphere from different sources react and/or transform during atmospheric transport and residence. Due to a large number of sources especially in urban areas, the exposure towards particles is characterised by a large spatio-temporal variation. We assess particle exposure by using state-of-the-art measurement and modelling approaches to resolve particle concentration variability on the local urban scale. A current work models the transformation of particle number size distributions during atmospheric transport from roadside into the urban background.

IGÖ | Prof. Dr. Stephan Weber

Researcher's Career

- Dean of studies Geoecology/ Environmental Sciences (2013-2017)
- Full professor Climatology and Environmental Meteorology, TU Braunschweig
- Post-Doc, Applied Climatology and Landscape Ecology, University of Duisburg-Essen
- Dr. rer. nat. at the University of Duisburg-Essen
- PhD student, Applied Climatology and Landscape Ecology, University of Duisburg-Essen
- Diploma Thesis at Royal Netherlands Institute for Sea Research, Texel, Netherlands
- Study of Physical Geography and Climatology, Ruhr University Bochum

Funding
DFG, BMBF, State lower Saxony (MWK), industry

Publications

- Heusinger J., Weber S. (2015). Comparative microclimate and dewfall measurements at an urban green roof versus bitumen roof. Building and Environment, 92: 713-723.
- von Bismarck-Osten C., Birmili W., Ketzel M., Weber S. (2015). Statistical modelling of aerosol particle number size distributions in urban and rural environments – a multi-site study. Urban Climate, 11: 51-66.
- Birmili, W., Sun, J., Weinhold, K., Merkel, M., Rasch, F., Wiedensohler, A., Bastian, S., Löschau, G., Schladitz, A., Quass, U., Kuhlbusch, T.A.J., Kaminski, H., Cyrys, J., Gu, J., Kusch, T., Flentje, H., Meinhardt, F., Schwerin, A., Bath, O., Ries, L., Gerwig, H., Wirtz, K., Weber, S. (2015). Atmospheric aerosol measurements in the German Ultrafine Aerosol Network (GUAN) - Part III: Black Carbon mass and particle number concentrations 2009-2014, Gefahrstoffe – Reinhaltung der Luft 11/12, 479-488
- Ruths M., von Bismarck-Osten C., Weber S. (2014). Measuring and modelling the local-scale spatiotemporal variation of urban particle number size distributions and black carbon. Atmospheric Environment, 96: 37-49
- Hussein T., Mølgaard B., Hannuniemi H., Martikainen J., Järvi L., Wegner T., Ripamonti G., Weber S., Vesala T., Hämeri K. (2014). Finger-Prints of Urban Particle Number Size Distribution in Helsinki – Finland: Local versus Regional Characteristics. Boreal Environment Research, 19: 1-20

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IGÖ | Institute of Geoecology | **Landscape Ecology and Environmental Systems Analysis**

Mission Statement

Understanding the relationships between patterns, processes, and functions in dynamic landscapes is the basis for the development of models for the conservation and sustainable management of plant and animal species, landscapes, and related ecosystem functions and services.

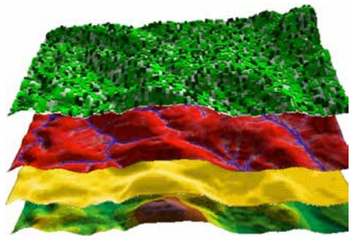
RESEARCH

Quantitative Landscape Ecology and Biogeography:
We use advanced statistical and machine learning methods to understand the drivers of spatiotemporal dynamics of species and communities and to predict the effects of environmental change on plants, animals and ecosystem functions across scales. The same approaches are used for soil landscape modelling as well as landslide modelling (DFG research unit FOR 816). Currently, we link species distribution models and mechanistic (meta)population models to develop mechanistic niche models.

Ecohydrology: We conducted experiments and developed models to understand the effects of ecosystem engineers on hydrological processes. Within the DFG research unit FOR 1598 (Catchments As Organised Systems CAOS), we studied the effects of earthworms generating macropores on water dynamics in the soil at catchment scale. In BfG-funded projects, we analysed the response and effect traits of plant species responding to and affecting ecohydraulic dynamics in estuaries. The effects of plant traits on sedimentation in salt marshes is studied in the MWK-funded Graduate School Gute Küste Niedersachsen.

Conservation Biology, Ecosystem Service Science, Sustainable Land Management:
We developed integrated landscape models linking hydrological, ecological and socio- economic models to study the effects of environmental change on species and to provide management options for conserving biodiversity. In the joint BMBF-project COMTESS, we studied the effects of sea level rise and climate change on ecosystem services and biodiversity as well as their trade-offs in Germany's coastal regions. And in the follow-up BMBF-project RUINS, we analysed risks, uncertainty and insurance under climate change and coastal land management on the German North Sea. The renaturation of seagrass meadows and related ecosystem services is in the focus of the MWK-funded project SeaArt as well as the BMBF-project SeaStore, whereas METAPOLIS (MWK-funded) focused on urban ecosystem services.

Landscape Epidemiology:
We study the distribution patterns and interrelationships of ticks, their hosts and pathogens causing tick-borne diseases such as Lyme disease with a focus on abiotic and biotic controlling factors in order to assess infection risks and derive prevention and intervention strategies to reduce such risks. Currently, we are focusing on tick-borne diseases in urban areas by studying transmission foci in public green infrastructure and private gardens.



IGÖ | Prof. Dr. Boris Schröder-Esselbach

Researcher's Career

- Full Professor for Environmental Systems Analysis, TU Braunschweig
- Ex-Coordinator TUBS-Research Focus Future Cities (Stadt der Zukunft)
- Member of Berlin-Brandenburg Institute of Advanced Biodiversity Research
- Liaison lecturer of the German National Academic Foundation (Vertrauensdozent der Studienstiftung), TU München
- Associate Professor for Landscape Ecology, TU München
- Guest Professor Environmental Modelling, Potsdam University
- Assistant Professor Landscape Ecology, Potsdam University
- Postdoc, Carl von Ossietzky University of Oldenburg
- Dr. rer. nat. habil. Potsdam University, Institute of Geoecology
- Dr. rer. nat. TU Braunschweig, Institute of Geoecology
- Study of Geoecology and Philosophy, TU Braunschweig

Funding
DFG, BMBF, BMWi, BfG, MWK State Lower Saxony, UBA, BMU, DBU

TEACHING

My teaching is oriented towards current research questions and practice, the courses impart geoecological competencies at the landscape scale as well as a broad spectrum of methods in statistics and modelling, which are indispensable for addressing pressing research questions.

Landscape Ecology: focuses on the conceptual, methodological and theoretical foundations of landscape ecology, abiotic and biotic components of the landscape as well as quantitative approaches to the analysis of relationships between patterns and processes in landscapes.

Statistics and **Geostatistics:** aims at the understanding of the basics of descriptive and inferential statistics, simple statistical modelling and geostatistical methods.

Modelling Environmental Processes and **Environmental Systems Analysis:** impart methodological competence to map environmental processes into mathematical models, e.g. in the form of differential equations and to apply methods of landscape ecological modelling.

Ecological Modelling imparts knowledge of the key - statistical and machine learning - methods of species distribution modelling as well as individual/agent-based modelling.

The group's lecturers are furthermore responsible for teaching in **Introduction to Academic Research, Scientific Writing,** the **Geoecological Excursion**, **Multivariate Statistics** as well as **Landscape Epidemiology**.

Publications

- Carus J, Heuner M, Paul M, Schröder B (2017): Which factors and processes drive the spatio-temporal dynamics of brackish marshes? - Insights from development and parameterisation of a mechanistic vegetation model. Ecological Modelling 363: 122-136
- Dormann CF, Guillera-Arroita G, Calabrese J, Matechou E, Barton K, Bahn V, Beale CM, Ciuti S, Elith J, Gerstner K, Guelat J, Keil P, Lahoz-Monfort JJ, Lennon J, Pollock LS, Reineking B, Roberts D, Schröder B, Thuiller W, Warton DI, Wintle BA, Wood S, Wüest R, Hartig F (2018) Model averaging in ecology: a review of Bayesian, information-theoretic, machine-learning and other approaches. Ecological Monographs 88(4): 485-504
- Schibalski A, Maier M, Kleyer M, Schröder B (2022): A framework for spatiotemporally explicit prediction of future ecosystem services in response to climate change, sea level rise, and land management options. Ecosystem Services 54, 101414
- Strohbach MW, Döring A, Möck M, Schneider A-K, Sedrez M, Mumm O, Weber S, Schröder B (2019): The hidden urbanization: trends of surface sealing in low-density housing developments and their impacts on the environment. Frontiers in Environmental Science 7: 29
- Wintle BA, Bekessy SA, Keith DA, Van Wilgen BW, Cabeza M, Schröder B, Carvalho S, Falcucci A, Maiorano L, Regan TJ, Rondinini C, Boitano L, Possingham HP (2011): Ecological-economic optimization of biodiversity conservation under climate change. Nature Climate Change 1(7): 355-359

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IGÖ | Institute of Geoecology | **Landscape Ecology and Environmental Systems Analysis**

Mission Statement

Our main interest is in freshwater biodiversity. Freshwater ecosystems are the most endangered ecosystems worldwide. Most freshwaters are stressed by human activity, such as habitat alteration and pollution, and increasingly also by climate change. We investigate how such pressures impact the species richness and ecological interactions between species and how freshwater communities may be changed with ongoing global change.

RESEARCH

We study how anthropogenic and natural environmental factors are governing freshwater macroinvertebrate communities. A focal group are dragonflies (Odonata), which are commonly used as sentinel organisms for indicating environmental changes.

Urban freshwaters. In cities most freshwater habitats are modified for various human use. Doing long-term monitoring at several running waters in Braunschweig we found that anyhow the freshwater biodiversity generally increased and many species recovered (Fig. 1). We examine which factors and treatments cause differences in species richness and water quality. We evaluate how to improve environmental conditions for freshwater conditions, e.g., how can management of water courses be adapted to increase species richness. We also explore methods of habitat restoration to recover natural freshwater communities. Monitoring permits us to recognise how climate change, by drying and warming, threatens to undo previously positive results of conservation and management efforts. Finally, we also explore methods for the conservation management of ponds. While doing field work mainly in Braunschweig we also analyse data sets from several cities in Central Europe to compare which conditions and concepts are most suited to improve biodiversity in urban areas.

C**hanging interactions in a changing climate.** Climate change affects organisms in several ways, e.g., via life cycle alterations generated by increasing temperatures. Indirect are more difficult to detect and may have massive consequences at the level of biological communities. Since warming affects all organisms differently each may vary in its reaction to a temperature increase, and, thus, formerly matching interactions between species become unmatching. This may disturb food webs and cause massive declines in species otherwise unharmed by climate change. We use dragonflies as proxies to study effects of rising temperature on the single species responses and the species interactions triggered by these responses, i.e., predation and competition between pairs and groups of species. We also consider the additional effects of range expanding species (caused by warming) invading the natural communities and usually react positive to warming. Our studies are mainly experimental but we also apply mechanistic mathematical models to explore several possible combinations of conditions.

Fig. 1: This dragonfly species, Ophiogomphus cecilia, one of our long-term study objects, was formerly threatened by extinction due to bad habitat quality of rivers, but improved during the last two decades from increased environmental quality of rivers in many parts Germany, and also in Braunschweig.

Fig. 2: Students sampling on a section of a stream in Braunschweig after revitalization.

IGÖ | Prof. Dr. Frank Suhling

Researcher's Career

- President Worldwide Dragonfly Association 2017-2019
- apl. Professorship, TU Braunschweig, Institute of Geoecology
- Global Red List Coordinator for International Union for the Conservation of Nature (IUCN), Dragonfly Specialist Group
- Habilitation TU Braunschweig, Institute of Geoecology
- Dr. rer. nat. TU Braunschweig, Institute of Zoology
- Study of Biology, TU Braunschweig

Funding
DFG, BMBF, DBU, Industry

TEACHING

Fundamentals of Ecology. Ecology is the science of the interactions between organisms and their biotic and abiotic environment, and of the material and energy balance of the biosphere and its ecosystems. This lecture considers the habitat requirements and adaptations of organisms, the different mechanisms and pattern of population biology, the interactions among organisms, and the consequences for the functioning of biological communities and whole ecosystems.

Water Quality Assessment. The course teaches methods of water quality assessment using indicator organisms such as diatoms, aquatic plants, macroinvertebrates and fish. This includes procedures and background of the assessment, especially considering the EU Water Framework Directive. Through a field course students gain practical experience, especially concerning the identification of the relevant organisms.

Biodiversity and Biodiversity Conservation. Biological diversity means the variability among living organisms, which includes diversity within species, between species and of ecosystems. Biodiversity is a core program at Master level. We teach the fundamentals of biodiversity and biogeography, such as the mechanisms and theories as well as the effects of diversity on ecological functions and ecosystem services. A module on conservation treats the current decline and threats to biodiversity, the strategies to combat the biodiversity crisis, and introduces into practical conservation issues at the level of local administrations in Germany. Field courses and excursions introduce students into the existing biodiversity.

Publications

- Goertzen D, Schneider A-K, Eggers TO, Suhling F (2022): Temporal changes of biodiversity in urban running waters – results of a twelve-year monitoring study. Basic and Applied Ecology 58: 74-87.
- Hogreve J, Suhling F (2022): Development of two common dragonfly species with diverging occupancy trends. Journal of Insect Conservation 26: 571–581.
- Goertzen D, Suhling F (2019): Urbanization versus other land use: diverging effects on dragonfly communities in Germany. Diversity and Distributions 25: 38-47.
- Suhling F, Suhling I, Richter O (2015): Temperature response of growth of larval dragonflies – an overview. International Journal of Odonatology 18: 15–30.
- Suhling I, Suhling F (2013): Thermal adaptation affects interactions between a range-expanding and a native odonate species. Freshwater Biology 58: 705-714.
- Clausnitzer V, Dijkstra KD-B, Koch R, Boudot JP, Darwall W, Kipping J, Samraoui B, Samways M, Simaika J, Suhling F (2012): Focus on African freshwaters: hotspots of dragonfly diversity and conservation concerns. Frontiers in Ecology and the Environment 10: 129-134.
- Braune E, Richter O, Söndgerath D, Suhling F (2008) Voltinism flexibility of a riverine dragonfly along thermal gradients. Global Change Biology 14: 470-482.

