TUHH
Hamburg
University of
Technology

ANNUAL REPORT 2020

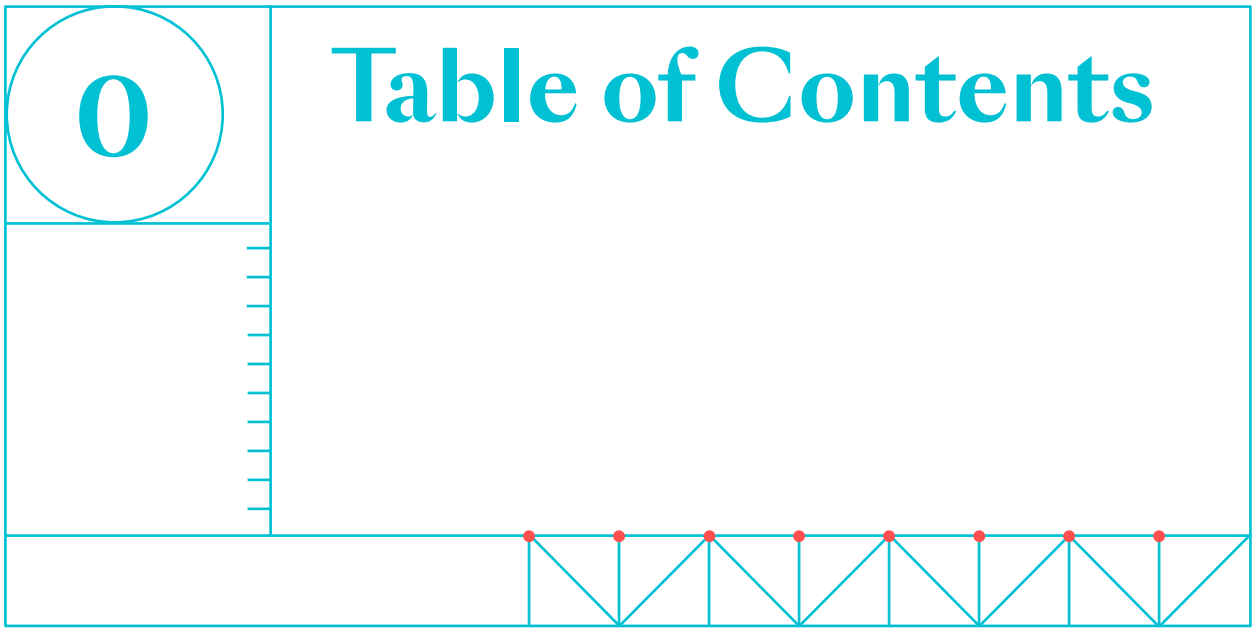
ANNUAL REPORT BY THE EXECUTIVE BOARD

2020

TUHH
Hamburg
University of
Technology

Puplisher
Präsident der TU Hamburg
Editorial staff
Dr. Johannes Harpenau, Dr. Oliver Rayiet
Layout
formlabor
Photography
© Eva Haeberle (Shokri, Skiborowski);
© TU Hamburg/Geringer (Scandariato);
© Ole Kracht (Heinrich)
Coporate Design
Gstrheinländer Worldwide GbR
Print
Hans Steffens Graphischer Betrieb GmbH

Hamburg University of Technology
Am Schwarzenberg-Campus 1
21073 Hamburg
November 2021



0 Table of Contents

1. FOREWORD 04

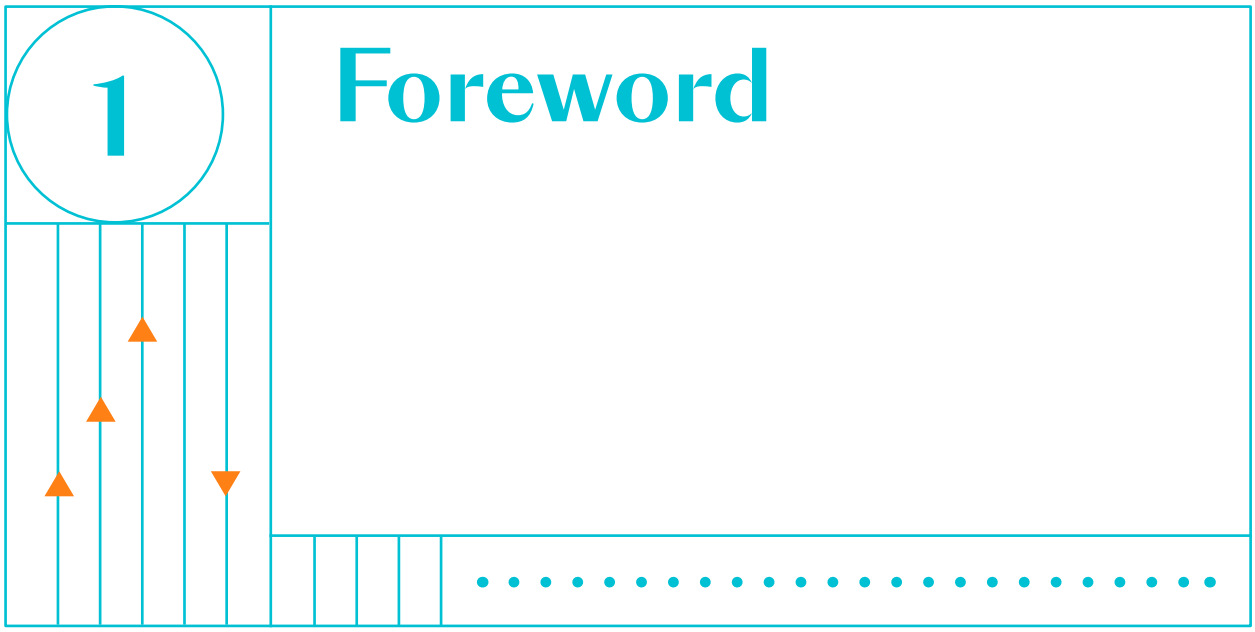
2. AT A GLANCE 06
2.1 Key Figures 06
2.2 Organizational Structure of the TU Hamburg 08
2.3 Overview of Teaching Programs 09
2.4 Overview of Research 10

3. GROWTH 12
3.1 Growth Program – Interim Status 14
3.2 New Professorships and the Joint Federal Government-Länder Tenure Track Program 15
3.3 Cooperation with Commerce and Industry via Endowed Chairs 16
3.4 Construction Work 17
3.5 Personnel Developments on the Executive Board 18
3.6 Strengthening Infrastructure and Administration 18
3.7 Deutschlandstipendium Scholarships at the TU Hamburg 19
3.8 Alumni Work – TU & YOU 20
3.9 Equal Opportunities

4. RESEARCH 17
4.1 I^3 Internal Research Funding Program 22
4.2 Basic Research: DFG 25
4.3 Research Funding by the Federal Government 25
4.4 State Research Funding 26
4.5 EU Research Funding 27
4.6 Technology Transfer and Startups 27
4.7 Good Scientific Practice at the TU Hamburg 29
4.8 Hamburg Open Science 29

5. TEACHING AND STUDIES 23
5.1 Teaching Mission Statement 33
5.2 Further Development of the Range of Study Programs 34
5.3 Student Recruitment: The 2020 Campaign 35
5.4 Consolidation of the Center for Teaching and Learning 36
5.5 Internationalization 38
5.6 Erasmus+ Charter for the TU Hamburg 39
5.7 Hamburg Teaching Prize 2020 39
5.8 In the Home Straight –TUNE Campus Management 40
5.9 Cooperation Partners in Teaching – MINTFIT and HOOU 41

6. STATISTICS 27
6.1 Teaching 28
6.2 Research 44
6.3 Personnel and Finances 50



1 Foreword

DEAR MEMBERS OF THE TU HAMBURG, COLLEAGUES, STUDENTS AND FRIENDS:

2020 was a year of many changes for Hamburg University of Technology. In particular, it was dominated by the Covid-19 pandemic, which posed for us entirely new challenges about how we work, teach and learn. The TU had to—and still has to—cope with more difficult financial framework conditions that affect us all, but 2020 was also a year of splendid achievements for us with interesting new stimuli provided by newly appointed professors and many (growth) plans for the future. Let me deal with a number of topics in greater detail:

2020 saw significant changes on the Executive Board. In February Arne Burda took over as Chancellor from his longstanding predecessor Klaus-Joachim Scheunert, and in the summer Hendrik (Ed) Brinksma took us by surprise, announcing that he was standing down as President of the TU Hamburg with effect from September 1, 2020.

