Technical University of Munich
MSc Computational Mechanics

COME Welcome 2024

Prof. Fabian DUDDECK
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TUM Origin in 1868

King Ludwig II founded the „Polytechnische Schule“

… and some castles

TUM History

Some milestones

1868	King Ludwig II founds the "Polytechnical School"
1877	Renaming to "Technical University"
1901	Right to Award Doctorates First Doctoral Candidate: Georg Hauser (Chemistry)
1905	Admittance of Female Students First Female Doctoral Candidate: Amalie Baur (Chemistry)
1930	Integration of the College of Agriculture and Brewing in Weihenstephan
1957	First Neutron Research Reactor in Germany
1967	TUM School of Medicine, University Hospital
1970	Presidential Constitution, "Technische Universität München"
1999	TUM‘s University Reform started, Entrepreneurial University Constitution
2000	TUM School of Life Sciences Weihenstephan (Matrix Structure)
2000	Foundation of the COME program

https://www.tum.de/en/about-tum/facts-and-figures/history

TUM clock tower, central campus

TUM History

Some more milestones

2002	TUM Branch in Singapore: TUM. Asia Pte. Ltd. TUM School of Management / Dep. of Sport & Health Sciences
2004	High-Flux Research Source Heinz Maier-Leibnitz
2005	TUM Institute for Advanced Study (IAS)
2006	TUM elected "University of Excellence" TUM Int. Graduate School of Science and Engineering (IGSSE)
2009	TUM School of Education / TUM Graduate School
2010	TUM Munich School of Engineering (MSE)
2012	TUM again elected "University of Excellence" Munich Center for Technology in Society (MCTS)
2014	Bavarian School of Public Policy
2015	Munich School of Bioengineering
2018	150 years jubilee Technical University of Munich
2019	TUM “University of Excellence“ for the third time
2021	TUM School of Engineering and Design
2024	YOUR start here at TUM


TUM Campus Garching Oskar-von-Miller Tower

TUM Facts and Figures

(statistics 2023/24)

7
Schools and Departments

18
Nobel Prize Laureates

10
Humboldt Professorships

666
Professors

9,532
Graduates in 2022/23

226
ERC Grants (since 2008)

480
million euros third-party funding

TUM Facts and Figures

(statistics 2023/24)