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IGÖ | Institute of Geoecology
Soil Science and Soil Physics Division

Mission Statement

Our research objective is improvement in understanding, measuring and modeling the transport of water, energy and solutes in the subsurface between atmosphere and groundwater. This is achieved by combining state-of-the-art methods in measuring and numerical modeling of flow and transport experiments on the lab and field scale.

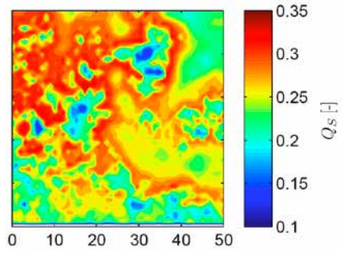
RESEARCH

Hydraulics of peatlands: In peatlands, the moisture content of the vadose zone (acrotelm) decisively controls oxygen diffusion rates, the redox state, and finally the turnover of organic matter. Thus, the water content dynamics determines whether peatlands act as sinks or sources of atmospheric carbon. Models designed to predict the carbon cycle must therefore adequately represent variably-saturated flow processes in ombrotrophic peatlands. We investigate how we can measure and model the water dynamics in peatlands in order to improve biophysical models of carbon exchange.

Biofilms in porous media: Understanding the influence of attached microbial biomass on water flow in partially water saturated soils is crucial for predicting flow in groundwater recharge basins, wastewater irrigation fields, constructed wetlands and in-situ bioremediation sites. We work on quantifying the influence of biomass on the hydraulic properties of unsaturated porous media. This is achieved through pore scale experiments and continuum scale column flow experiments with varying amounts and spatial distributions of biofilms.

Identification of hydraulic properties of porous media: A particular focus of our research lies on the general methodological development of identification tools to determine effective transport processes for water in liquid and vapour form in the unsaturated zone. To achieve this goal, we combine advanced measurement technology with state-of-the-art inverse numerical modeling using the Richards equation. This yields hydraulic properties in high resolution and quality and allows us to test existing parameterisations and to develop improved parameterisations.

Water resources and evaporation from soils: Soil plays a prominent role in the evaporation dynamics of terrestrial surfaces. After an initial phase, where the water uptake capacity of the atmosphere controls the amount of evaporation, a second evaporation stage follows where the unsaturated hydraulic conductivity of the soil and the vapor diffusion are limiting factors. Untangling the complex interactions between soil surface and atmosphere will help to assess the consequences of changing climatic conditions, e.g. on groundwater renewal rates in large arid and semi-arid areas.



IGÖ | Prof. Dr. Wolfgang Durner

Researcher's Career

- Full Professor for Geoecology and Soil Science
- Research Fellow at ETH Zürich
- Dr. rer. nat. at University of Bayreuth
- Diplom-Geoökologe at University of Bayreuth
- Head of the Soil Science and Soil Physics Division at the Institute of Geoecology
- Speaker of the Department of Civil Engineering and Environmental Sciences
- Head of the Soil Physics Commission of the German Soil Science Society
- Associate Editor of five leading international Journals
- Coordinator of Vadose Zone Hydrology program at the European Geosciences Union (EGU)

Funding
DFG, DAAD, BMBF, BASt

TEACHING

Fundamental of soil physics.
Soil physics is the study of the solid, liquid, and gaseous phases of soils and of fluxes of fluids and energy in soils. It is applied in studies of irrigation, drainage, and crop water use, soil erosion, organic matter management, compaction, and others. The lecture with exercises focuses on the composition of the solid, liquid and mineral phase of the soil, on interactions between the three phases in soils which determine the movement of fluids, the migration of solutes, and the energy balance.

Modeling water, energy, and matter transport in soil.
A key teaching topic is the conceptual and mathematical description of the transport processes of water, energy, gases and solutes by a combination of the respective flux laws and the principle of local mass conservation, expressed by the continuity equations for energy and mass. Characterization of the physical properties and processes in soils plays a key role in that. The transport processes are simulated by analytical solutions of steady-state transport processes and with numerical methods for transient problems with appropriate software packages.

Laboratory and Field Courses
We offer specific laboratory and field courses that provide practical training in measurement methods to characterize soil hydraulic properties, water infiltration in soils, monitoring of the soil water balance in the field, and tracing solute transport in lab columns and in the field.

Publications

- Diamantopolous, E., W. Durner, S.C. Iden, U. Weller, and H.-J. Vogel (2015): Modelling dynamic nonequilibrium water flow observations under various boundary conditions, Journal of Hydrology 529, 1851-1858.
- Hannes, M., U. Wollschläger, F. Schrader, W. Durner, S. Gebler, T. Pütz, J. Fank, G. von Unold, and H.-J. Vogel (2015): High-resolution estimation of the water balance components from high-precision lysimeters, Hydrol. Earth Syst. Sci., 19, 3405-3418.
- Peters, A., S.C. Iden und W. Durner (2015): Revisiting the simplified evaporation method: Identification of hydraulic functions considering vapor, film and corner flow, Journal of Hydrology 527, 531-542.
- Durner, W., E. Diamantopoulos, S.C. Iden, and B. Scharnagl (2014): Hydraulic properties and nonequilibrium water flow in soils, Chapter 17 in: W.G. Teixeira et al. (Eds.), Application of Soil Physics in Environmental Analyses: Measuring, Modelling and Data Integration, Progress in Soil Science Series. 2014, pp.403-434, Springer, Dordrecht. ISBN 978-3-319-06012-5.
- Iden, S.C., A. Peters, and W. Durner (2015): Improving prediction of hydraulic conductivity by constraining capillary bundle models to a maximum pore size, Advances in Water Resources 85, 86-92

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IGÖ | Institute of Geoecology
Division of Environmental Geochemistry

Mission Statement

Estimating anthropogenic contributions to biogeochemical cycling of trace elements and pollutants is based on profound knowledge of biogeochemical processes and interactions in terrestrial and marine ecosystems to predict future changes of fluxes of trace elements and pollutants.

RESEARCH

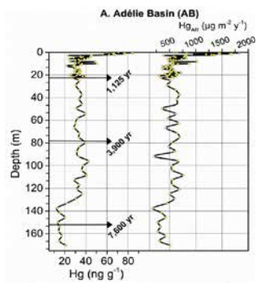
Biogeochemical Cycles: We investigate coupling of trace element and organic matter cycling in terrestrial and marine ecosystems on a micro- to landscape scale. Main emphasis is the understanding of processes of trace element organic matter interactions and their coupling to hydrological and climatic drivers, which both control fluxes of trace element, pollutants and carbon in ecosystems.

Currently, we study the release of dissolved organic matter and related contaminants from forest ecosystem under drought-stress.

Mercury and Primary Production in the Oceans:
We investigate the interaction between algae blooms and the biogeochemical cycling of Hg in the oceans. We are specifically interested in the interaction between sinking algal material in highly productive areas and the scavenging of mercury in the water column and its export to deep sea sediments. We have participated in a POLARSTERN cruise to the Southern Atlantic where we took water and sediment samples and marine snow down to a depth of more than 7000 m.

Geochemical Archives and Formation of Environmental Signals: We conduct several projects on the formation of environmental signals based on biogeochemical proxies. We are interested in understanding what geochemical signals indicate and how they are preserved in geo-archives such as peat bogs and lake sediments.

Mercury Speciation and Risk Assessment:
We apply these mercury speciation methods in combination with geochemical modelling to mercury contaminated industrial sites worldwide for risk assessment and remediation strategies.



IGÖ | Prof. Dr. Harald Biester

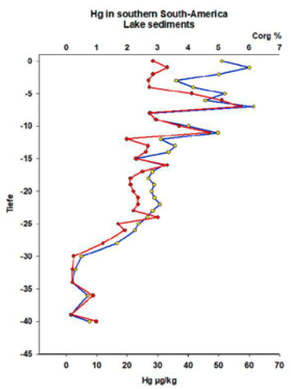
Researcher's Career

- Professor for Environmental Geochemistry
- Assistant Professor, Environmental Geochemistry, University of Heidelberg
- Post-Doc, Environmental Geochemistry, University of Heidelberg
- Habilitation, Geology, Mineralogy, University of Heidelberg
- Dr. rer. nat., University of Heidelberg
- Study of Geology, University of Heidelberg and University of Freiburg

Funding
Mostly DFG, Industry, State Lower Saxony

TEACHING

Teaching covers fundamentals in Environmental Geochemistry including Geochemical Modelling, Biogeochemical Cycling and the Fate of Inorganic Pollutants in the environment as well as Analytical Methods.



Publications

- McLagan, D. S., Schwab, L., Wiederhold, J. G., Chen, L., Pietrucha, J., Kraemer, S. M., and Biester, H. (2022) Demystifying mercury geochemistry in contaminated soil–groundwater systems with complementary mercury stable isotope, concentration, and speciation analyses, Environ. Sci. Process. Impacts, DOI: 10.1039/D1EM00368B.
- Pérez-Rodríguez, M., Biester, H. (2022) Sensitivity of river catchments to discharge-controlled dissolved carbon export: a study of eight catchments in southern Patagonia Biogeochemistry 160 (2), 177-197
- Kaal, J., Pérez-Rodríguez, M., Biester, H. (2022) Molecular Probing of DOM Indicates a Key Role of Spruce-Derived Lignin in the DOM and Metal Cycles of a Headwater Catchment: Can Spruce Forest Dieback Exacerbate Future Trends. Environmental Science & Technology 56 (4), 2747-2759.
- McLagan, D. S., Osterwalder, S., and Biester, H. (2021) Temporal and spatial assessment of gaseous elemental mercury concentrations and emissions at contaminated sites using active and passive measurements, Environ. Res. Commun., 3(5), p.051004.
- Zaferani, S., Biester, H. (2021) Mercury Accumulation in Marine Sediments–A Comparison of an Upwelling Area and Two Large River Mouths. Frontiers in Marine Science 8, 732720.
- Zaferani, S., Pérez-Rodríguez, M., Biester, H. (2018) Diatom ooze - A large marine mercury sink. Science 361 (6404), 797-800.

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IGÖ | Institute of Geoecology
Biodiversity of Agricultural Landscapes

Mission Statement

Understanding how biodiversity is developing in agricultural landscapes, which are the causal factors for the development, which management options exist, and which effects alternative options would have is the basis for developing concepts for sustainable land use.

RESEARCH

Landscape and land-use change
Our research focus is on the relationships between agricultural production, land use systems, landscape structure and biodiversity. We investigate where, which and how abundantly plants and animals occur in open agricultural landscapes, which functional role they play there and how this biological diversity (biodiversity) responds to the type and intensity of agricultural land use and other influencing factors. We analyse changes of biodiversity in agricultural landscapes and apply landscape-ecological methods to gain basic and applied knowledge about the importance and functioning of biodiversity in agroecosystems. Our research covers spatial scales ranging from the field and farm to the national scale.

Ecosystem services and agroecology
We study various functional groups of species, pollinating insects and natural biocontrol agents in particular, on multiple spatial scales in order to better understand the complex relationships between agricultural production, ecosystem functions and services. For this purpose, we use field-ecology, experimental and modelling approaches. The knowledge gained from our studies helps to point out perspectives and strategies for the sustainable use of biodiversity in cropping systems, while maintaining agricultural productivity for provisioning of food and renewable resources.

Monitoring and indicators
Our work aims at developing, improving and testing of scientific monitoring and assessment methods of biodiversity change in agricultural landscapes. To monitor drivers, pressures, state, impact and response (DPSIR) in relation to biodiversity change we rely on scientifically sound and representative indicators and appropriate monitoring programmes. Our objective is to help in developing and testing indicators and monitoring techniques which are adequately robust and sensitive for deriving meaningful information about the development of biodiversity in agricultural landscapes.

IGÖ | Prof. Dr. Jens Dauber

Researcher's Career

- Professor for Biodiversity in Agricultural Landscapes, TU Braunschweig
- Head of Institute, Thünen-Institute of Biodiversity, Johann Heinrich von Thünen Institute, Braunschweig
- Senior research officer, Thünen-Institute of Biodiversity, Johann Heinrich von Thünen Institute, Braunschweig
- Research fellow and scientific project manager, School of Natural Sciences, Botany, Trinity College Dublin, Ireland
- Research fellow, Institute of Integrative and Comparative Biology, Faculty of Biological Sciences, University of Leeds, UK
- Dr. rer. nat. habil., Justus-Liebig-University Giessen, Department of Animal Ecology
- Dr. rer. nat., Justus-Liebig-University Giessen, Department of Animal Ecology
- Study of Biology, Johannes-Gutenberg University Mainz

Funding
EU Horizon2020, BLE, FNR, DBU, Rentenbank

TEACHING

We teach the basic knowledge of agroecology, biodiversity conservation and sustainable use of biodiversity in agricultural systems:

Introduction to agroecology
Origin of agriculture
Development of agricultural landscapes
Agroecosystems
Agroecology as a science, a movement and a practice
Biotic interactions in agroecosystems

Biodiversity of agricultural landscapes
The biodiversity concept
Farmland biodiversity monitoring
Ecosystem services
Strategies of biodiversity conservation in farmland

Publications and Patents

- Pérez-Sánchez AJ, Zopf D, Klimek S, Dauber J (2018) Differential responses of ant assemblages (Hymenoptera: Formicidae) to long-term grassland management in Central Germany. Myrmecological News 27, 13-23.
- Jerrentrup JS, Dauber J, Strohbach MW, Mecke S, Mitschke A, Ludwig J, Klimek S (2017) Impact of recent changes in agricultural land use on farmland bird trends. Agriculture, Ecosystems and Environment 239, 334-341.
- Lomba A, Strohbach M, Jerrentrup JS, Dauber J, Klimek S, McCracken D (2017) Making the best of both worlds: can high-resolution agricultural administrative data support the assessment of High Nature Value farmlands across Europe? Ecological Indicators 72, 118-130.
- Dauber J, Miyake S (2016) To integrate or to segregate food crop and energy crop cultivation at the landscape scale? - Perspectives on biodiversity conservation in agriculture in Europe. Energy, Sustainability and Society, 6:25.
- Müller AL, Dauber J (2016) Hoverflies (Diptera: Syrphidae) benefit from a cultivation of the bioenergy crop Silphium perfoliatum L. (Asteraceae) depending on larval feeding type, landscape composition and crop management. Agricultural and Forest Entomology 18, 419-431.
- Strohbach MW, Kohler ML, Dauber J, Klimek S (2015) High Nature Value farming: From indication to conservation. Ecological Indicators 57, 557-563.
- Dauber J, Cass S, Gabriel D, Harte K, Aström S, O'Rourke E, Stout JC (2015) Yield-biodiversity trade-off in patchy fields of Miscanthus x giganteus. Global Change Biology - Bioenergy 7, 455-467.