We were able to reposition ourselves in time for his move to the Erasmus University in Rotterdam. First, I took over as Acting President and then we were able to enlist Professor Irina Smirnova as our new Vice President Research. Together with the existing Board members Professor Kerstin Kuchta as Vice President Academic Affairs and Arne Burda as Chancellor we as a team are now tackling the task of dealing with the manifold challenges.

In spring 2020 teaching, learning and working in pandemic conditions meant radical change for all members of the TU. Students could no longer enter the campus and the lecture

thea-ters, teachers had to convert their classes into digital formats at the shortest notice, and employees had to work from home wherever possible. That was a major accomplishment for all concerned, some of whom, for example, used their private terminal devices as a matter of course in order to keep the system up and running. In addition, families faced the twofold burden of home schooling and the closure of kindergartens. I would especially like to mention the data center employees, who most professionally and with an eye for what was essential made the changes possible in the first place. Safety at Work, Environmental and Health Protection (AUG) and Academic and Student Services (SLS) have ensured with their hygiene concepts that exams could and can be taken without infection. Sadly, laboratory research had to be discontinued for a while but has now been resumed subject to strict compliance with the hygiene rules. That is why I feel bound to say that I am proud of all that we have achieved. Nearly all classes and exams were held in the summer semester of 2020. The administration is operational from working at home. We have grown accustomed to virtual conferences and even though we are all probably looking forward to meeting around a table again I would like to thank you all for your hard work and to encourage you to keep it up together until the end of the pandemic.

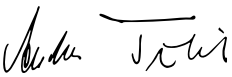
Negotiations on future contracts and on the financial framework for Hamburg universities in the next few years were held this year. In keeping with the general public-sector financial position the annual budget increases negotiated barely exceed anticipated wage and salary ris-es. There is also a structural deficit at the TU that can only be offset by strict economy and by postponing special measures, which we are doing. This applies to all areas of the TU in equal measure and I hope we will soon be able to cancel at least some of these measures.

Much, however, happened in 2020 that helps us to shape our university's future positively. The growth program was continued successfully, as shown inter alia by the fact that seven new professors, including four from the growth program, were able to start work in 2020. For a university with only 100 or so professors that represents a considerable input of new ideas in research and teaching. I would like to take this opportunity of extending a warm welcome to all new colleagues once more and of referring you to their brief profiles on the following pages. In research too there have been genuine highlights. With very good ratings the Collaborative Research Center (SFB) 986 had its final funding period approved, two items of large-scale equipment were given the go-ahead by the German Research Foundation (DFG), two major feasibility studies were commissioned from the TU Hamburg on Climate Change and Sustainable Flood Protection and Improvement of the Rail-borne Transportation Situation—and these are just a few outstanding examples. I was especially pleased by the lively participation in the lectures and workshops on good scientific practice, which have led to an intensive take-up on this important topic and to a practical arrangement for the TU Hamburg that is in keeping with the times. In the teaching sector the new Data Science study program was launched in the winter semester and the Green Technologies program will welcome its first students in the fall of 2021. Several accreditation procedures were undertaken successfully and in spite of a lost year of school leavers in Lower Saxony we have much the same number of new students as in the previous year.

Profile building at the TU Hamburg continues in all areas with strong commitment. On the basis of what has been achieved and taking into account the new professorial appointments, the impulses gained by research applications approved and the I^3 program, future research areas will be refined in an intensive dialog. Study programs will be reviewed and positioned for the TU's topics in Hamburg.

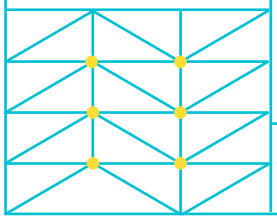
As you see, we are developing constantly and successfully, so I too am looking forward with great expectations to 2021, a year in which we are likely to be able to welcome many new colleagues and aim to continue our growth and profile building course.

Yours truly

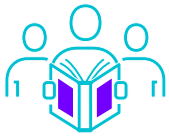


Andreas Timm-Giel
President

2 The TU Hamburg at a Glance



2.1
KEY FIGURES 2020

	**STUDENTS** 7,564	**FRESHMEN** Bachelor (B. Sc.): 1,011
	**DEGREES** 1,144	**DOCTORATES** 114
	**PROFESSORS** 99.1 (incl. junior professors, FTEs)	**ACADEMIC EMPLOYEES** 742.6 (FTEs, incl. third party funded employees)
	**PERCENTAGE OF WOMEN STUDENTS** 27.3 % (FTEs, incl. third party funded employees)	**PERCENTAGE OF WOMEN ACADEMIC STAFF** 20.8 % (FTEs, incl. third party funded employees)
	**INTERNATIONAL[1] PERCENTAGE STUDENTS** 25.7 % (FTEs, incl. third party funded employees)	**INTERNATIONAL[1] PERCENTAGE ACADEMIC STAF** 11.8 % (FTEs, incl. third party funded employees)
	**TOTAL EXPENDITURE** 146,064 (in € '000)	**THIRD-PARTY FUNDING** 46,152 (in € '000, incl. Tutech Innovation GmbH)

[1] *Persons of non-German nationality.*

2.2
ORGANIZATIONAL STRUCTURE OF TU HAMBURG

2.2.1
STRUCTURE OF SELF-ADMINISTRATION

ACADEMIC SELF-ADMINISTRATION

ADVISORY BOARD
1 chair + 4 members

SENATE
11 members
Senate committees

EXECUTIVE BOARD		
President	2 Vice-Presidents	Chancellor

SCHOOLS OF STUDY, RESEARCH CENTERS	
Heads	Spokespersons

STUDENT SELF-ADMINISTRATION

STUDENT PARLIAMENT
25 members

STUDENTS' UNION (ASTA)	
Executive Committee	Subject Specialists

8 FACULTY COUNCILS

2.2.2
INSTITUTIONAL STRUCTURE

6 SCHOOLS OF STUDY / 1 STUDY AREA 76 Institutes / Work Groups
6 CENTRAL FACILITIES
1 DFG COLLABORATIVE RESEARCH CENTER
2 DFG RESEARCH GROUPS (PARTICIPATION)
3 DFG PRIORITY PROGRAMS (HEAD)
3 DFG GRADUATE COLLEGES

2.3 OVERVIEW OF TEACHING PROGRAMS

SCHOOL OF CIVIL ENGINEERING (B)

Bachelor (B.Sc.)

- Civil and Environmental Engineering

Master (M.Sc.)

- Civil Engineering
- Environmental Engineering
- Water and Environmental Engineering

SCHOOL OF ELECTRICAL ENGINEERING, COMPUTER SCIENCE AND MATHEMATICS (E)

Bachelor (B.Sc.)

- Computer Science
- Data Science
- Electrical Engineering
- Computer Science and Engineering
- Technomathematics

Master (M.Sc.)

- Computer Science
- Electrical Engineering
- Computer Science and Engineering
- Information and Communication Systems
- Microelectronics and Microsystems

SCHOOL OF VOCATIONAL SUBJECT EDUCATION (G)

Teacher Training (Cross-University)

- Vocational Education/Technology
- Construction and Wood Technology
- Electrical Engineering/Computer Science
- Media Technology
- Metal Technology

SCHOOL OF MANAGEMENT SCIENCES AND TECHNOLOGY (W)

Bachelor (B.Sc.)

- Logistics and Mobility

Master (M.Sc.)

- Global Technology and Innovation Management & Entrepreneurship (G-TIME/Joint Master)
- International Industrial Engineering
- Logistics, Infrastructure and Mobility

SCHOOL OF MECHANICAL ENGINEERING (M)

Bachelor (B.Sc.)