45%
International Students

52,580
Students

178
Degree Programmes

12,051
Staff Members

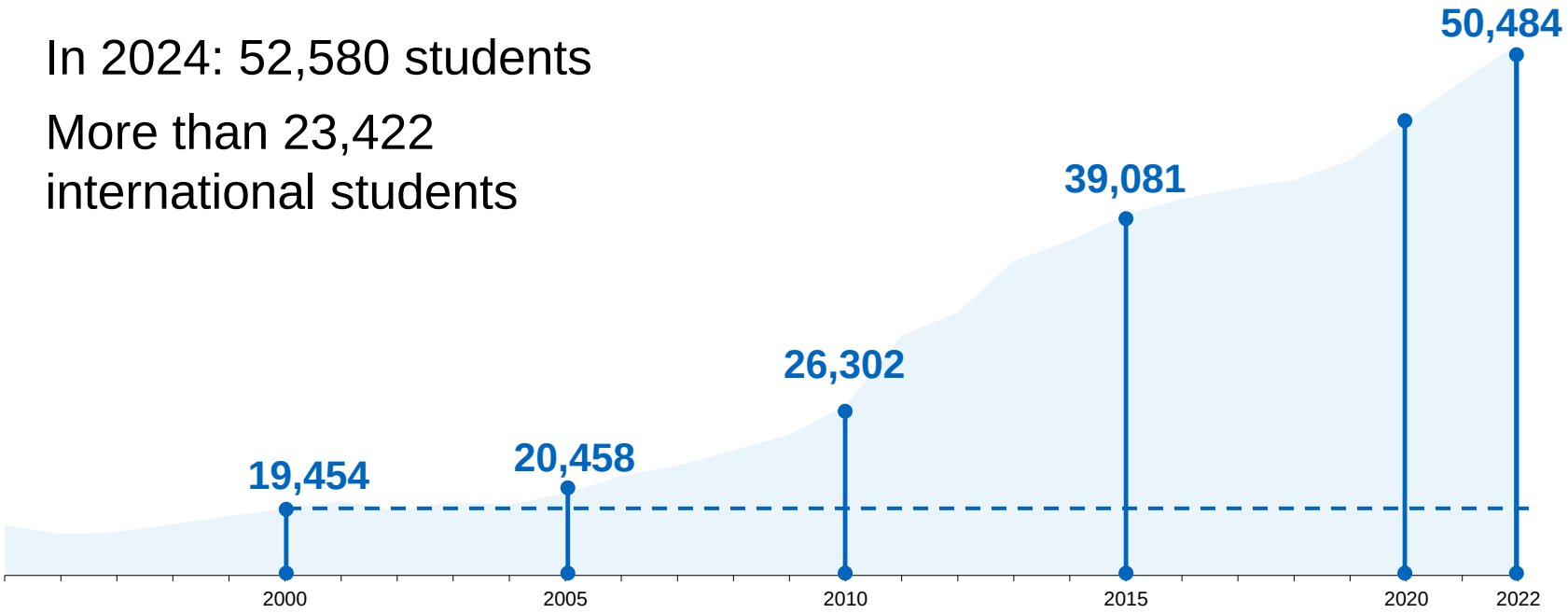
36%
Female Students

92,500
Active Alumni

7
Global locations

Growth Path Student Enrollment

- In 2024: 52,580 students
- More than 23,422 international students



Academic Rankings

QS World University Rankings 2022

No. **1**

in Germany

No. **28**

in the world

THE World University Rankings 2022

No. **1**

in Germany

No. **30**

in the world

Shanghai World University Ranking 2022

No. **2**

in Germany

No. **47**

in the world

18 Nobel Prize Laureates

TUM scientists and alumni have received the Nobel Prize in four fields:

- Chemistry,
- Literature,
- Medicine, and
- Physics.

Prof. Robert Huber
Nobel Prize 1988 / Chemistry
For the determination of the 3D structure of a photosynthetic reaction center

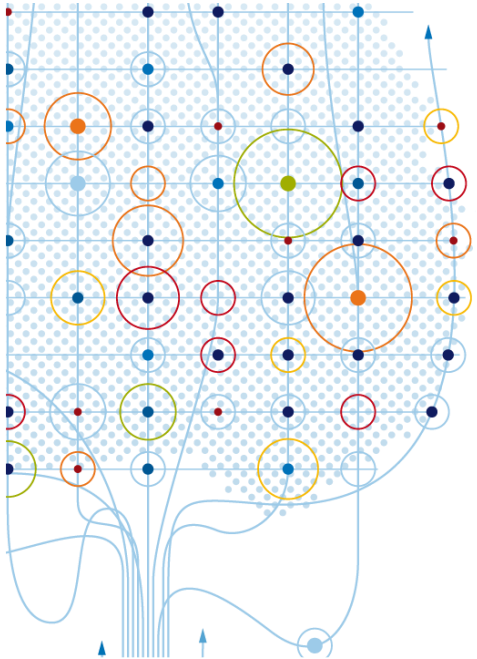
24 Leibniz Prize Laureates

(Deutsche Forschungsgemeinschaft DFG)

TUM members received the most prestigious award for scientists and scholars at German research institutions 24-times, including 10 distinctions in the last decade alone

Prof. Barbara Wohlmuth
Leibniz Prize (DFG) 2012
For her research achievements in numerical analysis in scientific and engineering computing. A focus of her research is the numerics of partial differential equations, to which she has made key contributions, especially with her theoretical study of mortar domain decomposition methods.

TUM Partners of Excellence

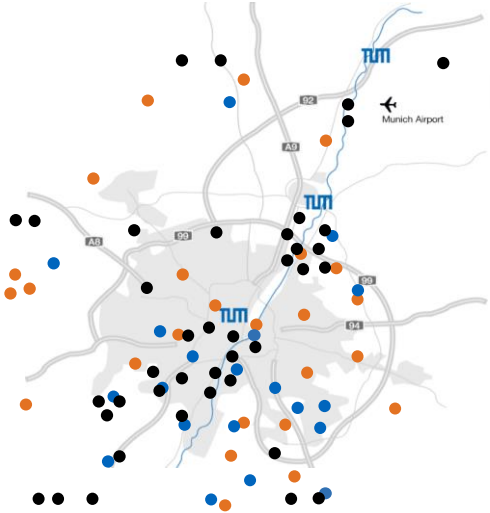


Airbus Group
ALTANA AG
AUDI AG
Bayerischer Bauindustrieverband e. V.
BMW AG
Robert Bosch GmbH
Busch Vacuum
Clariant International AG
Dräxlmaier Group
Evonik Industries AG
Google
Herrenknecht AG
HUAWEI
Infineon Technologies AG
Linde AG
MAN SE
Nestlé AG
Rohde & Schwarz GmbH & Co. KG
RWE Group
SAP SE
SGL CARBON SE
Siemens AG
TRUMPF GmbH + Co. KG
TÜV SÜD AG
vbw – Vereinigung der Bayerischen Wirtschaft e. V.
Volkswagen AG
Wacker Chemie AG