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IGÖ | Institute of Geoecology
Theoretical Ecohydrology

Mission Statement

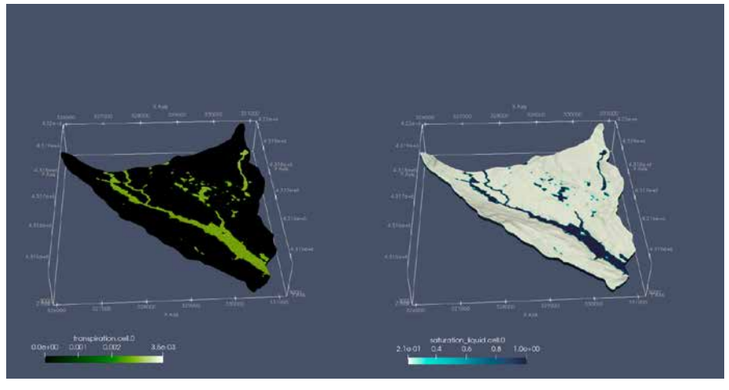
We use and develop theoretical methods – conceptual, mathematical, and numerical models – to study ecohydrological processes in urban and terrestrial systems, to support sustainable water and ecosystem management in these systems.

RESEARCH

Terrestrial ecohydrology
In terrestrial systems, hydro- and biosphere interact in a bidirectional way. The absence or abundance of water is often a limiting factor on vegetation growth, while vegetation modulates the hydrological cycle through transpiration. We numerically study plant–water relations in terrestrial systems. We are interested in plant response to water stress, from floods to droughts, and ecosystem resilience to wildfire.

Urban ecohydrology
Urban areas are characterised by a high degree of surface sealing and heterogeneity, which leads to a substantial disturbance of ecohydrological processes. Components of both the hydrological cycle and the ecosystems are disconnected to such a degree that they cannot be described using conventional concepts from „undisturbed" natural systems. We are studying the impact of urbanisation on ecohydrological processes using computational and data-driven approaches to improve our process understanding. Our efforts are related to urban Critical Zone Science, the study of relations among all compartments of Earth's Critical Zone in urbanised areas.

High-performance ecohydrological computing
Advances in computer technology have radically increased computing capabilities. However, the recent development of heterogeneous computer architectures in the current generation of supercomputing clusters poses a challenge, because writing parallelised code that performs similarly well across all these different architectures is non-trivial. Our group is part of the SERGHEI developer team, which aims to develop and maintain an open source high-performance code for ecohydrological simulations. SERGHEI can be run with similar performance on a broad range of computer architectures, ranging from personal computers to multi-GPU supercomputing clusters.



IGÖ | Prof. Dr. Ilhan Özgen

Researcher's Career

- Juniorprofessor of Modelling Urban Environmental Interfaces, Technische Universität Braunschweig
- Affiliate Faculty, Earth & Environmental Sciences Area, Lawrence Berkeley National Laboratory (USA)
- Postdoctoral Scholar, Earth & Environmental Sciences Area, Lawrence Berkeley National Laboratory (USA)
- Visiting Scientist, RIKEN Advanced Institute for Computational Science (Japan)
- Dr.-Ing., Technische Universität Berlin

TEACHING

Foundations of ecohydrology
Ecohydrology is an emerging subdiscipline of hydrology that focuses on the bidirectional interactions and feedbacks among hydro- and biosphere. It is related to Critical Zone science, the interdisciplinary study of processes across the compartments in Earth's Critical Zone—the thin layer of our planet that supports all life and spans from the canopies to the deeper regions of soil where groundwater flows freely. The lecture introduces fundamental concepts of terrestrial ecohydrology in various terrestrial systems, from drylands to wetlands and forests to urban areas and from plant scale to the catchment scale. Students work on a small research project along the lectures.

Urban ecohydrology
Urban ecohydrology studies plant–water relations within urban settings. The course discusses topics that are specific to urban sites, such as the urban water balance, urban groundwater recharge, urban heat islands, and the role of urban green spaces.

Modelling plant–water relations
Computational methods and computational models are important tools for ecohydrological investigations. Here, a key building block of such models are the so-called soil–plant–atmosphere continuum (SPAC) models, that describe the water flux through the plants from the soil to the leaf and atmospere. These essentially one-dimensional column models are often incorporated into large scale ecohydrological models and Earth System models. This course introduces students to this fundamental building block. We review model approaches for all compartments of the SPAC-soil, plant, and transpiration from the leaf into the atmosphere. Guest lectures from international researchers inform the students on research at the frontier of ecohydrological modelling.

Publications and Patents

- Caviedes-Voullième, D., Morales-Hernández, M., Norman, M.R., Özgen-Xian, I. (2022) SERGHEI(-SWE) v1.0: a performance portable HPC shallow water solver for hydrology and environmental hydraulics. *Geoscientific Model Development Discussions*.
- Xu, Z., Molins, S., Özgen-Xian, I., Svyatsky, D., Moulton, J.D., Steefel, C.I. (2022) Understanding the hydrogeochemical response of a mountainous watershed using integrated surface–subsurface flow and reactive transport modeling, *Water Resources Research*, 58, e2022WR032075.
- Özgen-Xian, I., Xia, X., Liang, Q., Hinkelmann, R., Liang, D., Hou, J. (2021) Innovations towards the next generation of shallow flow models, *Advances in Water Resources*, 149, 103867.
- Li, Z., Özgen-Xian, I., Maina, F.Z. (2021) A mass-conservative predictor-corrector solution to the 1D Richards equation with adaptive time control, *Journal of Hydrology*, 592, 125809.

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IGP | Institute of Geodesy and Photogrammetry

Mission Statement

We are performing research and education in the broad field of geodesy, which is the science of measurement and representation of the earth. In particular, we are active in engineering geodesy, remote sensing, photogrammetry and geoinformatics. Research questions range from the country or even continent level - such as quantification of land subsidence - to the individual (man-made) object, like digital building documentation.

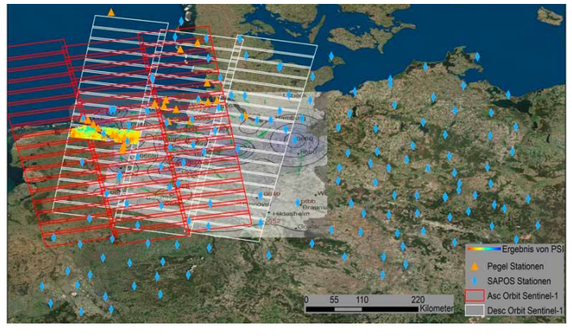
RESEARCH

Engineering Geodesy: The determination and modeling of dynamic processes in large temporal and geometric resolution is one of the core tasks in engineering geodesy. We are deriving such models for instance for bridge constructions using state-of-the-art measuring technology and statistic tools.

SAR Remote Sensing: Modern methods of satellite-based Synthetic Aperture Radar (SAR) allow determining motions on the earth's surface within millimeter-range. In combination with other geodetic techniques such as levelling or GNSS we are modeling phenomena, which are interesting for many scientific fields. For instance, in a BMBF-funded project we evaluated land rise/subsidence along the North and Baltic Sea. In the DFG-funded graduate project 'Geo-ecosystems in transition on the Tibetan Plateau (TransTiP)' we contribute to a better understanding of soil dynamics along the Nam Co by employing and further developing SAR data processing. We also developed a new method for miminizing the influence of troposphere to measurements.

Photogrammetry and Lasercanning:
To efficiently and accurately capture and model as-built (man-made) objects by developing techniques in the domains of photogrammetry and laserscanning is another research field. This might range from the representation of entire settlement areas or buildings to individual parts in civil or mechanical engineering. This is in particular interesting within the digital construction processes, which are in the focus of current research. One category of devices, so-called drones (or Unmanned Aerial Vehicles, UAV), have gained substantial attention in the last decade. We are also working with those instruments, for instance to retrieve reliable geometric and thematic information. In other projects we develop and employ state-of-the-art deep learning technology in remote sensing.

Geoinformatics:
Geospatial object modeling, representation and querying in databases is done within the geoinformatics domain. One project was concerned with the modeling of fine dust distribution in large cities, where the 3D-environment plays a crucial role. The involvement of citizens and laymen into decision processes using modern, interactive geospatial technology is also part of this work.



Left side: Footprints of satellite images, GNSS and gauge stations in Northern Germany.

Right side:: To create geometric (three-dimensional) models out of image sequences is one of the tasks of Photogrammetry. The images in this case were taken by a UAV.

IGP | Prof. Dr.-Ing. Markus Gerke

Researcher's Career

- Full Professor for Spatial Information at the Institute of Geodesy and Photogrammetry, TU Braunschweig
- Assistant Professor for Image Sequence Analysis, University of Twente, Enschede, The Netherlands
- Carl-Pulfrich-Award
- Dr.-Ing., Leibniz University Hannover, Germany
- Dipl.-Ing. Geodesy, Leibniz University Hannover, Germany

Funding
DFG, EU, BMBF, BMDV, DAAD

TEACHING

Our teaching portfolio covers in BSc level all basic knowledge of geodesy, including earth shape modeling, map projections, traditional surveying, geo-monitoring, remote sensing, photogrammetry, laserscanning and geoinformatics. In individual projects towards the end of the bachelor´s programme, students may work on some more concrete problems, e.g. related to questions occurring in civil or environmental engineering. In the master´s programme, we are offering advanced courses for all our sub-disciplines, including extended projects in selected fields. In those we aim to concentrate on the interdisciplinary nature of geodesy: all projects are connected to research problems in civil, environmental or mechanical engineering. Bachelor or master theses are constantly offered for interested students, as well.

Publications

- Kirui P, Riedel B, Gerke M. 2022. Multi-temporal InSAR tropospheric delay modelling using Tikhonov regularization for Sentinel-1 C-band data. 2022. ISPRS Open Journal of Photogrammetry and Remote Sensing (6).
- Reinosch E, Gerke M, Riedel B, Schwalb A, Ye Q, Buckel J. 2021. Rock Glacier Inventory of the Western Nyainqêntanglha Range, Tibetan Plateau, Supported by InSAR Time Series and Automated Classification. Permafrost Periglac. 32 (4), 657–672.
- Gerke M. 2018. Developments in UAV-Photogrammetry. Journal of Digital Landscape Architecture (3) (open access):262-272
- Gerke M, Przybilla H-J. 2016. Accuracy of RTK-GNSS-supported UAV image blocks. Photogrammetrie – Fernerkundung – Geoinformation (PFG) 1: 17-30.
- Crommelinck S., Bennett R.M., Gerke M., Nex F.C., Yang M.Y., Vosselman G. 2016. Review of automatic feature extraction from high-resolution optical sensor data for UAV-based cadastral mapping. Remote Sensing, 8(8), 28p.
- Vetrivel A, Gerke M, Kerle N, Vosselman G. 2016. Identification of structurally damaged areas in airborne oblique images using a visual-bag-of-words approach. Remote Sensing 8(3): 231
- Rottensteiner F., Sohn G., Gerke M., Wegner J. D., Breitkopf U., Jung J. 2013. Results of the ISPRS benchmark on urban object detection and 3D building reconstruction. ISPRS Journal of Photogrammetry and Remote Sensing (93), 256-271.

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IIM | Institute for Infrastructure and Real Estate Management

Mission Statement

To meet the increasing demands of our fast moving modern society efficient management of infrastructure and real estate is needed within the whole lifecycle. Especially the aspects of sustainable development, operation, maintenance and financing become more important.

RESEARCH

Infrastructure Management: Assessment of PPP infrastructure project conditions focusing on possibilities of participation of SME enterprises. The examination was instructed by the Zentralverband Deutsches Baugewerbe (ZDB) at the current design of PPP projects in federal highway construction and is characterized by high project volumes and long maturities, which are perceived by construction SMEs as restricting competition.

Member of the Advisory Board of the Federal Ministry of Transport and Digital Infrastructure (BMVI) for the assessment report 'Alternative business and financing models in federal highway construction'. Aim of the assessment is to examine what suitable development opportunities are available for the financing of federal highway PPP projects.

Expert for the Commission 'Construction and Maintenance of the Transport Network' of the Conference of State Ministers of Transport, headed by Kurt Bodewig. The commission investigates potential financing and organisational models for the construction and operation of federal highways.