- Mechanical Engineering
- Naval Architecture

Master (M.Sc.)

- Energy Systems
- Aircraft Systems Engineering
- Materials Science: Multiscale Materials
- Mechatronics
- Mechanical Engineering and Management
- Medical Engineering
- Product Development, Materials and Production
- Naval Architecture and Ocean Engineering
- Theoretical Mechanical Engineering

SCHOOL OF PROCESS ENGINEERING (V)

Bachelor (B.Sc.)

- Bioprocess Engineering
- Process Engineering

Master (M.Sc.)

- Bioprocess Engineering
- Chemical and Bioprocess Engineering
- Renewable Energy
- Process Engineering

INTERDISCIPLINARY ENGINEERING SCIENCES AND TECHNOLOGIES (FIT)

Bachelor (B.Sc.)

- *Allgemeine Ingenieurwissenschaften*
- Energy and Environmental Engineering
- Engineering Science
- Mechatronics

Master (M.Sc.)

- Energy and Environmental Engineering

NORTHERN INSTITUTE OF TECHNOLOGY MANAGEMENT (NIT)

Master (MBA/M.A.)

- Technology Management

OVERARCHING

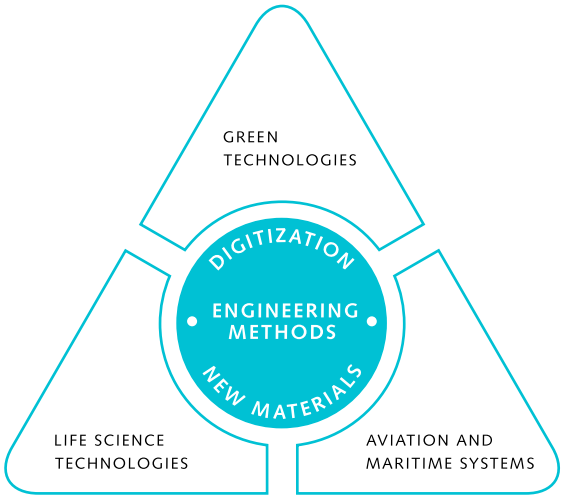
- Orientation Program

EUROPEAN CONSORTIUM OF INNOVATIVE UNIVERSITIES (ECIU)

- ECIU-University

2.4
OVERVIEW OF RESEARCH

TU HAMBURG AREAS OF EXPERTISE AND INTERDISCIPLINARY FIELDS



GREEN TECHNOLOGIES

- Renewable Energy Research Area
- Systems – Storage – Networks Research Area
- Water and Environmental Engineering Research Area

LIFE SCIENCE TECHNOLOGIES

- Medical Technology Research Area
- Biomaterials Research Area
- Bio- and Chemical Process Engineering Research Area

AVIATION AND MARITIME SYSTEMS

- Aeronautics Research Area
- Logistics and Mobility Research Area
- Maritime Systems and Structures Research Area

DFG COLLABORATIVE RESEARCH CENTER

- Tailor-made Multi-Scale Materials Systems – M^3 (SFB 986)

DFG RESEARCH GROUPS (WITH PARTICIPATING TU HAMBURG SCIENTISTS)

- Nanoporous gold - A prototype for a rational design of catalysts (FOR 2213)
- Memristive Devices for Neural Systems (FOR 2093)

DFG PRIORITY PROGRAMS

- 1679: Dynamic Simulation of Interconnected Solids Processes - DynSim-FP
- 1740: Reactive Bubbly Flows
- 2240: Bioelectrochemical and Engineering Fundamentals to Establish Electro-Biotechnology for Biosynthesis – Power to Value-Added Products (eBiotech)

DFG GRADUATE COLLEGES

- Processes in Natural and Technical Particle-Fluid Systems (PintPFS) GRK 2462
- Tailor-Made Multi-Scale Materials Systems – Collaborative Research Center SFB 986
- Modeling, Simulation and Optimization of Fluid Dynamic Applications (joint application with the University of Hamburg) GRK 2583

TU HAMBURG RESEARCH CENTERS

- Integrated Biotechnology and Process Engineering
- Climate-Protecting Energy and Environmental Technology
- Regeneration, Implants and Medical Technology
- Maritime Systems
- Aeronautics
- Product-oriented Materials Development
- Logistics and Mobility for Sustainable Value Creation

Understanding Unexplained Phenomena

Many will remember from their schooldays the contention that "you can explain everything with math." Exciting though the tenet may be, a direct relationship with everyday life is seldom apparent in mathematical formulas. At Hamburg University of Technology Matthias Schulte, a newly appointed professor at the Institute of Mathematics, is providing evidence to the contrary. With a focus on fundamental research in stochastics he is probing mathematical coincidence, which can serve to explain current phenomena such as social networks or the spread of Covid-19.

"In my work I investigate random structures such as random graphs and try to recognize patterns and understand previously unexplained phenomena," he says, adding that "with random graphs you can, for example, model how users behave on Instagram or Facebook and how they relate to each other." That is an important issue, given that more than 32 million people a day use the two media in Germany alone. A graph consists of so-called nodes connected by edges. In the case of social networks a node stands for a certain user. If this user makes friends with another user, an edge is drawn between the two nodes. "Analyses of such structures lead, for example, to the platform suggesting to a user people the user may know—in this case neighbors, colleagues or people in the user's extended environment," the mathematician explains.

MANY NODES, SPREADING FAST

Another example of complex networks are contact networks in, say, the spread of epidemics like the current Covid pandemic. In this connection, Schulte says, modeling by means of random graphs is also worthwhile: "The more neighbors a node—in other words a person—has, the higher, mathematically speaking, its degree. If a principal node of this kind is infected it will become a central point in the spread of the virus. The lower its degree, the unlikelier it is that the epidemic will spread further. Degree distribution plays an important role."

PROFESSOR MATTHIAS SCHULTE RESEARCHES MATHEMATICAL COINCIDENCE

Matthias Schulte discovered his delight in math at school in Hamburg and went on to study mathematics at Clausthal University of Technology. He studied for his PhD in Osnabrück, then moved further south to Karlsruhe Institute of Technology and from there to the University of Berne, where he did his habilitation. After working at Heriot-Watt University in Edinburgh he has researched and taught at the Hamburg University of Technology's Institute of Mathematics since September 2020. Professor Schulte will in future contribute his expertise in stochastics to data science and machine learning.

FOCAL POINTS OF RESEARCH:

- Stochastic geometry
- Limit theorems and Stein's method
- Random graphs
- Extreme value theory
- Stochastic processes

Further information at: https://www.mat.tuhh.de/

TU HAMBURG I³-LABS[1]

- Business Analytics – Optimization Potential and Strategic Risks for Maritime Logistics Systems
- Cyber Physical Energy Systems – Sustainability, Resilience and Economics
- Model-assisted Machine Learning for Soft Tissue Modeling in Medicine
- HELIOS Hamburg Electronics Lab for Integrated Optoelectronic Systems
- Interdisciplinary Competence Center for Interface Research (ICCIR)
- Novel Products from Maritime Resources
- Smart Reactors
- Structural Integrity Using Vibro-acoustic Modulation to Extend the Lifetime of Civil Infrastructure

STATE RESEARCH FUNDING

- CIMMS – Center for Integrated Multiscale Materials Systems – funding line HamburgX
- *Innovative luftgestützte urbane Mobilität (i-LUM) – Förderlinie HamburgX*
- Center for Data and Computing in Natural Science (CDCS) – funding line HamburgX
- *Simulationsbasierte Entwurfsoptimierung dynamischer Systeme unter Unsicherheiten*

PROMOTION OF YOUNG ACADEMICS

- TU Hamburg Graduate Academy for Technology and Innovation
- Graduate School of the Center for High-Performance Materials (ZHM) – Helmholtz Center Geesthacht (HZG)
- Data Science in Hamburg (DASHH) Graduate School – Helmholtz Graduate School for the Structure of Matter