TUM Local Network

Academic Network

TUM Joint Appointments: 51



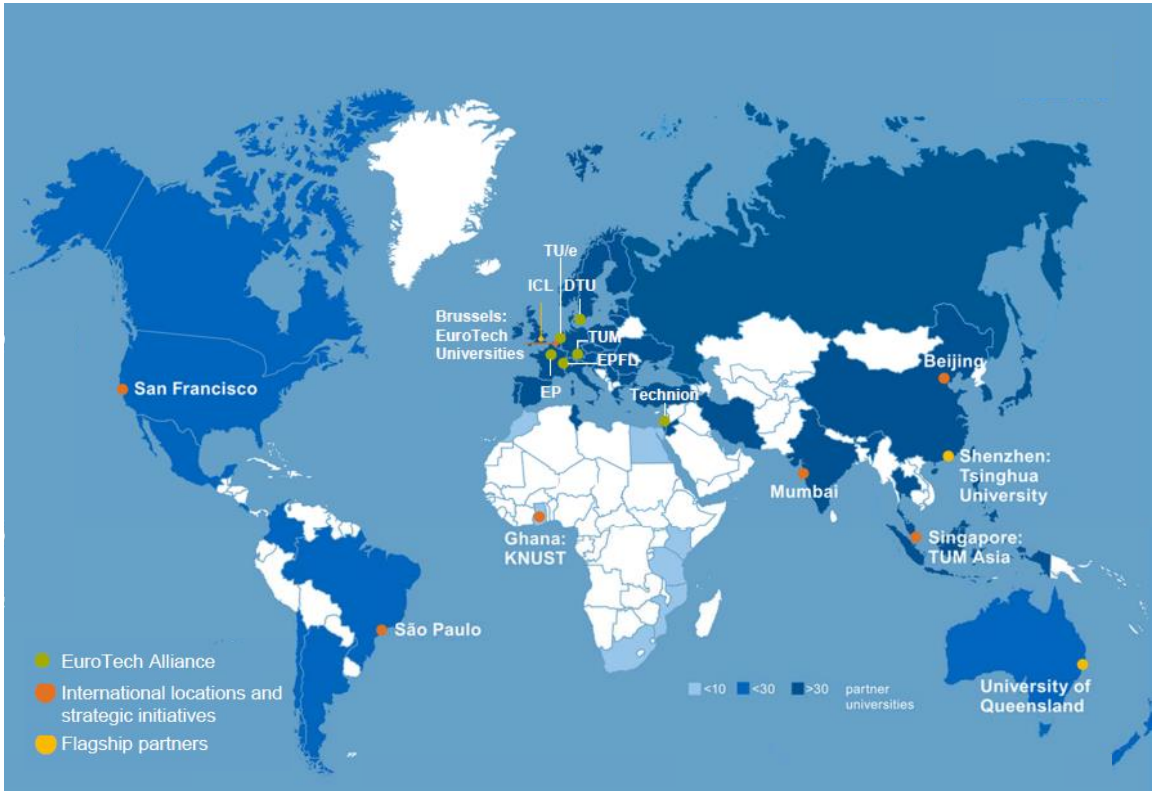
Industry Network

Start-up Network

TUM Global

150+ partner universities worldwide

350+ Erasmus partnerships across Europe



TUM Locations

Six large sites in Bavaria and one in Baden-Wuerttemberg:

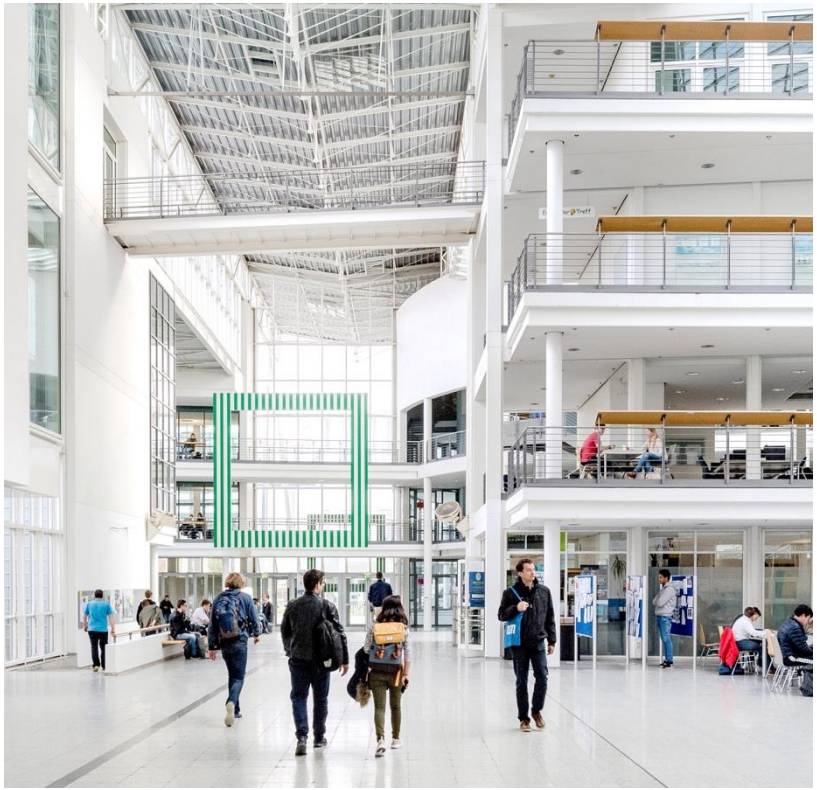
- Munich
- Garching
- Freising-Weihenstephan
- Ottobrunn
- Straubing
- Raitenhaslach
- Heilbronn

TUM Campus Downtown Munich

- TUM School of Computation, Information and Technology
- TUM School of Engineering & Design
- TUM School of Management
- TUM School of Social Sciences & Technology
- Hochschule für Politik München

TUM Campus Garching

- TUM School of Natural Sciences
- TUM School of Computation, Information and Technology
- TUM School of Engineering & Design