Real Estate Management: Evaluation of PPP real estate projects focusing on the operation phase. The examination is requested by the Hauptverband der Deutschen Bauindustrie to analyse the operative performance of PPP real estate projects which have been in use for a minimum of 2 years. The intended assessment criteria are:

- use costs
- performance quality
- innovations
- the change management / contract management
- dispute settlement
- PPP pulses
- the involvement of SMEs

IIM | Prof. Dr.-Ing. Tanja Kessel

Researcher's Career

- Head of Chair of Infrastructure and Real Estate Management
- Member of the Executive Board and General Partner PSPC GmbH
- Partner and CEO of PSPC GmbH
- Dr.-Ing. at the TU Berlin
- Study of Civil Engineering, TU Berlin
- Study of Civil Engineering, Loyola Marymount University, Los Angeles

Funding
BMVI, BMUB, BBSR, ZDB, HDB, Industry

Publications

- Kessel, Tanja, Kessel, Martti: Übertragung von Immobilienvermögen unter Berücksichtigung des Erbschafts- und Schenkungsgesetzes (ErbStG), Festschrift für Prof. Dieter Jacob, pp. 77 ff. (2015)
- Gottschling, Ines, Kessel, Tanja: Wirtschaftlichkeitsuntersuchungen bei öffentlichen Hochbaumaßnahmen in: Immobilien- und Bauwirtschaft aktuell – Entwicklungen und Tendenzen, Festschrift für Prof. Bernd Kochendörfer, pp. 47 ff. (2015)
- Kessel, Tanja, Völker, Wiebke: Nutzerverhalten ist wesentlich, Energieeffiziente Bauwerksbewirtschaftung, Behörden Spiegel Juni 2014, pp. 42
- Kohnke, Tanja, Riebeling, Klaus: PPP und Freibäder – zwei Praxismodelle, in: Knop, Detlef (Hrsg.), Public Private Partnership – Jahrbuch 2007, pp. 78-81 (2007)
- Kohnke, Tanja, Schauer, Werner: 3. Fallstudie PPP-Expresspaket der Stadt Köln in: Littwin, Frank/Schöne, Franz-Josef (Hrsg.), Public Private Partnership im öffentlichen Hochbau, Verlag W. Kohlhammer, pp. 416-422 (2006)

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IRMB | Institute for Computational Modeling in Civil Engineering | **Theory of Kinetic Methods**

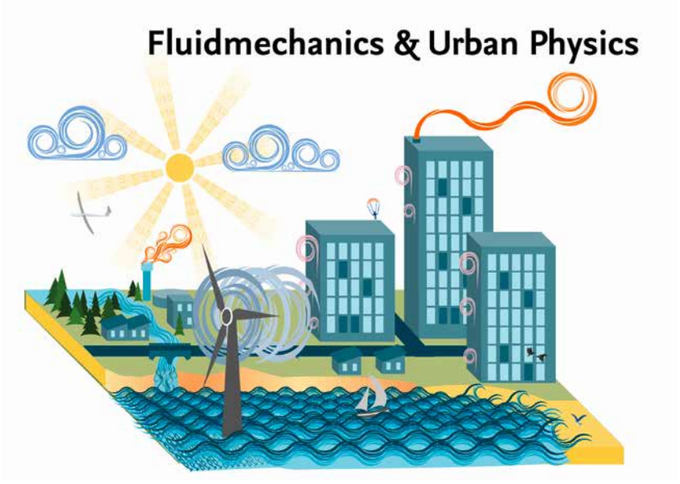
Mission Statement

Our mission is to develop efficient and accurate numerical models for transport problems in the natural and urban environment. Our approach is focused on the application of scalable kinetic methods describing matter as an ensemble of particles, rather than either individual molecules or a continuum.

RESEARCH

Our research focus is the development of kinetic methods for transport problems and a deepening of our theoretical understanding of such methods. Unlike continuum models, kinetic methods respect the molecular nature of matter. Unlike atomistic models they do not deal with individual particles but only with their statistic. They hence inherit some properties of atomist models while keeping the efficiency of continuum models. Our contribution to the theory of kinetic methods include the development of advanced statistical approaches based on cumulants and the development of efficient and versatile asymptotic analysis methods. With this we are able to automatically derive the equivalent continuum partial differential equation corresponding to a given kinetic method. This helped us to drastically increase the efficiency of our numerical simulations.

Kinetic methods are as parallel as nature, such that our algorithms run efficiently on modern many core computers such as GPUs. This enables us to apply our methods to complicated time dependent flow problems across many scales. Applications include fluids with complex rheology, (i.e. liquid cement), urban boundary layer flows, dispersion of pollutants, shallow water flows, reacting flows (i.e. fire) and classical lift and drag computations.



IRMB | Prof. Dr. rer. nat. Martin Geier

Researcher's Career

- W1 Professor for theory of kinetic methods
- Visiting professor at Indian Institute of Technology Kharagpur
- Visiting professor at Indian Institute of Technology Madras
- Post Doc at Kyoto University
- Dr. rer. nat. Albert-Ludwigs University Freiburg
- Diploma in Microsystems Engineering, Albert-Ludwigs University Freiburg

Funding:
DFG, DAAD, Japan Society of the Promotion of Science

TEACHING

Our teaching includes "Numerische Ingenieurmethoden" for bachelor students in civil and environmental engineering. Here we focus on the core principles of numerical approximations. This includes and understanding of how resolution influences accuracy and how numerical methods can be made more efficient. For master students we offer introductions to computer algebra methods and to the lattice Boltzmann method. These courses offer an advanced introduction to the derivation of numerical methods and their analysis through asymptotic analysis. In bachelor and master projects offered by us students can participate in the extension of our versatile open source fluid solver VirtualFluids.

Publications

- M. Geier, K. Kutscher, M. Krafczyk, "A direct effective viscosity approach for modeling and simulating Bingham Fluids with the cumulant lattice Boltzmann method", Open Journal of Fluid Dynamics, 11 (01), 34, 2021.
- M. Geier, A. Pasquali, M. Schönherr, "Parametrization of the cumulant lattice Boltzmann method for fourth order accurate diffusion Part I: derivation and validation", Journal of Computational Physics, vol. 348, no. 1 pp. 862-888, 2017.
- [M. Geier, M. Schönherr, "Esoteric Twist: An Efficient in-Place Streaming Algorithm for the Lattice Boltzmann Method on Massively Parallel Hardware", Computation, vol. 5 no. 2, 2017.
- M. Geier, M. Schönherr, A. Pasquali, M. Krafczyk, "The Cumulant Lattice Boltzmann Equation in three dimensions: theory and validation", Computers and Mathematics with Applications, vol. 70, issue 4, p. 507, 2015.
- M. Geier, A. Fakhari, T. Lee, "Conservative phase-field lattice Boltzmann equation for interface tracking", Physical Review E 91, p. 063309, 2015.

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IRMB | Institute for computational modeling in civil engineering *[Institut für Rechnergestützte Modellierung im Bauingenieurwesen]*
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IRMB | Institute for Computational Modeling in Civil Engineering | **Data-Driven Modeling**

Mission Statement

Modeling & Numerics & Machine Learning
Engineers develop models based on physical considerations and observational data to design, monitor and control infrastructures and products. Complex models can only be solved numerically with the aid of computers. Tailored machine learning approaches help us to link the information from experiments, sensing and simulations to build next generation models: digital twins.

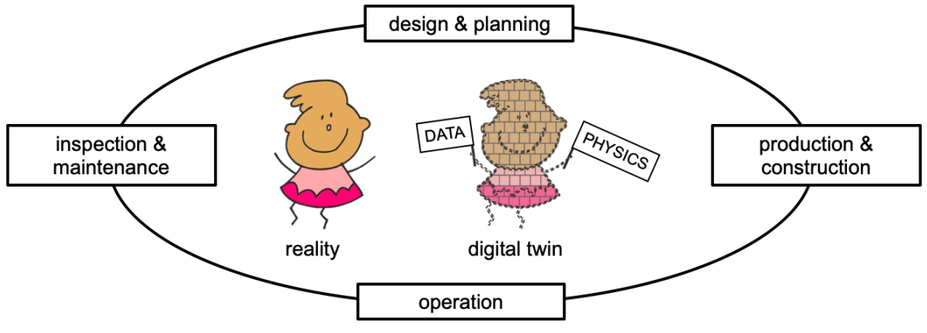
RESEARCH

Inverse problems and parameter identification
Engineers often have to deal with incomplete observations. Given such incomplete information, what is the stress field inside a steel girder? How does the flow field inside a river look like? Inverse modeling and parameter identification are our strategies to relate sparse information to what remains hidden to the human eye.

Model updating
Accurate computational models are often time consuming and lagging behind real time. Therefore, often simplified models are used for monitoring and control. Data-driven models enable a transfer of information from detailed computational models to service life.

Multi-scale modeling
It is understood that the composition and structure of materials at smaller scales determines their behavior on the component scale that is relevant for designers. We develop data-driven models to exploit this understanding for the optimization of materials in virtual design loops and for their monitoring during service life.

Additive manufacturing & multi-physics
Increased flexibility for designers is what made additive manufacturing popular. This flexibility is mostly due to the large amount of process parameters, which make process planning a complicated endeavor. With sophisticated computational methods we aim to increase this flexibility beyond what is known today, e.g. towards functionally graded materials.



IRMB | Prof. Dr.-Ing. Henning Wessels

Researcher's Career

- Assistant Professor at the Institute for Computational Modeling in Civil Engineering
- Awarded a Feodor-Lynen fellowhship of the Alexander-von-Humboldt foundation for a research stay at Brown University (not realized due to the pandemic)
- Scientific assistant (PhD and Postdoc) at the Institute for Continuum Mechanics at Leibniz University Hannover
- Fulbright Fellow and Visiting Scholar at UC Berkeley
- M.Sc. and B.Sc. in Mechanical Engineering from Leibniz University Hannover
- Internship at Robert Bosch GmbH
- Erasmus at Aristotle University, Thessaloniki

Funding
DFG, BMBF, BMUV,
State of Lower Saxony (MWK)

TEACHING

As in research, our courses cover the intersection of modeling, numerics and machine learning. Since data in engineering is usually limited, we learn how machine learning algorithms can be enriched with physical models. Given some observational data, students will be confronted with the questions: What is useful to learn? What is save to learn? How about the physics? What is the range of applicability of a trained model?

- In the course data-driven material modeling, we first integrate neural networks as material models into a finite element environment. Advanced lectures cover physics-informed neural networks, inverse problems and multi-scale materials from a data-driven mechanics perspective.
- In algorithms and programming, concepts are taught that enable students to understand existing and especially to draft own R&D software.
- In the project KI4All (ki4all.net) we are developing microcredentials: small study units, that provide students hands-on insight into current AI topics and encourage to realize own AI projects.

Publications

- Henkes, A. and Wessels, H.: Three-dimensional microstructure generation using generative adversarial neural networks in the context of continuum micromechanics. In: Computer Methods in Applied Mechanics and Engineering 400 (2022).
- Henkes, A., Wessels, H. and Mahnken, R.: Physics informed neural networks for continuum micromechanics. In: Computer Methods in Applied Mechanics and Engineering 393 (2022).
- Narouie, V. B., Wessels, H. and Römer, U.: Inferring Displacement Fields from Sparse Measurements Using the Statistical Finite Element Method. In: arXiv preprint arXiv:2212.13467 (2022).
- Fürstenau, J.-P., Wessels, H., Weißenfels, C. and Wriggers, P.: Generating virtual process maps of SLM using powder-scale SPH simulations. In: Computational Particle Mechanics 7.4 (2020).
- Wessels, H., Weißenfels, C. and Wriggers, P: The neural particle method – an updated Lagrangian physics informed neural network for computational fluid dynamics. In: Computer Methods in Applied Mechanics and Engineering 368 (2020).
- Wessels, H., Bode, T., Weißenfels, C., Wriggers, P. and Zohdi, T. I.: Investigation of heat source modeling for selective laser melting. In: Computational Mechanics 63.5 (2019).

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IS | Institute of Steel Structures

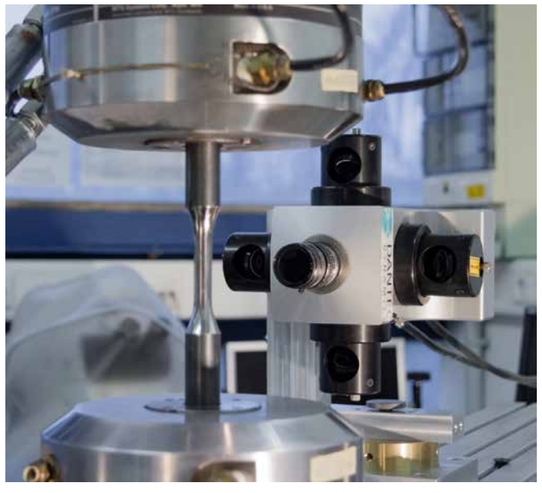
Mission Statement

Steel plays an increasingly important role for light-weight and wide-spanning civil engineering structures with advantages in economy and sustainability. Our work includes fundamental research as well as application-oriented research – also in fields connected to steel construction as wind engineering and building preservation.

RESEARCH

Remaining Service Life of Steel Structures.
For existing bridges and crane structures, quantification of the expected remaining service life time is of great importance. Up to now, no in-situ method is available to identify the pre-crack material aging. Several approaches are investigated within this project.

Material Properties under very high strain velocity.
High speed loading like explosions impose severe damage to structures. Design methods are to be developed to ensure safe evacuation of buildings after such events. The current project classifies typical construction steel due to its properties under high speed loading to predict structural robustness.



Design of silo structures with eccentric discharging.
Today's design of silo structures is not in all cases done with safe load assumptions. A numerical model for eccentric discharging behavior of silo content is developed. With this information, an engineering model for relevant loading of the silo structure is to be developed.

Material and process analysis.
As a subproject in the framework of the DFG Research Training Group "GRK 2075 - Modelling the constitutional evolution of building materials and structures with respect to aging", the fatigue behaviour of bolts with large diameters is examined. The aim of this project is the quantification of the residual stress state resulting from the deep-rolling process of the thread, as determined by x-ray or neutron diffraction at HZ-Berlin, as well as DIC-mesurements and complex material testing.

Three dimensional full-scale wind measurements on a 344 m high guyed mast.
Until now, wind speed and wind direction have been described using line like arrangement of wind sensors vertically or horizontally. A new extended wind measuring system based on 48 3d-ultrasonic anemometers is installed along the guys of the mast. From these measurements, improved models are developed to describe the structure of the atmospheric boundary layer.