TECHNOLOGY TRANSFER

- Tutech Innovation GmbH
- Startup Dock
- Hamburg Innovation

RESEARCH GROUP OF EXCELLENCE

CURRENT JUNIOR PROFESSORSHIPS	PARTNER
smartPORT	Hamburg Port Authority
Structure optimization in lightweight construction (SOL)	Airbus
Molecular dynamic simulation of soft material	Helmholtz-Zentrum Geesthacht
Multiscale simulation of solid systems	Glatt Ingenieurtechnik GmbH
Development and modeling of novel nanoporous materials	BASF

[1] The acronym I³ stands for Interdisciplinarity, Engineering Sciences (Ingenieurswissenschaften) and Innovation. These are structures in which research activities characterized mainly by interdisciplinary and innovative ap-proaches in TUHH research areas are bundled. The I3 elements that are funded are chosen by means of a competitive process. Interdisciplinary research labs consist of at least four professors and are funded for a four-year term

3 TU Hamburg: A Growing, Dynamic University

The reporting year 2020 was a year of change. As part of the growth program new appointments and targeted replacements began or continued a repositioning and profiling in research and teaching. Networking with partners in industry, commerce, extramural research and society in the metropolitan region is most important. It was accompanied by personnel renewal in the university's management. And despite the Covid situation and financial bottlenecks successes were achieved in research, teaching and transfer. They are dealt with in the following pages and subsequent chapters.

3.1 GROWTH PROGRAM – INTERIM STATUS

The growth program gained momentum in 2020. The first four of the 15 newly defined growth program professors were appointed (see Section 3.2). More are in the process of being appointed. In addition, the funding program for interdisciplinary and innovative research in the engineering sciences (the I^3 program) was implemented as scheduled (see Section 4.1).

Important priorities were already set with the classification and appointment of the new professorships and matching strategic appointments to fill vacancies:

- Materials sciences were strengthened and are to be taken forward to a cluster of excellence application in close cooperation with the Helmholtz Center Geesthacht (HZG), the German Electron Synchrotron (DESY) and the University of Hamburg, with the TU Hamburg as lead applicant. In this connection additional funding for four partly cooperative professorships was secured from the Hamburg state research funding program for the Center for Integrated Multiscale Materials Systems (CIMMS).
- Process engineering was helped to apply for a Smart Reactors collaborative research center status that will strengthen the above-mentioned cluster of excellence application.
- Computer science at the TU Hamburg was taken forward in coordination with the Hamburg informatics platform ahoi.digital as the basis for further digitization and a cross-disciplinary Machine Learning in Engineering (MLE) research initiative was launched.
- Appointments to fill vacancies and growth professorships serve to take digitization forward in mechanical engineering, process engineering, civil engineering and management sciences and technology.
- Cooperative professorships, as in aviation and in maritime technologies, supplement and strengthen Hamburg University of Technology's scientific portfolio.

We also succeeded in securing two endowed chairs from industry and the TU Hamburg is further extending its cooperation with the German Aerospace Center (DLR), the Fraunhofer Society, DESY and the HZG by means of jointly appointed cooperative professorships, five of which have already been advertised or are in the course of selection. Overall, TU Hamburg is able by means of the growth process to build further profile and offer attractive study programs.

3.2 NEW PROFESSORSHIPS AND THE JOINT FEDERAL GOVERNMENT-LÄNDER TENURE TRACK PROGRAM

As part of the growth concept and in the course of filling vacancies we were able to welcome seven new professors to the TU Hamburg in the reporting year:

Prof. Dr.-Ing. habil. Alexander Kölpin
High-Frequency Technology, E-3
Prof. Dr. Mirko Skiborowski
Process Systems Engineering, V-4
Prof. Dr. Alexander Penn
Process Imaging, V-10 (Growth)
Prof. Dr. Nima Shokri
Geo-Hydroinformatics, B-11 (Growth)
Prof. Dr. Matthias Schulte
Stochastics, E-10 (Growth)
Prof. Dr. rer. pol. Timo Heinrich
Digital Economics, W-5 (Growth)
Prof. Dr. Riccardo Scandariato
Software Security, E-22 (Growth)

Profiles of these new professors are included in this report. They consist of a brief introduction and photo, a short resumé, research interests and a reference to the Institute.

Another important development building block is the 11 tenure track professorships that the TU Hamburg has secured from the Joint Federal Government-Länder Tenure Track Program. For the term of these junior professorships the TU receives up to EUR 1.3 million a year in funding. This strengthens research and teaching of computer science, logistics and materials science and innovation research. Tenure track professorships pave the way for young scientists to secure a full professorship and help them to establish themselves in the academic world. After successful tenure evaluation a direct transfer to a W3 professorship is possible. The first six of these junior professorships were advertised in the reporting year; the first appointment was made as of April 1, 2020.

3.3 COOPERATION WITH COMMERCE AND INDUSTRY VIA ENDOWED CHAIRS

One of the TU Hamburg's greatest strengths is its traditionally close ties with commerce and industry. Hamburg as a science and business location derives special benefit in the current Covid pandemic from the TU Hamburg, which with its intensive cooperation arrangements in aviation and shipping, renewables, logistics, medical technology and digitization, all of which are significant economic sectors for Hamburg and the Hamburg metropolitan region, is taking forward the scientific and technological basis of innovation. Together with economic

partners such as Fujitsu, Airbus, NXP, Jungheinrich or Tempowerk and with associations and chambers the TU Hamburg has a vibrant network to show for itself, the strength of which is enhanced in technology transfer by the activities of TuTech Innovation GmbH and the TU Foundation. The two new endowed chairs acquired during the reporting period with partners Fujitsu, Dataport and Tempowerk (previously hit-Technopark) are an especially good example of how work on sustainable subjects in research, teaching and technology transfer can be undertaken in partnership.

FUJITSU ENDOWED CHAIR OF HARDWARE-AWARE COMBINATORIAL OPTIMIZATION

In Fujitsu a leading international technology group was secured as a partner in the business fields of information technology, semiconductors, networks and telecommunications with an endowed chair in combinatorial optimization, a research area of great importance for industrial applications with a very high computing requirement. In addition, Fujitsu contributes the world's first quantum-inspired digital annealer technology. The Digital Annealer uses a digital circuit design that is similar in performance potential to that of quantum computer. It can solve problems that are too difficult or too time-consuming for classical computers. Jointly with Dataport, a pilot user of this new technology, Fujitsu is supporting practical and application-driven research and teaching in this field by endowing a professorship with a fully equipped institute. The aim is to develop new algorithms that build a bridge to the next generation of quantum-based computer architecture in order to solve complex optimization problems.

TEMPOWERK ENDOWED CHAIR OF ORGANIZATIONAL DESIGN & COLLABORATION ENGINEERING

The hit-Technopark (today's Tempowerk) was founded in 1985 on the initiative of the Birkel family of entrepreneurs in cooperation with the TU Hamburg and the city of Hamburg. Laboratories, offices and production rooms for startups were set up in the former factory premises of the automaker Tempo. Most of the young entrepreneurs who undertook research and developed creative projects there in the early days were TU graduates. Since 1995 has developed into one of the most important high-tech locations in Hamburg and now houses over 100 tech companies with around 600 employees.

The newly endowed chair is intended to create the scientific basis for field tests in the area of innovative technology transfer. In a collaborative approach research is to be undertaken on novel methods for designing agile business models, products and services just as practically as inter- and transdisciplinary collaboration on the development of open socio-economic systems to intensify knowledge transfer such as corporate networks, innovation platforms, online communities or virtual development teams.

The two endowed chairs are scheduled to be in place for the 2021/22 winter semester and the appointments will be made in keeping with the Stifterverband für die deutsche Wissenschaft's code of conduct in order to ensure free and independent research and teaching in the establishment of endowed chairs based on private funding.

3.4 CONSTRUCTION WORK

Growth requires more space. Additional personnel and successfully acquired third-party funding lead to a need for new space. In this connection the TU Hamburg has already moved into HIP One, the first section of the Hamburg Innovation Port in the Harburg inner harbor. Additional space requirements must in the event of further growth be made available in the form of new buildings or rental space that could be provided in the inner harbor area.