TUM Campus Heilbronn

- TUM School of Management

TUM Campus Straubing

- Biotechnology
- Sustainability

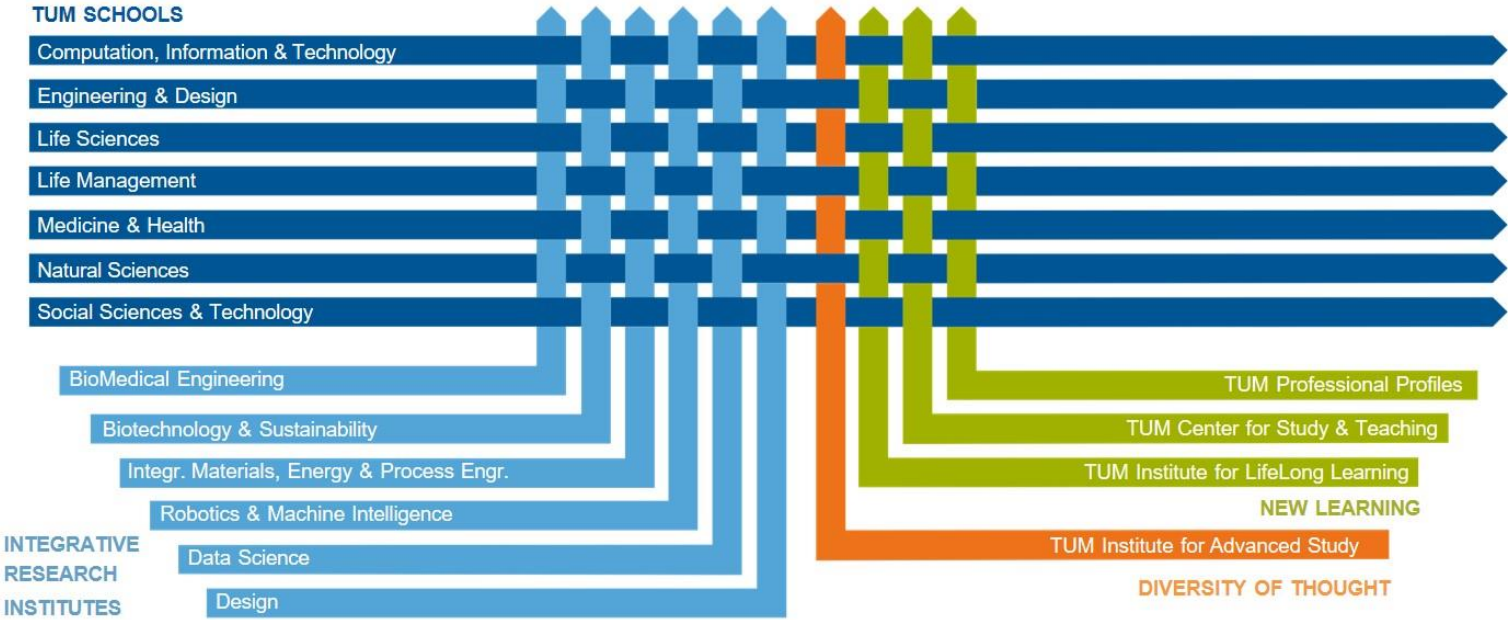
TUM Campus Freising / Weihenstephan

- TUM School of Life Sciences

TUM Science & Study Center Raitenhaslach

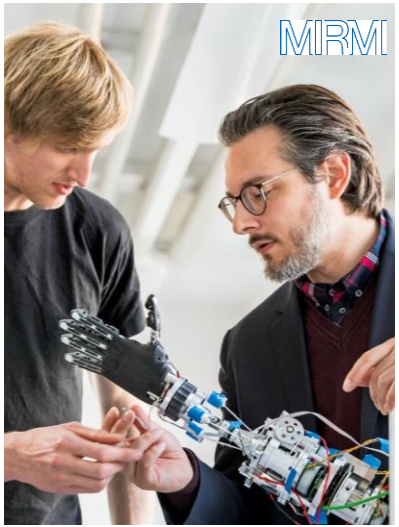
- Former monastery in Raitenhaslach in the Southeast of Bavaria
- Full service, year-round conference facility

TUM Innovative University Structure

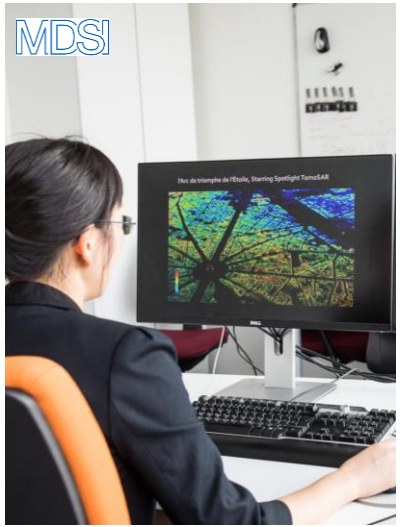


Integrative Research Institutes (IRI)

Munich Institute of Robotics and Machine Intelligence (MIRMI)

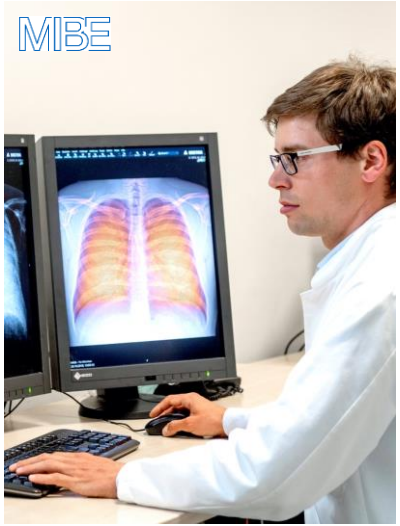


Munich Data Science Institute (MDSI)



Munich Institute of Integrated Materials, Energy and Process Engineering (MEP)

Munich Institute of Biomedical Engineering (MIBE)



TUM Master‘s Programs (105 in 2023)

Master (incomplete)

Aerospace
Automotive Engineering
Bioinformatics
Biomedical Engineering & Medical Physics
Civil Engineering
Computational Mechanics (CoMe)
Computational Science and Engineering (CSE)
Data Engineering & Analytics
Ecological Engineering
Electrical Engineering & Information Technology
Energy & Process Engineering
Environmental Engineering
Ergonomics - Human Factors Engineering
ESPACE Earth Oriented Space Sci. & Techn.
Informatics / Games Engineering
Materials Science & Engineering
Mathematics in Data Science
Mathematics in Science and Engineering
Mechanical Engineering
Mechatronics, Robotics & Biomechanical Engineering
Medical Engineering & Assistance Systems
Physics (Applied and Engineering Physics)
Power Engineering
Quantum Science & Technology
Rail, Transport & Logistics
Research on Teaching and Learning
Responsibility in Science, Engineering & Technology
Risk and Safety
Robotics, Cognition, Intelligence
Science and Technology of Materials
Software Engineering
Sustainable Management and Technology

M.Sc. Computational Mechanics (COME)

- The M.Sc. *Computational Mechanics* was founded in 2000
- It aims for educating experts for industry and academia in the field of computational methods in mechanics for all areas of engineering

Logo by COME students 2011/12

http://www.come.tum.de

M.Sc. Computational Mechanics (COME)

Lectures are offered at the central campus.