IS | Prof. Dr. sc. tech. Klaus Thiele

Researcher's Career

- Head of Institute of Steel Structures, TU Braunschweig
- Acting Head of Institute of Preservation of Buildings and Structure
- Full Professor of Steel Structures, TU Braunschweig
- Head of Design and Construction Office at Max Bögl Stahl- und Anlagenbau GmbH&Co. KG, Neumarkt
- Dr. sc. techn. at IBK, ETH Zürich
- M.E.Sc. at Boundary Layer Wind Tunnel Laboratory, University of Western Ontario, London, Canada
- Dipl.-Ing., Civil Engineering, TH Darmstadt

Funding
DFG, AiF, DAAD, Industry

TEACHING

We pursue an education that is ambitious in creating theoretical background and training practical skills. Cooperation with industry and engineering offices reinforces the practical relevance in teaching. A close connection to the research at the institute ensures to meet the scientific claim of our teaching.

For Bachelor´s programmes, the basic course 'Stahlbau 1' introduces a general view on steel construction principles, the design of members, bolts and weldings, and an elementary view on stability issues. The advanced course 'Stahlbau 2' consolidates the concepts of modeling of systems, loads and material and introduces composite construction.

'Stahlbau 2' received the LehrLEO prize 2018 for the best lecture at TU Braunschweig.

The Steel construction specialisation in master's programmes contains three main courses: At the beginning, the fundamentals of steel design are deepened for lateral torsional buckling, plate buckling, warping torsion and fatigue, a practical training in the lab is included. Secondly, during a design course students practice the steel structure development. The ability to tackle engineering tasks independently, to develop constructions alone or in groups and to convey them to others plays an important role. In a third course, special topics as lightweight steel structures, steel cable structures, wind engineering and dynamics are offered.

We offer study projects as design and construction work. For Master students, we also offer scientific projects that are supported by lectures on scientific writing.

Publications and Patents

- Gusella, F., Orlando, M., Vignoli, A., Thiele, K.: Flexural capacity of steel rack connections via the component method. Open Construction and Building Technology Journal (2018)
- Höbbel, T., Thiele, K., Clobes, M.: Wind turbulence parameters from three dimensional full-scale measurements at 344 m high guyed mast site Gartow 2. Journal of Wind Engineering and Industrial Aerodynamics (2018), S. 341–350
- Ritter, K., Thiele, K.: Zur frühen Detektion von Ermüdungsrissen mithilfe der Speckle-Interferometrie. 21. DASt-Forschungskolloquium (2018), S. 134–139
- Scholl, N., Minuth-Hadi, F., Thiele, K.: Modelling the Strain Rate Dependent Hardening of Constructional Steel using semi-empirical models. Journal of Constructional Steel Research (June 2018), S. 414–424
- Stengel, D., Thiele, K., Clobes, M., Mehdianpour M.: Aerodynamic damping of nonlinear movement of conductor cables in wind tunnel tests, numerical simulations and full scale measurements. Journal of Wind Engineering & Industrial Aerodynamics (October 2017), S. 47–53
- Unglaub. J., Reininghaus. M., Thiele, K.: The fatigue behaviour of bolts with large diameters under overloading. The Eighth International Conference on Low Cycle Fatigue (LCF8) 27.- 29.06 2017, Dresden

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ISBS | Braunschweig Pavement Engineering Centre

Mission Statement

The major requirements of modern road pavements are safety, functionality and sustainability. Our research work focuses on these requirements, emphasizing the increase in durability of asphalt pavements by means of structural optimisation for making the design, selection of materials and construction, rehabilitation & recycling techniques as fully perfect and effective as possible.

RESEARCH

Laboratory testing of road building materials:
We run a well-equipped laboratory for testing asphalt materials, in particular for identifying the characteristics of the individual components (aggregate and bitumen) as well as of the composed mixtures. We use the latest test methods and are developing new performance-based methods. Thus, new recipes can be optimized, and asphalt quality can be assured.

Modeling behavior of road materials and pavement structures: With help of the results from laboratory testing and by means of computer simulation of road pavement behavior under controlled climate conditions and under repeated loading, we predict short- and long-term performance of road materials and pavement structures. Our objective is to support the development and optimisation of new road building materials and new methods for pavement design and road construction, rehabilitation & recycling techniques, considering the actual growth in heavy vehicle traffic, new trends in the automobile and tire industries, the effects of climate, as well as the changing availability of bitumen and the strong need for re-using reclaimed asphalts.

Developing tools for systematic pavement management:
We are developing methods for pavement condition assessment and evaluation, as well as for systematic road maintenance. A major research focus is dedicated to improving the performance prediction functions within Pavement Management Systems (PMS) by considering the individual properties of the actual pavement materials and structures.

ISBS | Prof. Dipl.-Ing. Dr. techn. Michael P. Wistuba

Researcher's Career

- Full Professor of Pavement Engineering, TU Braunschweig
- Head of Braunschweig Pavement Engineering Centre
- Board member of the accredited testing laboratory for road-building materials according to the German guidelines RAPStra, Braunschweig
- Steering group member of the European Asphalt Technology Association (EATA)
- Scientific board member of Deutsches Asphaltinstitut (DAI)
- Scientific board member of the Swiss Expert Association for Road and Transport Engineering (VSS)
- Board member of Christian Doppler Laboratory for performance based optimization of flexible road pavements, TU Wien, 2003-2008
- Post-Doc research associate at Ecole polytechnique fédérale de Lausanne (EPFL, Switzerland), 2002-2003
- Ph.D. in Civil Engineering, TU Wien
- Research Associate at TU Wien, 1988-2008
- Diploma in Civil Engineering, TU Wien, 1989

Funding
EU, BMVBS, BASt, AiF, FFG, DAAD, Lower Saxony, industry

Publications

- Cannone-Falchetto, A., Moon, K. H. & Wistuba, M. 2014. Microstructural Analysis and Rheological Modeling of Asphalt Mixtures Containing Recycled Asphalt Materials. Materials, Int. Journal, MDPI editions, Special Issue Recycled Materials vol. 7, pp. 6254-6280, open access publication, doi:10.3390/ ma7096254, ISSN 1996-1944, www.mdpi.com/journal/materials.
- Cannone Falchetto, A., Wistuba, M. & Marasteanu, M. Size effect in asphalt mixture at low temperature: Type I and Type II. Proc., Association of Asphalt Paving Technologists Annual Meeting, March 13-16, 2016, Indianapolis.
- Büchler, S., Wistuba, M. & Cannone-Falchetto, A. 2015. Evaluation of crack propagation in asphalt mixture through photoelasticity. Proc., 8th Int. RILEM SIB Symposium, Testing and Characterization of Sustainable & Innovative Bituminous Materials, October 7-9, 2015, Ancona, Italy.
- Isailović, I., Cannone-Falchetto, A. & Wistuba, M. 2015. Energy Dissipation in Asphalt Mixtures Observed in Different Cyclic Stress-Controlled Fatigue Tests. Proc., 8th Int. RILEM SIB Symposium, Testing and Characterization of Sustainable & Innovative Bituminous Materials, October 7-9, 2015, Ancona, Italy.
- Wistuba, M., Weninger-Vycudil, A., Ringleb, A., Mladenovic, G. & Litzka, J. 2013. 'InteMat4PMS' – Integration of material-science based performance models into life-cycle-analysis processed in the frame of pavement management systems. Final report, No 832708, ERAnet-Road II.

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ISD | Institute of Structural Analysis

Mission Statement

Research and teaching aim at modeling the stess-deformation behavior of civil engineering structures. Limit states concerning instabilities and failure as well as coupled multi-field processes are in focus, employing adequate numerical methods as finite element or discrete element analysis.

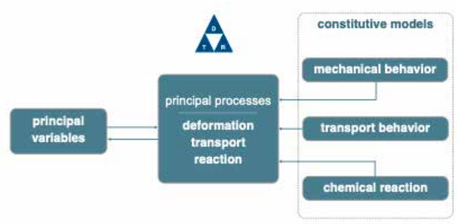
RESEARCH

Material Modeling:
Inelastic material behavior concerning plastic and viscoplastic deformations as well as damage up to failure is modeled in context of continuum mechanics and thermodynamics of irreversible processes. Numerical analyses are performed with adequate tools, e.g. FEM and DEM. Nonlocal damage behavior is modeled employing gradient enhanced formulations in FEM.

Multicomponent materials as concrete, UHPFRC, soil, waste, asphalt or wood are modeled, anisotropies are taken into account to describe elastic, inelastic and transport behavior. In many fields of engineering it is important to predict the failure of components as exact as possible. Especially statements concerning the time of failure, the location and the ultimate loading are of great interest. Therefore, life-cycle management systems are to be established for effective maintenance and to prevent failure.

Model parameters are to be determined from experimental data. Numerical optimization strategies are employed, which identify iteratively the best set of parameters for a given model. Thereby the target function influences significantly the quality of the results. Hybrid strategies combine the excellent global search characteristics of stochastic evolution strategies with the high rate of convergence of deterministic gradient and simplex methods.

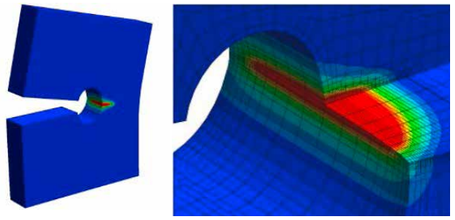
Coupled Multi-field Processes:
Multiphysics phenomena including material mechanics, transport processes focusing on thermal and hydraulical transport mechanisms, chemical reactions as well as biological processes are modeled to analyse complex structures. In porous media, like concrete, asphalt, soil or waste, the different physical-mechanical, biological-chemical or transport processes interact strongly with each other. Research aims at efficient algorithms for numerical analysis of thermo-hygro-mechanical-chemical coupled processes in volume coupled multifield systems. Significant couplings are to be considered in the related constitutive models.

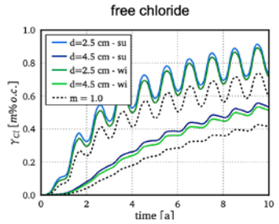


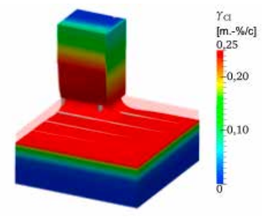
above: Solution strategy for coupled multi-field processes.

left: Steel CT-specimen, creep damage distribution. Optical enlargement of damage distribution.

below: Chloride concentration at the column base of a parking deck.







ISD | Prof. Dr.-Ing. Ursula Kowalsky

Researcher's Career

- Deputy Head of Institute
- Deputy speaker of RTG 2075
- Adjunct Professor for "Structural Analysis"
- Academic Director of Institute of Structural Analysis
- Dean of Studies (CSE)
- Course Director of the international Master's programme "Computational Sciences in Engineering" (CSE)
- Senior Researcher at Institute of Structural Analysis
- Dr.-Ing. TU Braunschweig
- Dipl.-Ing. TU Braunschweig

Funding:
DFG, DAAD

TEACHING

Limit Load Analysis:
- steel and reinforced concrete structures
- limit loads of frames
- M-N interaction
- theories of 1st and 2nd order
- deformations at limit state

Modeling of Discrete Structures:
- advanced beam and arch models
- cable networks
- girder grids
- soil-structure interaction
- cross bracing of tall buildings

Introduction to Finite Element Methods:
- principle of virtual displacements
- weighted residuals
- bars, beams, membrane and bending structures
- heat conduction
- quadrilateral and triangular elements
- isoparametric concept
- numerical integration
- error indication and estimation

Advanced Finite Element Methods:
- advanced element formulations
- mixed and hybrid formulations
- geometrically nonlinear structural behavior
- physically nonlinear material and structural behavior

Publications

- R. G. Venkateswaran, U. Kowalsky, D. Dinkler. A modified bond model for describing isotropic linear elastic material behaviour with the discrete element method, Computational Particle Mechanics, 2021. [DOI]
- Reinstädler, S.; Kowalsky, U.; Dinkler, D.: Analysis of landslides employing a space-time single-phase level-set method. Comput. Methods Appl. Mech. Engrg. 347, pp. 639-662, 2019.
- Lanwer, J.-P.; Oettel, V.; Empelmann, M.; Höper, S.; Kowalsky, U.; Dinkler, D.: Bond behavior of micro steel fibers embedded in ultra-high performance concrete subjected to monotonic and cyclic loading. Structural Concrete 20, Heft 4, S. 1243-1253 (2019).
- F. Cramer, U. Kowalsky, and D. Dinkler. Coupled chemical and mechanical processes in concrete structures with respect to aging. Coupled systems mechanics, 3:53-71, March 2014. [DOI]
- U. Kowalsky, S. Bente, and D. Dinkler. Modeling of coupled THMC processes in porous media. Coupled systems mechanics, 3:27-52, March 2014. [DOI]
- U. Kowalsky, J. Meyer, S. Heinrich, and D. Dinkler. A nonlocal damage model for mild steel under inelastic cyclic straining. Computational Materials Science, 63:28-34, 2012. [DOI]
- K. Schuster, U. Kowalsky, and D. Dinkler. System identification and structural health monitoring using piezoceramic actuators. Mechanics of Advanced Materials and Structures, 18(7):540-547, 2011. [DOI]
- U. Kowalsky, T. Zümendorf, and D. Dinkler. Random Fluctuations of Material Behaviour in FE-Damage-Analysis. Computational Material Science, 39:8-16, 2007. [DOI]

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ISWW | Institute of Sanitary and Environmental Engineering

Mission Statement

Developing the wastewater sector towards a circular economy: water reuse, resource recovery, production of renewable bio-energy while removing pathogens and pollutants by applying multi-barrier concepts. Resource oriented sanitation concepts (NASS), resource economy and materials flow management, transformation-concepts for the wastewater sector.

RESEARCH

Environmental Process Technology
The ISWW develops and investigates process technologies and process chains for the treatment and processing of water, wastewater and sewage sludge, for the recovery of nutrients and for regenerative bio-energy production in municipal and industrial sectors.