CENTER FOR STUDENTS AND DOCTORAL STUDIES (ZSP)

As a further element of growth at the TU Hamburg, construction of the Center for Students and Doctoral Studies was completed and handed over to the TU by Sprinkenhof GmbH in December. Modern rooms for student work groups, the Graduate Academy and the College of Excellence are now in place. On nearly 2,000 square meters of floor space the new three-storey building provides facilities for the approximately 7,600 TU Hamburg students. The first floor consists of a welcoming foyer and cafeteria with flexible wall units that make it suitable for a variety of uses. The upper floors are envisioned as work areas for first-degree and doctoral students and the ZSP provides the Graduate Academy for Technology and Innovation with its first integrated on-campus meeting place and point of contact.

Understanding the Environment and Natural Resource Management

Natural resources such as water and soil are vital to our life on Earth. Sustainable resource management requires a profound understanding of highly complex and nonlinear processes governing the ecosystem. That is a task Professor Nima Shokri has pursued at Hamburg University of Technology's newly established Institute of Geo-Hydroinformattics since July 2020. "I am interested in understanding physical mechanisms controlling the processes occurring near the Earth's surface. My research includes, for example, investigation of soil salinization, developing novel methods for improving soil health, water management, and land-atmosphere interactions under changing climate."

SUSTAINABLE WATER AND LAND MANAGEMENT

What motivates Shokri is the desire to change the world and make it a better place to live via conducting state-of-the-art research and employing innovative teaching approaches. In one of his current research projects, he looked into the issue of soil salinization which is a global problem. Soil salinization refers to the excess accumulation of salt in soil which is driven by a variety of parameters including climate change and anthropogenic activities like irrigation with brackish water. Salt storms from saline soils, desertification, reduced crop production and worsening of economic opportunity which may lead to human migration are some of the detrimental consequences of soil salinization. "Global scale predictions of soil salinization are rare. To close this gap we have used machine learning techniques that enable us to show how topsoil salinity has changed globally over the past 40 years. Moreover, we could predict the future of soil salinization on a global scale under different climate scenarios in the 21st century using machine learning algorithms. Our findings help to identify the future hotspots for soil salinization in Europe as well as on a global scale, which is currently not available. This contributes toward devising and implementing the necessary action plans for soil protection against salinization which is one of the major drivers for soil degradation."

SHARE KNOWLEDGE AND INSPIRE OTHERS

As a scientist Professor Shokri would like to inspire young people and sharpen their views on the environment and the planet. He started a few new modules focused on environmental issues at TUHH, one on the consequences of microplastics in environment. Since the start of the Covid pandemic he has regularly put his lectures online on his YouTube channel, which now has over 330,000 views.

NIMA SHOKRI EXPLORES THE COMPLEX PROCESSES GOVERNING OUR PLANET'S ECOSYSTEMS.

Nima Shokri began his scientific career at the Sharif University of Technology in Teheran, Iran. He received his PhD from Ecole Polytechnique Federale de Lausanne (EPFL) in 2009 followed by a postdoctoral research at ETH Zurich. He worked as Assistant Professor (2010 – 2012) at Boston University (USA) and as Lecturer and Senior Lecturer (2013 – 2020) at The University of Manchester (UK). In 2020, he joined Hamburg University of Technology as the Chair and Professor of Geo-Hydroinformatics in the new Institute of Geo-Hydroinformatics. In his leisure time he explores the Hamburg metropolitan region with his wife and daughter and enjoys the city's flair and character.

FOCAL POINTS OF RESEARCH

- Soil salinization
- Sea-level rise and coastal processes
- Sustainable land and water management
- Soil water evaporation
- Multiphase flow and transport in porous media

Further information at: https://www.tuhh.de/ghi
Youtube: https://bit.ly/3bgNuae

3.5 PERSONNEL DEVELOPMENTS ON THE EXECUTIVE BOARD

Due to TU Hamburg President Ed Brinksma accepting a position at the Erasmus University in Rotterdam from September 1, the post of President became vacant and the Vice President, Professor Andreas Timm-Giel, took over as Acting President. A commission was set up to find a new President. On its recommendation the Acting President was elected by the Academic Senate on January 6, 2021 and confirmed in office by the Advisory Board.

That created a vacancy for the position of Vice President for Research. Professor Irina Smirnova took the post on and in August was confirmed in office by the Academic Senate for a three-year term starting on September 1. The University Senate had on February 1, 2020 unanimously elected Arne Burda as the TU's new Chancellor. With these personnel changes the Executive Board was complete once more.

3.6 STRENGTHENING INFRASTRUCTURE AND ADMINISTRATION

A modern university of technology needs an efficient administration. For one, the number of administrative procedures increases sharply with the establishment of professorships and the considerable in-house project funding, inter alia in personnel, and in third-party and state funding management, and also in real estate management or procurement. For another, the need to professionalize administrative personnel, processes and instruments becomes more apparent with an increasingly dynamic academic sector.

Important measures undertaken so far have been setting up an academic appointments department and professionalizing the schools of study by means of appropriate appointments. In Academic and Student Services (SLS) the "HIS in One" campus management system's introductory project was completed. In addition, previously fixed-term jobs in the International Office were made permanent against the backdrop of the TU's internationalization targets. In the core administrative sector the vacancy for a Head of Finance and Accounts was filled. In addition, a strategic financial control officer was appointed to make central control issues such as budget planning, allocation of funds, forecasting and reporting more professional and to provide the Executive Board with relevant control information at all times. The real estate-related departments Facility Management, Technical Service Construction, Technical Operating Service and the Structural Development department that previously reported to the Executive Board were merged in a newly established Real Estate Management department. A head of department has been appointed. The concept also provides for an urgently needed further development of space management, including expansion of the database held in the CAFM system.

All administrative areas have hitherto suffered from inadequate digitization. Further consistent modernization and digitization of the administration is indispensable and requires, at least for a longer transition period, additional resources the need for which must most definitely be taken into account in the continuation of the growth program.

3.7 DEUTSCHLANDSTIPENDIUM SCHOLARSHIPS AT THE TU HAMBURG

Another example of networking Hamburg University of Technology with private individuals, foundations and enterprises is the Deutschlandstipendium. The scholarship is awarded to gifted students who in addition to their excellent academic performance show social commitment and have successfully overcome handicaps in their own lives and education. Ninety-one Deutschlandstipendium scholarships were awarded in 2020/21. They amount to € 300 a month for a year. Especially in times of coronavirus this is both a token of recognition and a financial relief because the students had to clear many hurdles due to the pandemic. Awarded irrespective of income or subject studied, the scholarships are funded in equal parts by the Federal Ministry of Education and Research (BMBF) and private individuals, companies and foundations. The funders and donors showed great solidarity, especially against the background of the Covid pandemic.

3.8 ALUMNI WORK – TU & YOU

Keeping in touch with alumni and "looking after" TU Hamburg graduates are the objectives of alumni work. TU & YOU is a network initiative of the university, the alumni association and the Foundation to Promote the TU and Tutech Innovation

GmbH that promotes personal and subject-related exchange between alumni, students, TU members, foundation members and representatives of business, industry and society. TU & YOU provides services, holds events and has a website (http://www.tuandyou.de). It looks after alumni in social networks such as LinkedIn and XING. Over the past five years membership has been doubled to over 2,000.

Events are a major feature of alumni work, held to establish and maintain ties with the network and the alma mater. As all in-person events had to be canceled in 2020 a virtual event format was launched that now connects the global community digitally. Since July 2020 TU & YOU has zoomed its Talk Around the World on every second Wednesday in the month. The first part consists of news from the TU Hamburg such as from the Executive Board or a live transmission from an Institute laboratory. In the second part, the Alumni Talk, guests are interviewed about their work, their projects and their time at the university. Talk guests have included the Economic Affairs Minister of Costa Rica, an Airbus employee from Toulouse and a startup founder from New York. The format is increasingly popular. After starting with 12 participants at the first event in July the December Talk included 127 guests from all status groups: alumni, students, professors, staff and donors—very much in keeping with the idea behind the foundation of the TU & YOU family.