Main professors involved are:

- Comput. Modeling & Simul., André BORRMANN
- Comput. Solid Mechanics, Fabian DUDDECK
- Hydromechanics, Michael MANHART
- Structural Mechanics, Gerhard MÜLLER
- Structural Analysis, Roland WÜCHNER


A. Borrmann

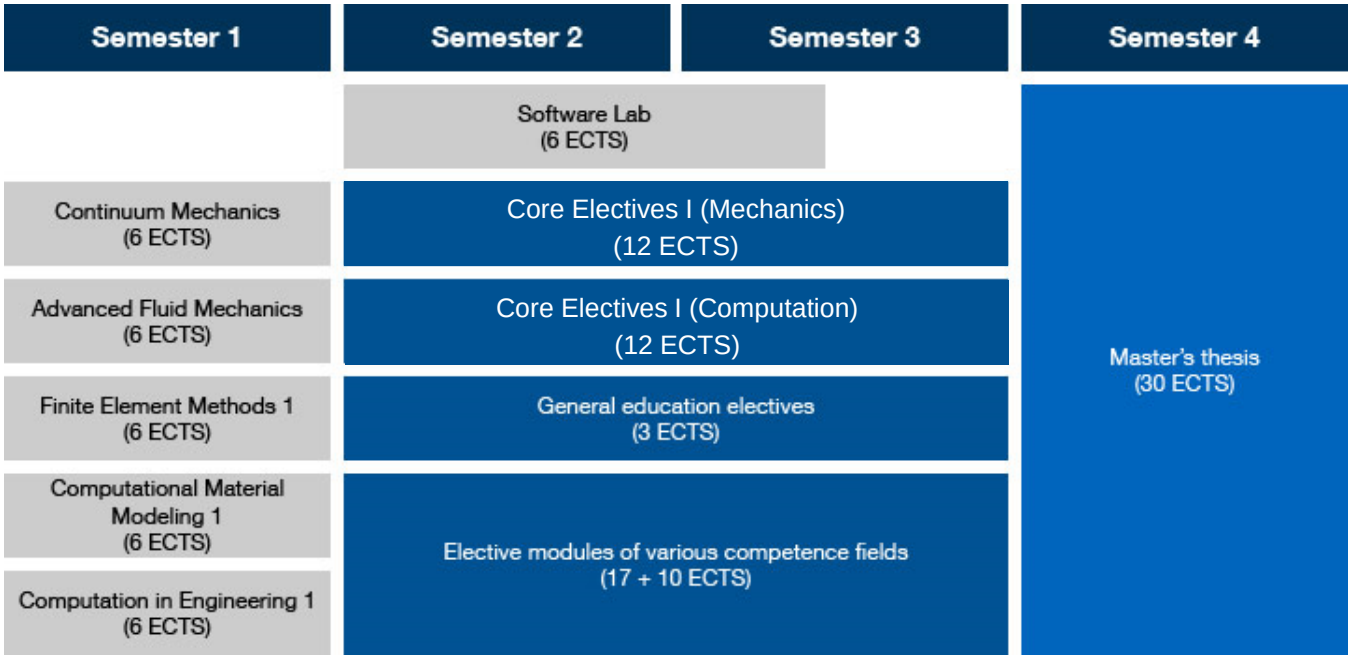

F. Duddeck


M. Manhart


G. Müller


R. Wüchner

M.Sc. Computational Mechanics (COME)



M.Sc. Computational Mechanics (COME)

2-years program (120 ECTS credits)

- 36 ECTS compulsory courses
- 24 ECTS core elective courses
- 27 ECTS elective courses
- 3 ECTS general education (language)
- 30 ECTS master‘s thesis

- **Additional qualification during your COME studies (optional)**
  BGCE - Bavarian Graduate School of Computational Engineering