Water Reuse in Hydroponic Systems
The ISWW has been leading the inter- and transdisciplinary BMBF projects HypoWave and HypoWave+, where an innovative concept for a resource-efficient water reuse in hydroponic systems for regional vegetable production is being developed and implemented on a large scale for the first time. Key objectives include the development of new water sources for agricultural irrigation, the appropriate treatment of the irrigation water, the use of nutrients from the wastewater sector and the production of high-quality agricultural products.

Phosphor-Recycling and Management
Municipal wastewater is one of the most important collectors of the essential and finite resource phosphorus within our economic system. However, until now phosphate contained in wastewater has not been returned to the economic cycle but disposed of with sewage sludge. The ISWW is head of the joint research project P-Net, in which phosphate is recovered as secondary raw material fertilizer at wastewater treatment plants and - starting from the region Braunschweig-Gifhorn - a regional network for phosphorus recycling and management is to be established.

Renewable Bio-Energy
In numerous projects, the ISWW has been investigating the generation of regenerative energy based on organic residues from the wastewater sector. This includes the production of biogas from wastewater, sewage sludge and renewable raw materials, the increase of substrate availability by using disintegration processes as well as the development of bioelectrochemical systems such as microbial fuel cells and microbial electrolysis cells.

Removal of Organic Micropollutants
Wastewater frequently contains organic trace substances such as pharmaceutical residues which are often only insufficiently degraded during the wastewater treatment process. The ISWW is working on innovative processes such as activated carbon biofiltration, which are highly successful in removing trace substances from wastewater treatment plant effluents and irrigation water.

ISWW | Prof. Dr.-Ing. habil. Thomas Dockhorn

Researcher's Career

- Director of ISWW
- Prof. at TU Braunschweig
- Habilitation on Resource-Economy and Materials flow Management at TU Braunschweig
- Dr.-Ing. in Sanitary Engineering at TU Braunschweig
- Study of Biology at TU Braunschweig

Funding:
BMBF, BMELV, BMU, DBU, Industry, Municipalities

TEACHING

Sanitary Engineering is an integral part of the BSc and MSc courses in Civil and Environmental Engineering. In addition, students from up to 20 different study programs take part in our classes in the course of interdisciplinary qualification.

Besides our fundamental lectures where students acquire all the basic and specialized knowledge required for the understanding and dimensioning of wastewater and sludge treatment systems, we also offer interactive seminars where students can apply their acquired knowledge by working in teams on case studies in national and international contexts.

We also supervise numerous BSc and MSc theses, most of which are offered as practical research work in our various projects investigating exciting and current research topics.

Publications

- Kreuzig, R., Haller-Jans, J., Bischoff, C., Leppin, J., Germer, J., Mohr, M., Bliedung, A., Dockhorn, T. (2021): Reclaimed water driven lettuce cultivation in a hydroponic system: The need of micropollutant removal by advanced wastewater treatment. Environmental Science and Pollution Research. https://doi.org/10.1007/s11356-021-14144-6
- Mohr, M., Dockhorn, T., Drewes. J.E., Karwat, S., Lackner, S., Lotz, B., Nahrstedt, A., Nocker, A., Schramm, E., Zimmermann, M. (2020): Assuring water quality along multi-barrier treatment systems for agricultural water reuse. Journal of Water Reuse and Desalination, jwrd2020039. https://doi.org/10.2166/wrd.2020.039.
- Bliedung, A., Dockhorn, T., Germer, J., Mayerl, C., Mohr, M. (2020): Experiences of running a hydroponic system in a pilot scale for resource efficient water reuse. Journal of Water Reuse and Desalination, jwrd2020014. https://doi.org/10.2166/wrd.2020.014.
- Dockhorn, T. (2016): The Resource Economic Dimension of Wastewater Treatment vs. Green Technologies. In: Green Technologies for Sustainable Water Management; ASCE, ISBN: 978-0-78441-442-2|, pp. 753-788 http://dx.doi.org/10.1061/9780784414422#sthash.VjnVv1Wc.dpuf
- Brown, R.K., Harnisch, F., Dockhorn, T., Schröder, U. (2015): Examining sludge production in bioelectrochemical systems treating domestic wastewater; Bioresource Technology, 198 (2015) 913-917
- Dockhorn, T. (2014):, The role of engineering sciences in sustainable water management. In: Five Years of Exceed –Sustainable Water Management in Developing Countries. ISBN 978-3-00-046519-2, S. 36-44

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IVE | Institute of Transport, Railway Construction and Operation

Mission Statement

Integration, efficiency and competitiveness of the railway system determines the work of IVE in the fields of research, teaching and consulting. Scientific employees of various disciplines develop system and special detail solutions. National and international co-operations enable us to process a wide range of subjects.

RESEARCH

The work on research projects forms a major work field. Besides railway operational questions all other fields of transportation are contents of the research activities at the institute.

Specific fields of activity:

- Strategies and transport planning in passenger and freight traffic
- Railway operation, scheduling, rolling stock rostering
- Track technology
- System research
- Software development

Our projects benefit from the existing scientific knowhow within the institute and the developed software and tools. The experience gained in consulting projects and research activities is fed back into university teaching.

Operational analysis, timetabling and simulation:

- Capacity analysis of Hamburg port railways
- Concept for regional railways Braunschweig 2014+
- Operational concept for the U-Bahn München
- Concept for express-trains for the S-Bahn Hannover

Strategic Investigation

- Microscopic feasibility study Deutschland-Takt
- Influence of the infrastructure on the reliability of the railway system (BVWP 2015)
- REPLAN - Optimisation of the alignment of time supplements and buffer times

Permanent Way:

- Evaluation of the load transmission on tracks with ballast
- Model for the optimisation of the length of track possessions

The following software we developed with the institute is distributed by co-operation partners:

- Dispo (Optimised Vehicle Allocation)
- Dispo-IRM (Recovery of past incident effects)
- DWS (Digital Ordering of Turnouts)
- Dynamis® (Driving Dynamic Calculations of any Train Configuration)
- EcoTransIT World® (www.ecotransit.org) (Ecological Transport Information Tool)
- NEMO (Network Evaluation Model)
- RailSys® (www.rmcon.de) (Innovative Solutions for Railway Transport)
- SOG® (Computer Aided Planning of Track Maintenance)

IVE | Prof. Dr. Thomas Siefer

Researcher's Career

- Full Professor TU Braunschweig
- Adivsory Professor Tongji University Shanghai
- Visiting Professor, Beijing Jiaotong University
- Managing partner of IVE mbH
- Chairman of DVWG Niedersachsen-Bremen
- spokesman of the scientific advisory board of VDV
- Full Professor Leibniz University of Hannover 1997 - 2009
- Project manager 'railway operation', Deutsche Bahn AG
- Member of staff at Deutsche Bundesbahn
- German 'Bauassessor'
- Special on-the-job training at Deutsche Bundesbahn
- Study of Civil engineering, University of Hannover

Funding

BMBF, State Lower Saxony, EU, Industry

TEACHING

Teaching at IVE deals with the engineering questions of track technology and railway operations research.
In addition to the design of the superstructure, questions of maintenance play an important role, as rail operation should also be possible during the construction phases if possible. These requirements are dealt under the topic 'Driving and Building'.

In addition, the entire subject area of public transport is covered, with the topics 'operation and vehicles', 'planning of infrastructure' and 'offer planning'. In addition, concepts for future passenger and freight transport by rail are developed in the lecture 'offer planning and transport strategies'.

In the lectures, it is taught that in addition to the purely engineering tasks, the requirements of the customers also play a major role in the acceptance of public transport and the railway system.

Publications

- Siefer, Th., Lillie, D. (2017): Smarte Bauablaufdokumentation auf Gleisbaustellen in Ingenieurspiegel 2/2017
- Siefer, Th; Jiang, Zhibin, Coping with growth on China´s urban rail networks, metro Report International Juni 2016
- Siefer, Th.; Fangrat, S.; Kiehl, M. (2014): Connection of the City of Nordhorn to the regional passenger rail transport, in EI-Der Eisenbahningenieur 09/2014, pp. 98ff.
- Siefer, Th.; Jakob, C.: Neue Studienangebote - Mehr Nachwuchs im Ingenieurbereich? in ZEVrail 6-7 2014
- Siefer: Bahnkompetenz in Braunschweig, in Privatbahn Mag., 01/02 2014
- Siefer, Th.; Kollenberg, C.: Dem Verschleiß auf der Spur, in Privatbahn Magazin 06/2013
- Siefer, Th.; Fangrat, S.; Geschwinder, K.: Extended offer in regional passenger transport in the Hanover region, in EI, 11/2012.
- Siefer, Th.; Fangrat, S.: Adjustment and dimensioning of time supplements within the project RePlan, in ETR-Eisenbahntechnische Rundschau, 01+02/2012.
- Siefer, Th.; Gille, A.: Simulation of operations for capacity usage differentiation, in EI, 07/2011
- Gille, A.; Bittner, S.; Klemenz, M.: Passenger-oriented public transport connection planning, in EI, 06/2011
- Gille, A.; Siegmann, J.; Balser (2011): Route planning based on abstracted infrastructure data, in EI, 05/2011
- Gille, Radtke, Ostermayer, Anthes: EcoTransITWord – Online calculation for worldwide green logistics, in EIK - Eisenbahningenieurkalender 2012
- Siefer, Th.; Gille, A.: Capacity Simulation, Paper on the congress Intern. Association for Railway Orientated Research (IAROR), Rom 2011

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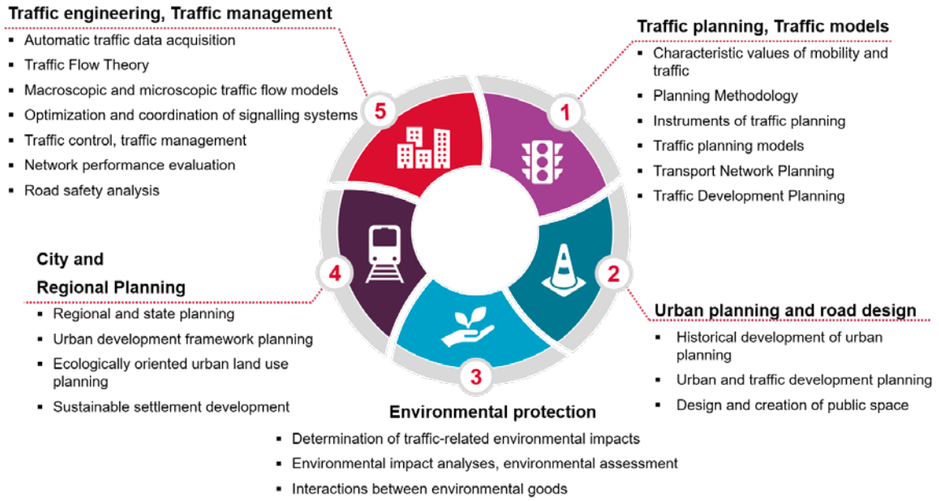
IVS | Institute of Transportation and Urban Engineering

Mission Statement

Both the individual mobility of people and the planning of urban spaces are changing in the context of climate change and increasing digitalization. Our research focuses on innovative methods for surveying, modeling, and managing traffic to create livable and efficient cities.

RESEARCH



IVS | Univ.-Prof. Dr. Bernhard Friedrich

Researcher's Career

- Director of Institute of Transportation and Urban Engineering at TU Braunschweig
- University Professor for Planning, Design and Operation of Road Traffic Facilities at the Leibniz University of Hannover 2000 – 2007
- Founding and establishing of the engineering company TRANSVER as managing partner
- PhD at the Technical University of Munich
- Research Assistant at the Department of Traffic Planning and Traffic Engineering at the TU Munich
- Diploma in Civil Engineering at the Technical University of Munich

Funding
DFG, BMDV, BMBF, DAAD, BASt

TEACHING

With our courses we offer a wide range of topics in the fields of urban and regional planning, traffic planning, traffic engineering and environmental protection. In this way we create opportunities for individual professional qualification.
Courses WINTER SEMESTER:

- Microscopic traffic flow simulation
- Sustainability in transport and urban planning
- Public building law 1
- Planning methodology and planning models
- Environmental protection in traffic and urban planning

Courses SUMMER SEMESTER

- Public transport planning
- Urban design
- Street space design
- Road Traffic Technology
- Traffic management on freeways
- Public building law 2

Publications

- Fourati, W., & Friedrich, B. (2021). A method for using crowd-sourced trajectories to construct control-independent fundamental diagrams at signalized links. Transportation research part C: emerging technologies, 130, 103270.
- Bienzeisler, L., Lelke, T., Wage, O., Thiel, F., & Friedrich, B. (2020). Development of an agent-based transport model for the city of Hanover using empirical mobility data and data fusion. Transportation Research Procedia, 47, 99-106.
- Friedrich, B. (2016). The effect of autonomous vehicles on traffic. Autonomous Driving: Technical, Legal and Social Aspects, 317-334.
- Pascucci, F., Rinke, N., Schiermeyer, C., Friedrich, B., & Berkhahn, V. (2015). Modeling of shared space with multi-modal traffic using a multi-layer social force approach. Transportation Research Procedia, 10, 316-326.
- Pohlmann, T., & Friedrich, B. (2010). Online control of signalized networks using the cell transmission model. Paper presented at the IEEE Conference on Intelligent Transportation Systems, Proceedings, ITSC, 1-6. doi:10.1109/ITSC.2010.5625064
- Priemer, C., & Friedrich, B. (2009). A decentralized adaptive traffic signal control using V2I communication data. In 2009 12th international ieee conference on intelligent transportation systems (pp. 1-6). IEEE.

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LWI | Leichtweiß-Institute for Hydraulic Engineering and Water Resources (LWI)
Division Waste and Resource Management

Mission Statement

New strategies for proper waste and water management are needed in emerging and developing countries, to meet existential challenges in the context of climate change. The research focusses waste, plastic and microplastic waste prevention strategies as well as questions related to water-energy-nexus and urban water security index.