3.9
EQUAL OPPORTUNITIES

Since 2013 the TU Hamburg has been certified as a family-friendly university; in 2019 it was successfully re-audited for the third time. Reconciling family and career is purposefully pursued. In 2020 the certification requirements were confirmed in the Equal Opportunities department's report as continuing to be fulfilled.

Specific steps have been undertaken to upgrade the CampusNest flexible day care center into a full-scale day care center for children. The equal opportunities check, funded by the federal government's Anti-Discrimination Office and undertaken at the TU Hamburg in July 2019, was concluded successfully at the beginning of 2020 with a final workshop. The findings of the family-friendly university audit and the equal opportunities check were incorporated into a new equal opportunities concept that is the basis of an equal opportunities plan for academic personnel and students that is in preparation.

New appointment regulations that focus on the promotion of equal opportunities also came into force in 2020. The Pro Exzellenzia plus project having been approved by the European Social Fund for Hamburg and Hamburg's Ministry of Science, Research, Equalities and Districts (BWFGB), scholarships will be awarded to highly qualified scientists once more in collaboration with the other Hamburg universities.

The TU Hamburg has also successfully applied to participate in the "Close the gap" project. Funded by the BWFGB, it seeks to alleviate consequences of the pandemic for academics in particular, including female academics with family tasks. At present the TU Hamburg is taking part in a study on reconciling academic employment and family tasks commissioned by the BWFGB from the German Center for University and Scientific Research (DZHW).

4 Research – Status and Developments

The TU Hamburg is consistently pursuing a sharpening of its research profile. The starting point for the development of new technologies at a university of technology is strong and internationally networked basic research that forms a basis for application-oriented research and development. Research lives on the ideas of its scientists who carry out both individual research and large-scale coordinated research with industry and business and with university and extra-mural research.

Third party funding of newly approved projects in 2020 totaled around € 57 million. Third party revenue for ongoing projects amounted to about € 46 million in the reporting year. 114 young scientists brought their PhD studies to a successful conclusion in 2020.

4.1 I³ INTERNAL RESEARCH FUNDING PROGRAM

I³ stands for Innovation and Interdisciplinarity in Engineering (*Interdisziplinarität und Innovation in den Ingenieurwissenschaften*). The program aims to identify new interdisciplinary projects and seed them with in-house startup financing to the extent that projects are then able to apply for external funding from, say, the DFG, the EU or the federal government. Ideally, emerging germ cells of future research focal points at the TU

Hamburg can in this way be identified at an early stage. The I³ program is competitive and consists of three funding lines with different framework conditions.

I³-Labs supports the projects of four experienced scientists for four years, each with a research position and material resources. Project partners should then be in a position to, say, make a DFG or BMBF research group application and over time develop new mainstays of scientific activity at the TU Hamburg. Funding totals about € 1.4 million per lab for four years. Since the program was launched in 2018 seven I³ labs have been supported, initially each for three years.

The first five I³ Labs in the initial round of applications were prepared in the reporting year for evaluation by external assessors. They are:

- Process Engineering (New Reactor Technologies): Smart Reactors
- Maritime Logistics: Business Analytics – Optimization Potential and Strategic Risks for Maritime Logistics Systems
- Medical Engineering: Model-assisted Machine Learning for Soft Tissue Modeling in Medicine
- Cyber-physical Systems: HELIOS – Hamburg Electronics Lab for Integrated Optoelectronic Systems
- Mechanical/Civil Engineering/Cyber-physical Systems: Structural Integrity Using Vibro-acoustic Modulation to Extend the Lifetime of Civil Infrastructure.

Research in all I³ labs, in addition to its marked interdisciplinarity and basic character, is directly linked to Hamburg's economy. In the VAM I³ lab (Structural Integrity Using Vibro-acoustic Modulation to Extend the Lifetime of Civil Infrastructure), for example, innovative sensor technology is developed in combination with artificial intelligence to measure wirelessly the condition of different structures (bridges, wind farms, etc.) and identify damage at an early stage. Measurements are taken at real sites in Hamburg such as the Köhlbrand Bridge.

The second invitation to tender for I³ Labs was aimed at strengthening Green Technologies & Energy and Aviation. Two labs were funded accordingly:

- Green Technologies: Novel Products from Maritime Resources
- Energy: CPES: Cyber Physical Energy Systems – Sustainability, Resilience and Economics

The third invitation focused in 2020 on Medical Engineering and on collaboration with the University Medical Center Hamburg-Eppendorf (UKE). It was decided to establish an Interdisciplinary Competence Center for Interface Research (ICCIR) in order to intensify networking between the UKE and the TU Hamburg. The objective is to strengthen focused cutting-edge research on the interfaces and properties of multiscale cell structures, tissues, organs and biomaterials. The wide-ranging competences of the UKE and the TU Hamburg will be aligned in an area that in the medium to long term will form the basis for excellent individual projects and above all create collaborative projects the results of which will make a fundamental contribution toward increasing the efficiency of diagnostic and therapeutic procedures for the benefit of patients.

I³ Projects were established as the I³ program's second funding measure. Projects of two scientists are supported for three years, each with a research position and material resources. A follow-on application for an I³ lab or for external funding is then conceivable. Funding amounts to around € 250,000 per project with at least an application for funding from a public-sector funder envisioned as a follow-on. Since 2018 eight projects have been supported (project launch 2019/20) and a further five were recommended in 2020 by the Committee on Strategic Planning of Research.

I³ Junior Projects, finally, are aimed at junior scientists, who can apply for one year's funding for material resources. The volume of funding is around € 10,000 per junior project. In all, ten projects have been funded, applications having been received from both students and academic staff. A special point is that these seed projects are not supervised by professors. That gives students and young academics the freedom to develop their own ideas and maybe prepare their projects for longer-term funding of their work. One project supported was submitted by the e-gnition Hamburg initiative, which develops and constructs innovative electric racing cars. As part of the project the concept of autonomous driving was analyzed and innovative approaches to the construction of hybrid engines were developed. The team is presenting its successes and the vehicle tit developed at Formula Student, the world's largest international competition for students of engineering.

The I³ program makes a decisive contribution to profile building in research by TU Hamburg. Powered by the program's catalytic effect, research areas at the TU Hamburg are further developed in an internal strategic process. It is already apparent that the methods and processes of cyber-physical systems are playing a more important role than previously. In

Looking Right Inside Reactors

As a child, Alexander Penn loved the Disney comic inventor Gyro Gearloose. At school, he looked forward most to the experiments in chemistry and physics classes. And to this day, his goal is to understand how nature works. At the Hamburg University of Technology he is building the new Institute of Process Imaging, where he develops imaging technology based on magnetic resonance to help make the world more sustainable and climate-neutral.

THE QUEST FOR RESPONSIBLE SOLUTIONS

Our society faces the huge challenge to defossilize the entire economy within the next years and decades. For Alexander Penn, chemical and bioprocess engineering play a key role in this challenge: "Mankind knows how to produce plastic and fuels from crude oil. The next step, however, will be much more complicated: We need to invent and scale industrial processes and reactors that convert biomass or wind power from the North Sea into useful products such as biodegradable packaging films and synthetic aviation fuels. To succeed in this challenge, we need to understand and control the involved transport processes and chemical reactions in much greater detail. That is exactly where my research kicks in, providing direct measurement that aid understanding of the processes."

At the Hamburg University of Technology he would like to re-invent magnetic resonance imaging (MRI) for the engineering field and establish it as a primary imaging tool. The principle of magnetic resonance was originally discovered by physicists and has since been mainly developed for medical use. "For me as a physicist reclaiming the technology for the engineering sciences is particularly exciting," Penn says. In the future, he would like to make flows and chemical reactions measurable in process engineering facilities by means of MRI to make industrial processes more energy- and resource-efficient. For example, the provision of renewable energy, processing of food or the manufacture of medications. "It is barely conceivable, but in many instances, we still know very little about what exactly goes on in the interior of chemical reactors, especially in solids process engineering. That makes reactors vulnerable to malfunction. The better we know what's going on inside a reactor, the better we can control the process," says the scientist, adding optimistically, "In process engineering, MRI is still in its infancy, but it is becoming increasingly popular. Being at the forefront here is exciting for me and also for my students."