Compulsory courses

Semester 1				
Computation in Engineering 1 (6 ECTS)	Advanced Fluid Mechanics (6 ECTS)	Finite Element Methods 1 (6 ECTS)	Computational Material Modelling I (6 ECTS)	Continuum Mechanics (6 ECTS)

TOTAL: 30/120 ECTS

Semester 3				
Software Lab Project with focus on one of the specialisations (6 ECTS)				
Computer Science	Fluids	Solids & Structures	Materials	Mechanics

TOTAL: 6/120 ECTS

Semester 4
Master Thesis (30 ECTS)

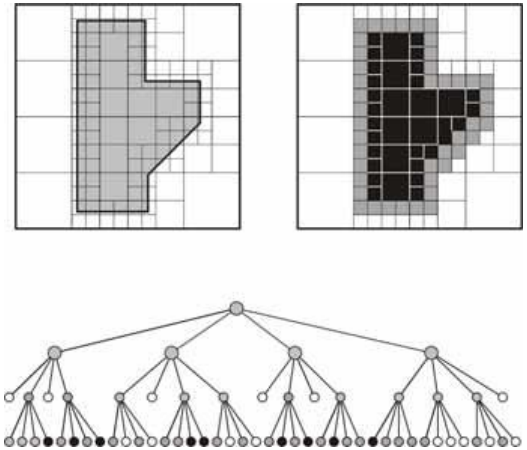
TOTAL: 30/120 ECTS

Compulsory Modules

Computation in Engineering 1

CONTENT

- Object oriented modeling and programming (C++)
- Data structures, classes, etc.
- Sets, relations, and graphs
- Geometrical modeling
- Direct and indirect representations
- Space trees (octrees etc.)
- Curve representations
- Approximation methods
- Implementation schemes



Quadtree for discretisation of a 2D region.

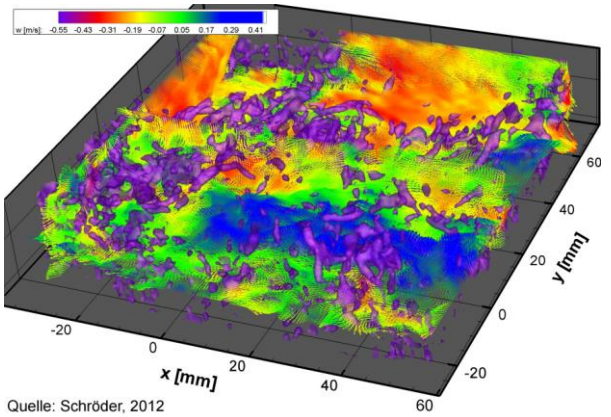
Stefanie Schraufstetter, André Borrmann, Ernst Rank

Compulsory Modules

Advanced Fluid Mechanics

CONTENT

- Continuum hypothesis, kinematics
- Transport equation, equation of motion
- Navier-Stokes equations
- Fundamentals of fluid mechanics
- Scaling laws, Dimensional analysis
- Advection and diffusion
- Boundary layer theory
- Flow instabilities
- Introduction to turbulent flows



Quelle: Schröder, 2012

Compulsory Modules

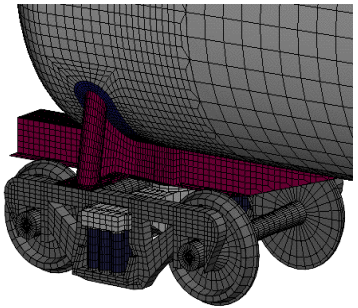
Finite Element Methods 1

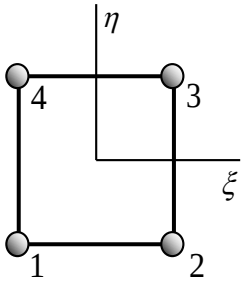
CONTENT (FEM1 – Part 1)

- Direct Stiffness Method, Variational Formulation
- Beam, Plane Stress, Plate Elements
- Convergence, Locking and FE Technology
- Implementation etc.