RESEARCH

Waste Management
Poor solid waste management, which can be observed in particular in developing and emerging countries, leads to air, water and soil pollution as well as marine litter and contributes to climate change. As a result of non-existing collection systems and ineffective disposal of waste on dumps, there is an uncontrolled spreading of waste, which mainly affects the health and living conditions of the poor. The research focuses on one hand on the adaptation of international best practice waste management techniques (avoidance, collection, recycling, treatment, landfilling) to the local boundary conditions and needs. On the other hand the focus is set on capacity building by developing tools to train municipalities, the private and informal sector to choose the right technologies and methodologies for each specific case.

The practical knowledge of waste handling is integrated into the educational sector (from public schools to universities). Networks with international partner universities are evolved.

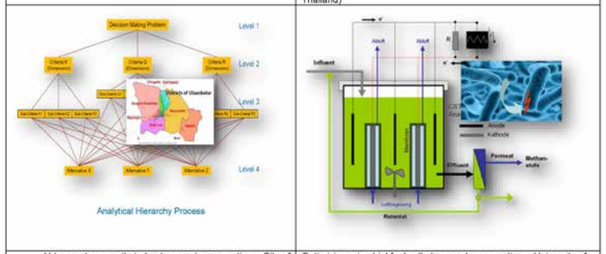
Microplastic in the aquatic environment
The global production of plastics was about 360 million tonnes in 2018. This has led to microplastics increasingly becoming a time bomb. Plastic waste poses a serious threat to aquatic life and the ecosystem. Over 600 species, including invertebrates, turtles, fish, seabirds and mammals, have now been found to be threatened by plastic waste. The research focuses on the occurrence of microplastics in the aquatic environment and the development of standard methods for the analytical treatment of samples. Furthermore, innovative methods for the elimination of microplastics and micropollutants from wastewater are being investigated.

Urban water security index
Compounded by the climate change uncertainties, water security issues result in a set of problems that particularly impact communities in low and middle-income countries. Analytical methods, such as analytic hierarchy methodologies, for the routine assessment of the water security components, such as water supply or infrastructure development are crucial for the sustainable utilization of the finite resource of water. The research focuses on quantifying the performance of the water sector and the related water index to assess water security for urban areas.

Microorganisms as electricity suppliers
Theoretical and technical possibilities of using anaerobic microorganisms in combination with wastewater as a substrate source in order to produce corresponding power densities and electricity quantities in economically justifiable processes.

Waste management: Improvement of working conditions for sorting of recyclable materials (Rio de Janeiro, Brazil)

Microplastic analytics and methods standardisation (research cooperation – University of Jordan and Thammasat University, Thailand)



Urban water security index (research cooperation – City of Ulaanbatar, Mongolia)

Optimising microbial fuel cells (research cooperation – University of Guadalajara, Mexico)

LWI | Prof. Dr. Andreas Haarstrick

Researcher's Career

- Professor for Bioengineering at TU Braunschweig
- Research Associate at Institute of Bioengineering, TU Braunschweig
- Postdoc at Department of Chemical Engineering, ETH Zurich
- Research Assistant at Institute for Biotechnology, TU Braunschweig
- Dipl.-Chem. and doctoral candidate at Institute of Biotechnology, TU Braunschweig

Funding:
DFG (SFB), BMBF, AiF, DAAD

TEACHING

The teaching of the Waste and Resource Management Division covers the areas of waste, recycling (circular economy), landfill technology, mechanical and thermal waste treatment, use of biomass in anaerobic processes to produce methane, life cycle assessment, water-energy-nexus, waste management, and water security.

A freely accessible e-learning platform "tech4waste" was developed, providing comprehensive information and teaching materials as Open Educational Resources (OER) that can be used by universities and stakeholders worldwide. Since 2009, an international graduate programme (Professional Master in Urban and Environmental Engineering) has been offered in cooperation with the Department of Civil and Environmental Engineering at PUC-Rio, Brazil.

Publications

- Rene Alejandro Flores-Estrella, Victor Alcaraz-Gonzalez, Andreas Haarstrick (2022): A catalytic Effectiveness factor for a microbial electrolysis cell biofilm model, April 25, 2022 submitted to Energies (MDPI)
- Victor Alcaraz-Gonzalez, Rene Alejandro Flores-Estrella, Uriel Garza-Rubalcava, Andreas Haarstrick (2021): An Electrical Bacteria Biofilm Dynamic Model for Microbial Fuel-Electrolytical Cells Systems, New Ideas Concerning Science and Technology Vol. 8, 102-125
- Anh Tuan Ta, Sandhya Babel, Andreas Haarstrick (2020): Microplastics Contamination in a High Population Density Area of the Chao Phraya River, Bangkok. J. Eng. Technol. Sci., 52(4), 534-545
- Mukand Babel, Eaindra Oo, Victor Shinde, Ambili Kamalamma, Andreas Haarstrick (2020): Comparative study of water and energy use in selected automobile manufacturing industries, Journal of Cleaner Production, 246, 1-13

Books

- From Traditional to Modern African Water Management; Eds. Chrispin Kowenje, Andreas Haarstrick, Springer Publisher, 2022
- Water and Wastewater Management - Global Problems and Measures; Eds. Andreas Haarstrick, Müfit Bahadir, Springer Publisher, 2021
- Towards Water Secure Societies – Coping with Water Scarcity and Quality Challenges (2021); Eds. Lars Ribbe, Andreas Haarstrick, Mukand babel, Sudeh Dehnavi, H. Biesalski, Springer Publisher, ISBN 978-3-030-50652-0
- Water Security in Asia – Opportunities and Challenges in the Context of Climate Change (2021); Eds. Mukand Babel, Andreas Haarstrick, Lars Ribbe, Victor Shinde, Springer Publisher, ISBN 978-3-319-54612-4

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LWI | Leichtweiß-Institute for Hydraulic Engineering and Water Resources (LWI) **| Division of Hydraulic Engineering and River Morphology**

Mission Statement

Our research contributes to the better understanding of complex natural and anthropogenic flow and transport processes shaping riverine environments. We combine theoretical and experimental work to address knowledge gaps at the water-biota and water-sediment interface to aid the development of tools for sustainable and ecologically-appropriate river management strategies and to solve practical problems mainly related to morphodynamics and flood prevention.

RESEARCH

The research topics tackled at our institute are highly relevant for the development of sustainable river management strategies taking into account morphodynamic processes, flood management, and ecology. The different and sometimes even contradicting requirements related to these fields reflect the area of conflict in which a modern hydraulic engineer is working today. Our research aims at providing scientifically based tools to overcome these difficulties. The key to developing such tools is the assessment of physical processes controlling the complex interaction between water flow, vegetation, morphology, hydraulic structures, and ecology – these topics are thus in our focus.

Our research is mainly experimentally based. Experiments are carried out both in the LWI hydraulic laboratory and the field. The LWI hydraulic laboratory is uniquely equipped with differently sized hydraulic flumes and state-of-the-art hydraulic instrumentation which are predominantly used for basic research applications, e.g. the characterisation of turbulent flow over rough-beds. Custom-made hydraulic scale models are mainly used in applied research projects to solve practical problems. The development of innovative experimental methods is another important aspect in our research work.

Scale model production of an unlined rock blasted tunnel
(white structure shows the digital elevation model of the tunnel).
(Photo: R. Eikenberg)

Velocity measurements in the field over an unstructured block ramp
(Photo: R. Eikenberg)

LWI | Prof. Dr.-Ing. Jochen Aberle

Researcher's Career

- Full Professor for Hydraulic Engineering and River Morphology at LWI
- Full Professor for Hydraulic Engineering at Norwegian University of Science and Technology (NTNU), Trondheim, Norway
- Head of Hydraulic Laboratory, LWI, TU Braunschweig
- Research Associate, LWI, TU Braunschweig
- Postdoctoral Researcher, National Institute of Water and Atmospheric Research Ltd. (NIWA), Christchurch, New Zealand
- Dr.-Ing., University of Karlsruhe (TH)
- Dipl.-Ing. Civil Engineering, University of Karlsruhe (TH)

Funding
BAW, BMDV, BMBF, DBU, DFG, EU, State of Lower Saxony, Industry

TEACHING

Our teaching covers three main topics which are of importance for hydraulic engineers – classical hydraulic engineering, computational fluid dynamics, and environmental hydraulics. Knowledge in classical hydraulic engineering, for example, is required for the maintenance and modernisation of existing hydraulic structures; the application of computational fluid dynamics for the simulation of flow and transport processes is nowadays an indispensable tool for scientific and practical applications; and the education in environmental hydraulics enables engineers to gain insight in complex natural processes and to work in transdisciplinary environments. An important aspect in our teaching are lectures in which the students apply their gained knowledge in specifically designed practical exercises, and we have recently extended our teaching portfolio by introducing a new module on project management in waterway engineering.

Publications

- Aberle, J., Branß, T., Eikenberg, R., Henry, P.-Y. & Olsen, N.R.B. (2022). Directional dependency of flow resistance in an unlined rock blasted hydropower tunnel. J. Hydraul. Res., 60(3), 504-513, doi:10.1080/00221686.2021.2001596
- Branß, T., Aberle, J., Hentschel, B. (2023). Impacts on alternate bar geometry and dynamics in a trained sand bed river. Frontiers in Water, doi:10.3389/frwa.2022.1091872
- Branß, T., Núñez González, F. & Aberle, J. (2022). Fluvial levees in compound channels – A review on formation processes and the impact of bedforms and vegetation. Environ. Fluid Mech. 22(2-3), 559-585. doi:10.1007/s10652-022-09850-9
- Kazemi, E., Koll, Ka., Tait, S. & Shao, S. (2020). SPH modelling of turbulent open channel flow over and within natural gravel beds with rough interfacial boundaries. Advances in Water Resources, 140, doi:10.1016/j.advwatres.2020.103557
- Sukhodolov, A.N., Sukhodolova, T. & Aberle, J. (2022). Modelling of flexible aquatic plants from silicone syntactic foams. J. Hydraul. Res., 60(1), 173-181, doi:10.1080/00221686.2021.1903590
- Vettori, D., Niewerth, S., Aberle, J. & Rice, S.P. (2021). A link between plant stress and hydrodynamics? Indications from a freshwater macrophyte. Water Resour. Res., 57, e2021WR029618, doi: 10.1029/2021WR029618

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LWI | Leichtweiß-Institute for Hydraulic Engineering and Water Resources (LWI) **| Division of Hydrology and River Basin Management (HydRiv)**

Mission Statement

Our research focuses on the integrated consideration of water quantity and water quality for surface and groundwater in the context of hydrological extremes and associated risks. We seek to deepen our understanding of the interactions between hydrological processes and human interventions. For this goal, we develop methods, simulation models and tools for the sustainable and flexible management of future water resources systems.

RESEARCH

Global change - with aspects of climate change, demographic change, changes in land use, globalization of markets and other transformations - poses unprecedented challenges for sustainable development. From a water management perspective, for instance, hotter and drier summers and more frequent heavy rainfall increase the pressure on natural water resources and exacerbate the risk of hydrological extremes. In addition, due to the contamination of the groundwater, rivers and lakes, and the ongoing environmental degradation, the ecological condition of water bodies and the production and supply of drinking water are increasingly impaired.

Research at HydRiv contributes to these urgent, socially relevant questions with a particular focus on the following topics:

- Ensuring the quantity and quality of water resources and water bodies in the long term under increasing usage demands
- Develop sustainable adaptation options to cope with more frequent and intense heat, drought and heavy rainfall events
- Adapt water infrastructure and optimize its interconnected management to ensure its long-term performance

Our research mission is motivated by two key objectives:

- Increase knowledge about the complex inter-dependencies, feedbacks, and use conflicts in hydrological human-environment systems
- Provide methods and tools for monitoring, modelling, and integrated management of water resources systems and assessing associated risks.

We apply and develop explorative data analysis and numerical modelling techniques for **system analyses** to gain a deeper understanding of interactions and chains of effects, especially in areas with different hydrological characteristics and land use structures such as urban and rural areas or surface and groundwater bodies.

We are working on concepts for **system-oriented monitoring** to close data gaps and optimize the collection of information on relevant variables and characteristics in meso-scale observation areas. Topics are i) the integration of new data sources (e.g. IoT sensors, crowd-sourced data, and ground-, air-, and space-based sensors) with data from established observation networks and measurement campaigns and ii) the use of data science methods for the management and exploration of data providing opportunities for scientific analysis and the more efficient use of information in decision contexts.

The improvement of modelling and predictive capabilities requires the further **development of algorithms and modelling approaches** that integrate hydrological human-environment sub-systems into a higher-level integrated system model, taking into account processes and interactions. To this end, we develop hybrid approaches that combine numerical models with machine learning methods.

We conduct our research activities both at the fundamental level and in application-related settings.

LWI | Prof. Dr.-Ing. Dr. rer. nat. habil. Kai Schröter

Researcher's Career

- Full Professor for Hydrology and River Basin Management at TU Braunschweig, Germany
- Senior Scientist at Section Hydrology, Helmholtz Centre Potsdam German Research Centre for Geosciences GFZ, Potsdam, Germany
- Private Lecturer at University of Potsdam, Faculty of Science, Potsdam, Germany
- Research Asssociate at Center for Disaster Management and Risk Reduction Technology (CEDIM)
- Project Engineer and Project Manager at BWS GmbH, Hamburg, Germany
- Research Associate at Section Engineering Hydrology and Water Resources Management, Darmstadt, Germany
- Dr. rer. nat. habil. in Hydrology at University of Potsdam
- Dr.-Ing. in Engineering Hydrology at TU Darmstadt
- Dipl.-Ing, Civil Engineering at TU Darmstadt

Funding
EU, Climate KIC, BMBF, DFG, Helmholtz Association, Industry

TEACHING

The topics of teaching cover the broad spectrum of hydrology and water management, hydrogeology and groundwater management, river basin management and water quality management. Content on hydrological and hydraulic modelling as well as flow and transport processes in groundwater and water quality complement the teaching offer. Further courses impart specific knowledge on data science and geospatial methods as well as on measurement techniques for water quantity and quality, including practical methods of fieldwork. The focus is on methodological knowledge for data acquisition, data analysis, mathematical process modelling and subsequent computer-based processing with complex simulation models.