PROFESSOR ALEXANDER PENN IS RE-INVENTING MAGNETIC RESONANCE IMAGING FOR ENGINEERS

Alexander Penn studied technical physics at the University of Vienna and graduated with a PhD thesis on MRI at the ETH Zurich. After research stays at Columbia University in New York, and Osaka University in Japan, he moved to Hamburg University of Technology.

FOCAL POINTS OF RESEARCH

- Development of high-resolution imaging technology
- Real-time magnetic resonance imaging of multiphase flow and reactive systems
- Development of MRI hardware and software
- Data-driven modeling of multiphase flow systems

Further information at: https://www.ipi.tuhh.de/

the interaction between informatics, electrical engineering, process engineering and mechanical engineering they are developing into a new research field at the TU Hamburg.

4.2 BASIC RESEARCH: DFG

In DFG basic research the TU Hamburg succeeded in taking the existing "Tailor-made Multiscale Materials Systems – M3" collaborative research center to the third funding phase. In addition, further approvals were secured from the DFG in the reporting year by the normal process and for large items of equipment totaling € 8.5 million.

The TU Hamburg also aims to establish a second collaborative research center for new reactor technologies in process engineering. The Smart Reactors collaborative research center deals with smart reactors for chemical and biochemical processes that can use modern developments in process engineering and computer science to produce more flexibly and more sustainably. These reactors of the future must be smart, or capable of adapting fast and flexibly to changing commodity qualities, energy sources and individual requirements. In addition, smart reactors must be able to recognize problems in the process, such as an increase in pressure losses due to blockages, independently and to respond autonomously, such as by changing throughputs or adjusting heat inflow or extraction. Intervening directly and precisely in suboptimal process behavior requires a profound process understanding that can, however, be acquired by using predictive models and simulations and can—ideally—lead to a simultaneous virtual process (a digital twin).

The Smart Reactors collaborative research center outline was recommended for revision by the DFG in November 2020 and will be re-submitted in the fall of 2021. The collaborators are, in addition to the TU Hamburg, the HZG, DESY and the University of Hamburg.

4.3 STATE RESEARCH FUNDING

For a university of technology obtaining funding from the funding programs of the federal ministries is very important. In the reporting year TU Hamburg scientists were highly successful at securing approvals, mainly in the areas of aviation and maritime research, totaling around € 18.5 million. The largest funder by far was the Federal Ministry of Economic Affairs and Energy (BMWi).

An example of a research prtoject funded by the Federal Ministry of Education and Research is the BrainEpP project at the Institute of High-Frequency Technology. It involves sensor systems for medical monitoring of patients. The research team and its partners are among the first in Europe to develop radar systems for medical use and have already carried out clinical tests on patients. Both heartbeat and breathing can be analyzed contactlessly and continuously using the new radar technology.

A project co-financed by the Federal Ministry of Economic Affairs and Energy is the joint project on Validation, Measurement and Optimization of Floating Wind Energy Systems (VAMOS). Research scientists at Hamburg University of Technology's Institute of Fluid Dynamics and Ship Theory are investigating wind turbines anchored in the sea to find out how they can be optimized and their costs can be reduced. Unlike wind turbines sited on the seabed, floating wind turbines can be deployed in deeper water. The aim of the project is to utilizef more wind resources and make renewable energy competitive. Research is undertaken at the French offshore wind farm FLOATGEN.

4.4 LANDESFORSCHUNGSFÖRDERUNG

In competitive state research financing the TU Hamburg and its partners have secured funding for two HamburgX funding line projects.

In the HamburgX project CIMMS – Center for Integrated Multiscale Materials Systems, with the TU Hamburg as its lead university and the University of Hamburg, the German Electron Synchrotron (DESY) and the Helmholtz Center Geesthacht (HZG) as joint partners, a "bridge professor" of High-Resolution X-Ray Analytics for Materials partnered with DESY was appointed as a first step.

In 2020 the second HamburgX project, Innovative Airborne Urban Mobility (i-LUM), received BWFGB approval of funding totaling around € 2.0 million. Research is now under way with project research partners the Helmut Schmidt University (HSU), the Hamburg University of Applied Sciences (HAW), the HafenCity University of Hamburg (HCU) and the German Aerospace Research Center (DLR). The aim of the i-LUM

joint project is to draw up and comprehensively evaluate innovative airborne urban mobility concepts.

4.5 EU-FORSCHUNGSFÖRDERUNG

Research funding in 2020 by the European Union began for four Horizon 2020 and two Erasmus projects. In addition to aviation research on climate-optimized flight paths, they deal with secure and open availability of software and flexible modular production in small and midrange shipyards. EU and international external funding approvals in 2020 totaled around € 3.2 million.

The EU's Horizon 2020 program ended with a last call, the Green Deal Call, which included eight applications with TU Hamburg participation.

4.6 TECHNOLOGY TRANSFER AND STARTUPS

In 2020 Tutech Innovation GmbH (Tutech) again supported the TU Hamburg in all aspects of knowledge and technology transfer, in in some areas doing so in collaboration with its sister company Hamburg Innovation (HI). Together with TU Hamburg institutes € 6.67 million in contract research was earned.

Close networking of this cooperation is especially apparent in the support provided for innovative new entrepreneurs and startups. In recent years the TU Hamburg has successfully positioned itself as a strong startup university with uts innovation and entrepreneurship institutes and its Startup Dock, which makes a significant contribution to the subsequent success of the startups that it supports in the areas of sensitization, finding ideas, direct consulting, extracurricular qualification and assistance with fundraising.

Building on these foundations to further improve start-up-friendly framework conditions, the Startup Dock has continuously intensified its collaboration with other universities and non-university research institutions. During EXIST funding of the TU Hamburg by the BMWi between 2013 and 2018 a closely collaborating network of startup-supporting scientific institutions was established in Hamburg. That network is the basis of cross-institutional collaboration of startup services in Hamburg in the beyourpilot project.

The three largest Hamburg universities—the University of Hamburg, the HAW Hamburg and the TU Hamburg—joined forces with DESY to promote and support knowledge-based startups even more effectively with beyourpilot. The beyourpilot project uses startup services' existing startup support and enlarges their resources, including personnel, meaningfully. In the online part of the platform prospective startups, start-ups and young enterprises gain low-threshold access to the support system, to financing instruments, to other experts who are not members of partner institutions and to resources such as office space, laboratories and tools. Hamburg's Ministry of Economic Affairs and Innovation supports the project financially.

The development and expansion of cooperation in startup support provided by universities in the Hamburg metropolitan region took shape in 2020 in another strong partnership coordinated by the TU Hamburg. In the Startup Port project funded by the BMWi's EXIST program seven universities in the metropolitan region have joined forces to enable tomorrow's entrepreneurs to set up in business with even better prospects of success. To begin with, the existing offerings of the HAW Hamburg, the University of Hamburg, the Leuphana University in Lüneburg, the FH Wedel, the Helmut Schmidt University, the University Medical Center Hamburg-Eppendorf and the TU Hamburg are bein interlinked and made available for all university members. In addition, ne new programs are developed as required.

Tutech also assisted the TU Hamburg in the field of contract research in 2020. An example of the many hoghly demanding third-party funding projects is the Allianz prot P.S.I. cluster project, which is now entering its second, three-year term. The TU Hamburg is involved in four subprojects while Tutech is in charge of the cluster management. The aim of the project is to make biocatalysis under pressure fit for use along a research and value chain from protein structure analysis via process analytics to process development and implementation.

In patent protection of research results and in patent exploitation 2020 was a very successful year for the TU Hamburg. Fourteen new inventions were submitted, especially on innovative research findings in medical engineering such as neuro-interventional X-ray free treatment training for junior medics. Hamburg universities' Patent Exploitation Agency followed their progress intensively and concluded ten exploitation agreements. Income was also generated in the form of license fees.