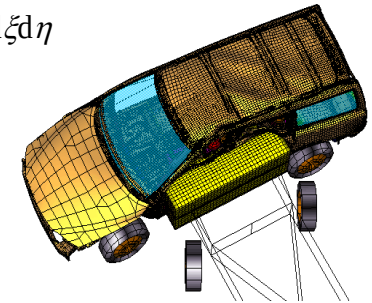
CONTENT (FEMSV – Part 2)

- Modelling, Simulation, and Validation (2D / 3D)
- Introduction to an FE software (ANSYS)
- Applications (elasticity, plasticity, heat transfer)





$$\mathbf{K} = \int_{-1}^{1}\int_{-1}^{1} t\,\mathbf{B}^T \cdot \mathbf{C} \cdot \mathbf{B}\,|J|\,\mathrm{d}\xi\mathrm{d}\eta$$

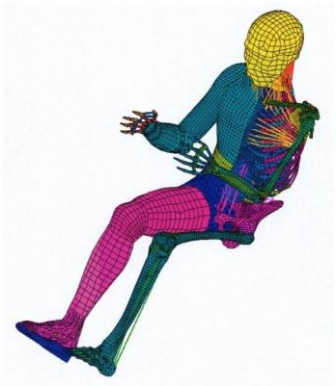


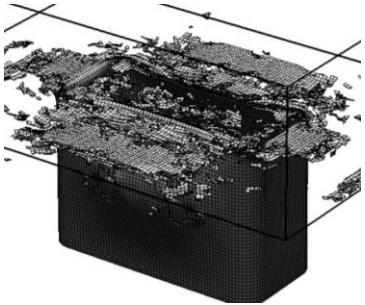
Compulsory Modules

Computational Material Mechanics 1

CONTENT (Basic Materials – Part 1 “mechanics”)

- Elasticity
- Plasticity
- Visco-elasticity
- Visco-plasticity





CONTENT (Composites – Part 2 “materials”)

- Composites, Fiber-reinforced polymers
- Honeycombs, Foams, Biomaterials (bones)

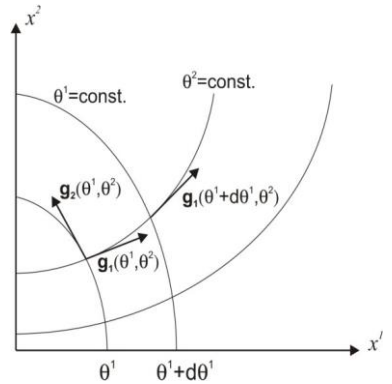
Compulsory Modules

Continuum Mechanics

CONTENT

- Introduction into tensor analysis
- Description of stress states in arbitrary, curvilinear coordinates
- Lagrangian description of strain states
- Conservation of energy
- Conservation of mass
- Constitutive relations
- General treatment of continuum mechanical knowledge in order to solve non-linear problems

$$\tau^{im}\Big\|_i + Q^m - \rho\, b^m = 0$$

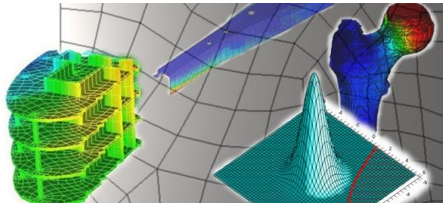


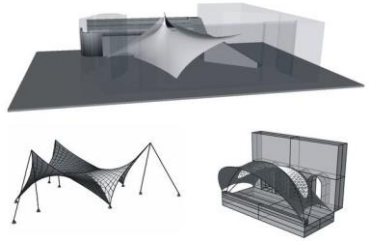
Compulsory Modules

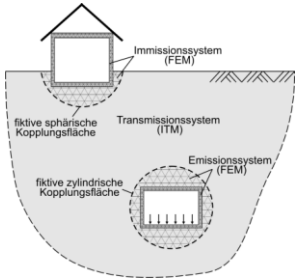
Software Lab (2nd / 3rd Semester)

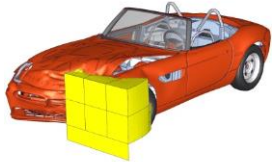
CONTENT

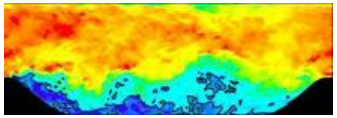
- Group work on software development.
- Engineering problems from different application fields.
- Collaboration with industry and academia











Bavarian Graduate School of Computational Engineering BGCE

The Bavarian Graduate School ...

of Computational Engineering is an association of three Master programs:

1. **Computational Engineering (CE)** at the Friedrich-Alexander-Universität Erlangen-Nürnberg,
2. **Computational Mechanics (COME)**, and
3. **Computational Science and Engineering (CSE)** at the Technische Universität München.

- “Elite" degree program for our best MSc students
- Additional exclusive course offers and training
- Intensive interaction with research staff
- Additional certificate

Elitenetzwerk Bayern

http://www.bgce.de/

Thanks for joining us – Have fun and success …