Practical applications are a central element and are oriented towards the acquisition of competencies to meet current challenges for hydrology and water management: i) the development of sustainable adaptation options to cope with increasingly frequent and intense heat, drought and heavy rainfall events, ii) the long-term safeguarding of the quantity and quality of water resources and water bodies in the face of increasing demands, iii) the adaptation of water infrastructures and their management to ensure their long-term performance.

Publications

- Fohringer, J., D. Dransch, H. Kreibich, Schröter. K. 2015. 'Social Media as an Information Source for Rapid Flood Inundation Mapping'. Nat. Hazards Earth Syst. Sci. 15 (12): 2725–38. https://doi.org/10.5194/nhess-15-2725-2015.
- Kreibich, H., Van Loon, A.F., Schröter, K., Ward, P.J., Mazzoleni, M., Sairam, N., et al. 2022. 'The Challenge of Unprecedented Floods and Droughts in Risk Management'. Nature 608 (7921): 80–86. https://doi.org/10.1038/s41586-022-04917-5.
- Schröter, K., Kreibich, H. Vogel, K., Riggelsen, C., Scherbaum, F., Merz. B. 2014. 'How Useful Are Complex Flood Damage Models?' Water Resources Research 50 (4): 3378–95. https://doi.org/10.1002/2013WR014396.
- Schröter, K., Kunz, M., Elmer, F., Mühr, B., Merz. B. 2015. 'What Made the June 2013 Flood in Germany an Exceptional Event? A Hydro-Meteorological Evaluation'. Hydrol. Earth Syst. Sci. 19 (1): 309–27. https://doi.org/10.5194/hess-19-309-2015.
- Schröter, K., Lüdtke, S., Redweik, R., Meier, J., Bochow, M., Ross, L., Nagel, C., Kreibich, H.. 2018. 'Flood Loss Estimation Using 3D City Models and Remote Sensing Data'. Environmental Modelling & Software 105 (July): 118–31. https://doi.org/10.1016/j.envsoft.2018.03.032.
- Steinhausen, M., Paprotny, D., Dottori, F., Sairam, N., Mentaschi, L., Alfieri, L., Lüdtke, S., Kreibich, H., Schröter, K.. 2022. 'Drivers of Future Fluvial Flood Risk Change for Residential Buildings in Europe'. Global Environmental Change 76 (September): 102559. https://doi.org/10.1016/j.gloenvcha.2022.102559.
- Ward, P. J., de Ruiter, M.C., Mård, J., Schröter, K., Van Loon, A., Veldkamp, T., von Uexkull, N. et al. 2020. 'The Need to Integrate Flood and Drought Disaster Risk Reduction Strategies'. Water Security 11 (December): 100070. https://doi.org/10.1016/j.wasec.2020.100070.

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LWI | Leichtweiß-Institute for Hydraulic Engineering and Water Resources (LWI) **| Division of Hydrology and River Basin Management (HydRiv)**

Mission Statement

Our research focuses on the integrated consideration of water quantity and water quality for surface and groundwater in the context of hydrological extremes and associated risks. We seek to deepen our understanding of the interactions between hydrological processes and human interventions. For this goal, we develop methods, simulation models and tools for the sustainable and flexible management of future water resources systems.

RESEARCH

Global change - with aspects of climate change, demographic change, changes in land use, globalization of markets and other transformations - poses unprecedented challenges for sustainable development. From a water management perspective, for instance, hotter and drier summers and more frequent heavy rainfall increase the pressure on natural water resources and exacerbate the risk of hydrological extremes. In addition, due to the contamination of the groundwater, rivers and lakes, and the ongoing environmental degradation, the ecological condition of water bodies and the production and supply of drinking water are increasingly impaired.

Research at HydRiv contributes to these urgent, socially relevant questions with a particular focus on the following topics:

- Ensuring the quantity and quality of water resources and water bodies in the long term under increasing usage demands
- Develop sustainable adaptation options to cope with more frequent and intense heat, drought and heavy rainfall events
- Adapt water infrastructure and optimize its interconnected management to ensure its long-term performance

Our research mission is motivated by two key objectives:

- Increase knowledge about the complex inter-dependencies, feedbacks, and use conflicts in hydrological human-environment systems
- Provide methods and tools for monitoring, modelling, and integrated management of water resources systems and assessing associated risks, a.o. groundwater / surface water interaction and coastal groundwater /surface water interaction

We apply and develop explorative data analysis and numerical modelling techniques for system analyses to gain a deeper understanding of interactions and chains of effects, especially in areas with different hydrological characteristics and land use structures such as urban and rural areas or surface and groundwater bodies.

We are working on concepts for system-oriented monitoring to close data gaps and optimize the collection of information on relevant variables and characteristics in meso-scale observation areas. Topics are i) the integration of new data sources (e.g. IoT sensors, crowd-sourced data, and ground-, air-, and space-based sensors) with data from established observation networks and measurement campaigns and ii) the use of data science methods for the management and exploration of data providing opportunities for scientific analysis and the more efficient use of information in decision contexts.

The improvement of modelling and predictive capabilities requires the further development of algorithms and modelling approaches that integrate hydrological human-environment sub-systems into a higher-level integrated system model, taking into account processes and interactions.
To this end, we develop hybrid approaches that combine numerical models with machine learning methods. We conduct our research activities both at the fundamental level and in application-related settings.

The topics of teaching cover the broad spectrum of hydrology and water management, hydrogeology and groundwater management, river basin management and water quality management. Content on hydrological and hydraulic modelling as well as flow and transport processes in groundwater and water quality complement the teaching offer.

LWI | Prof. Dr. rer. nat. habil. Hans Matthias Schöniger

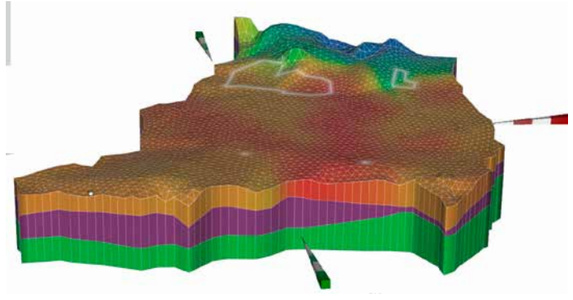
Researcher's Career

- Professor for Hydrology at TU Braunschweig, Division of Hydrology and River Basin Management (HydRiv) and honorary professor of hydroinformactic, Leuphana Universität Lüneburg,
- Scientist director at the Division of Hydrology and River Basin Management
- Independent expert of environmental engineering, HMS
- Private Lecturer at the Institute of Geoecology, TU Braunschweig
- Habilitation: Venia Legendi of Hydrology / Geoecology, Faculty of Natural Sciences TU Braunschweig
- Dr. rer.nat. in Hydrology at TU Braunschweig, Faculty of Natural Sciences TU Braunschweig

Funding
DAAD, DFG, BMBF, State of Lower Saxony, Tennet TSO GmbH, drinking water supplier (HWW GmbH, BS|ENERGY et al.), water board / associations

TEACHING

The topics of teaching cover the broad spectrum of hydrology and water management, hydrogeology and groundwater management, river basin management and water quality management. Content on hydrological and hydraulic modelling as well as flow and transport processes in groundwater and water quality complement the teaching offer. Further courses impart specific knowledge on data science and geospatial methods as well as on measurement techniques for water quantity and quality, including practical methods of fieldwork. The focus is on methodological knowledge for data acquisition, data analysis, mathematical process modelling and subsequent computer-based processing with complex simulation models.



Finite Element analysis of groundwater flow and transport

Publications

- Schöniger, H.M. & Langmann, T. et al. (2022): Implementierung strategischer Entwicklungsziele im Küstenzonenmanagement. Abschlussbericht zum GRoW-Verbundprojekt go-CAM. https://bmbf-grow.de/de/system/files?file=document/Schlussbericht_%20go-CAM_final_reduziert.pdf
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LWI | Leichtweiß-Institute for Hydraulic Engineering and Water Resources (LWI) **| Division of Hydromechanics, Coastal and Ocean Engineering**

Mission Statement

The world faces climate change, extreme coastal hazards, rapid urban expansion at coasts and the increasing demand on natural marine resources. Our research activities are directed towards understanding and prediction of hydro- and morphodynamic processes in both natural and constructed environments. We develop sustainable, innovative, nature-friendly solutions and strategies for coastal management and protection as well as marine food and energy resources.

RESEARCH

The research activities, related to coastal, ocean and harbor engineering, are characterized by a mix of fundamental, application- and industry-oriented approaches. Methodologically, we conduct laboratory experiments, numerical modelling and theoretical approaches including nonlinear data analysis. The division is equipped with modern, small- to large-scale experimental facilities for investigation of 2D and 3D problems such as coastal hydro- and morphodynamics, structural integrity analysis and stability considerations, testing ecohydraulics as well as extreme hydraulic conditions. The division partakes in operating the large wave flume at Coastal Research Center, Hannover, Germany. Our research activities can be subdivided into the following research areas:

Marine Technology, Marine Constructions and Aquaculture
A massive development of marine infrastructure for wind and ocean energy harvesting as well as marine aquaculture is currently taking place. The main challenges related to this development are economic and environmental issues as well as increasing their efficiency and life span. The most promising solutions represent offshore platforms combining multiple functions such as energy extraction, aquaculture, transport and leisure activities. Our current research interests cover testing of novel aquaculture systems, flow-biota-interaction and planning of improved offshore multi-purpose platforms.

Coastal Protection Structures, Morphodynamics and Ecohydraulics
Design of appropriate means of coastal protection against erosion and flooding is based on understanding of local hydrodynamic and morphodynamic processes determining wave loading and sediment budget. Nowadays, environment-friendly, nature-based and sustainable solutions such as beach nourishment, green dikes, coastal vegetation and submerged breakwaters are preferable as compared to the hard means of coastal protection commonly used in the past (e.g. sea walls, revetments, sea dikes). New hybrid solutions combining green and grey coastal protections are currently investigated in respect to their functionality, stability and effect on the environment as well as wave-vegetation-interaction. In parallel, development of numerical tools for a better prediction of wave-soil-structure interaction is taking place.

Natural Hazards
Coastal zones are exposed to different types of natural hazards such as extreme storm surges and tsunami. Thus a better understanding of their physics and interaction with the built environment is required to develop resilient communities and appropriate risk management strategy. Our current research topics are related to extreme flow condition interacting with the natural and built environment, including transport of water-borne debris and coarse sediment, loading on structures and resulting structure damage.

Waterway and Port Engineering
Both growing marine traffic and increasing size of the vessels pose challenges for the planning of waterway and port infrastructure. Design of port facilities is very often supported by physical and/or numerical modelling in respect to wave loading, wave overtopping and the overall structure stability. In addition, a better understanding of the hydromechanics behind waves induced by vessels is indispensable for appropriate design of port and waterway infrastructure. Our current research topics encompass issues related to ship-induced waves and design of port and marine facilities.

LWI | Prof. Dr.-Ing. habil. Nils Goseberg

Researcher's Career

- Full Professor Coastal and Ocean Engineering at TU Braunschweig, Germany
- Managing Director of Coastal Research Center, Hannover (Forschungszentrum Küste, FZK)
- Habilitation Thesis (venia legendi) at Leibniz Universität Hannover, Germany
- Senior Research Associate at Ludwig-Franzius-Institute for Hydraulic, Estuarine and Coastal Engineering, Leibniz Universität Hannover
- Marie Curie International Outgoing Fellow and Visiting Professor at Department of Civil Engineering, University of Ottawa, Canada
- Research Associate at Ludwig-Franzius-Institute for Hydraulic, Estuarine and Coastal Engineering, Leibniz Universität Hannover
- Dr.-Ing. Coastal Engineering at Leibniz Universität Hannover
- Dipl.-Ing. Hydraulic Engineering/ Geotechnics at Technische Universität Dresden, Germany

Funding
DFG, DAAD, BMBF, BMBi, KFKI, Volkswagen Stiftung, Industry

TEACHING

Our main educational aim is to equip the students with a well-balanced combination of theoretical knowledge and practical experience in the field of Hydromechanics and Coastal Engineering, which is achieved through diversified teaching activities. Teaching in the Division of Hydromechanics and Coastal Engineering encompasses a bachelor's course in Hydromechanics and a variety of lectures dealing with different topics from the field of Coastal Engineering in the master's programme Civil Engineering. The study offer is completed with a lab training in coastal engineering as well as practical seminars.

In the bachelor's course in hydromechanics, the basic laws and concepts in hydrostatics and hydrodynamics are introduced to the students. The coastal engineering specialisation in the master's programme consists of two obligatory courses in Coastal Engineering I and II and a number of practical courses in the framework of Applications in Coastal Engineering.

The course Coastal Engineering I provides fundamental knowledge on characteristics and prediction of linear and nonlinear water waves (including real sea states, storm surges and tides), wave transformation processes and interaction with barriers. In the course Coastal Engineering II students are trained in sediment transport in coastal zones as well as wave-induced loads on offshore and coastal structures.

The Applications in Coastal Engineering deepens the student's theoretical knowledge through participation in practical modules focussing the North and the Baltic Sea, Maritime Waterways Engineering and Harbour Planning as well as advanced topics (Fluid-Structure-Soil-Interaction, Spectral Analysis of Nonlinear Waves in the Coastal Area, Tsunami Engineering).

Publications

- Brühl, M. and Becker, M. (2018): Analysis of subaerial landslide data using nonlinear Fourier transform based on Korteweg-deVries equation (KdV-NLFT). Journal of Earthquake and Tsunami, 12 (2).
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- Goseberg, N., Stolle, J., Nistor, I. and Shibayama, T. (2016): Experimental analysis of debris motion due the obstruction from fixed obstacles in tsunami-like flow conditions. Coastal Engineering, 118, 35-49.

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