Making Software Applications More Secure

Making Internet software secure is an important task. Nearly half of all users have already felt the effects of malware on their smartphones or computers, and personal data is frequently passed on without permission. That is exactly what Professor Riccardo Scandariato would like to prevent in the future with his research at Hamburg University of Technology's newly established Institute of Software Security. "My task," the newly appointed TU Hamburg professor says, "is to create innovative tools and techniques to design and implement secure and privacy-friendly applications." Italian-born Professor Scandariato joined Hamburg University of Technology from the University of Göteborg in October 2020.

Asked about his personal motivation, Riccardo Scandariato says he sees cybersecurity and protection of privacy as an important societal task he would like to promote. Usability is an important criterion for his work, which focuses on the design of secure applications such as distributed systems, Internet of Things (IoT) apps or automotive software. Riccardo Scandariato is already working on his first research project, AssureMOSS (short for Assurance and certification in secure Multiparty Open Software and Services). "Our project's mission is to deliver lightweight, scalable technologies that can be put to effective use in checking the security of complex software development projects."

REMEDY THE SHORTAGE OF SECURITY EXPERTS

Along with academic excellence Professor Scandariato seeks to set up a comprehensive network of cooperation arrangements with the German industry, especially in the Hamburg region. "My aim," he says, "is to be inspired by problems from practicioners in order to be able to offer solutions that are at the same time innovative and practical in orientation. In my experience this kind of collaborative research is also great fun." He would like his students to be enthusiastic about security too. In industry, he feels, there is a general shortage of qualified security experts. That is why he is hopeful that TU Hamburg students will be incentivized to embark on a career in this field. "I also hope to be able to inspire some of them to pursue a career in research and am very pleased that five research assistants are already reinforcing my team."

SCANDARIATO APPLIES AN INTER-DISCIPLINARY APPROACH TO CREATE INNOVATIVE TOOLS AND TECHNIQUES TO DESIGN AND IMPLEMENT SECURE AND PRIVACY-FRIENDLY APPLICATIONS

Riccardo Scandariatio obtained his PhD in computer science from Politecnico di Torino (Italy), and worked at KU Leuven (Belgium) and the University of Göteborg (Sweden). He was attracted to Hamburg, which he had previously visited several times and come to like. He spends his leisure time with the family, his two sons, and on his hobby, which is photography.dem Fotografieren.

FOCAL POINTS OF RESEARCH

- Model-based security
- Program repair for software security
- Prediction of software vulnerabilities
- Benchmarking security features in application software
- Threat and risk analysis
- Usable security and privacy

Further information at: http://scandariato.org/

To pave the way for practical implementation of new ideas, creative concepts and innovative technologies the TU Hamburg and HI jointly established the Calls for Transfer (C4T) funding format. In 2020 the BWFGB approved the application for further funding and prolonged it until 2023. TU members have made active use of the C4T format. Six out of eight project applications in a wide range of research areas were approved. A high success rate was also achieved in the wake of project funding: over € 1.3 million in external funding, one start-up, a new patent application, numerous publications and the identification of new cooperation partners. The establishment of a company by the name of traceless is especially interesting. Its objective is to use an innovative process to manufacture a new kind of biodegradable material to deal with the global challenge that plastic waste poses to the environment

4.7 GOOD SCIENTIFIC PRACTICE AT THE TU HAMBURG

The German Research Foundation (DFG) published in 2019 a new code of Guidelines to Ensure Good Scientific Practice. This code replaced the 2014 DFG memorandum and all universities must implement it in a legally binding manner by July 31, 2022 if they are to continue to receive DFG funding. For the TU Hamburg that specifically means revising and adjusting its previous guidelines on ensuring good scientific practice.

All TU members were given an opportunity to take part in the discussion on implementing the code. Three keynote speeches on different aspects of good scientific practice and three workshops were held in the fall of 2020 and anyone who was interested could take part in the process. The TU's guidelines were revised on the basis of the workshop findings and harmonized with the DFG's specifications.

4.8 HAMBURG OPEN SCIENCE

With the 2018-20 Hamburg Open Science (HOS) program the city of Hamburg helped state universities and the Carl von Ossietzky State and University Library (SUB) to further develop research processes with a view to ensuring openness, sustainability and participation and, as far as possible, barrier-free provision of research findings. The TU Hamburg is keenly interested in strengthening discussion on open science, open access, open education and open source, a mission statement incorporated in the policy on openness in research and teaching and approved by the Academic Senate.

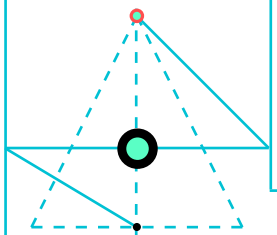
The University Library (tub.) participated successfully for the TU Hamburg in three subprojects of the Open Science program: Research Data Management (project management), the Research Information System (FIS) and Modern Publishing (project management). For research data management the TU has an institutional research repository of its own: TUHH Open Research (TORE). Researchers can be accompanied and advised throughout the publication process by the University Library. Assistance is available from applying for research projects for planning and dealing with the future availability of research data.

A reporting function was added to FIS in 2020. Annual research reports are produced and statistical evaluations of projects and publications are generated from the system. Maintenance reports help ensure quality assurance and make it easier for scientists to check content, thereby contributing to transparency and user-friendliness. The University Library helps users to beim Umgang mit dem System.

Modern Publishing, the third project launched jointly with the SUB, provides on the basis of open source software a platform on which to speed up and simplify the publication processses of quality-assured publications. Cross-university exchange in particular, based on the needs of the most different specialist cultures, has enriched employees in all projects and will be continued when the program is concluded.

Hamburg Open Science is at the same time the portal for research from Hamburg—freely accessible and user-oriented. The results of publicly financed Hamburg research are to be easy to find for all interested parties. The Ministry of Science, Research, Equalities and Districts (BWFGB) funded an Internet portal that makes scientific publications, research data and information about research projects centrally available in the context of open access and open science. Despite Covid restrictions the scheduled results are available and are continuously further developed.

5 Developments in Teaching and Studies



University teaching in 2020 was very much overshadowed by the Sars-CoV-2 pandemic. With the greatest input and a great deal of flexibility and pragmatism on the part of teachers and students a majority of the classes were converted into digital formats in a few weeks. The creativity and dedication of TU Hamburg teachers also enabled virtual solutions to be found for classes such as practical laboratory courses so that students could continue with practical learning in the "Covid semesters." The first countrywide lockdown in March 2020 hit the university in the middle of the winter semester 2019/20 exams. Fifty-six exams had to be canceled at short notice. Thanks to enotmous commitment on the part of Academic and Student Services (SLS) and Safety at Work and Environmental and Health Protection (AUG) the TU succeeded in holding all of the canceled exams during the Whitsun vacation. A comprehensive hygiene concept ensured that exams were held safely in both the winter semester 2019/20 and the summer semester 2020.

Cooperation between the Data Center (RZ), Academic and Student Services (SLS) and the Center for Teaching and Learning (ZLL) was additionally intensified durting this period in order to create the necessary technical, organizational and didactic support structure for teachers in switching to digital formats. Many measures were adopted ad hoc at the start of the summer semester to make the necessary technical infrastructure available, to develop the online information and exchange facilities for for digital teaching at

the TU Hamburg for teachers and students and to provide appropriate further qualification offerings for teachers.

The Data Center, for example, significantly upgraded the StudIP learning management system and the systems for creating, editing and saving lecture notes and teaching videos. A campus license for the video conference software Zoom was acquired and the BigBlueButton platform was set up in parallel.

New digital exchange formats for teachers were organized by the ZLL (Round Table on Zoom, Round Table on Digital Teaching). The Hamburg Open Online University (HOOU) at the TU Hamburg set up the OnlineEduTUHH chat channel using the instant messaging service Mattermost for networking among teachers and for sharing information about digital and hybrid teaching. The ZLL, HOOU at the TU and the RZ joined forces to create an online decision-making aid (Decision Trees) on digital tools for teaching.

Evaluations of the digital summer semester 2020 and the winter semester 2020/21, which was run as a hybrid until December show that with assistance from the TU's service centers teachers were able to develop an extraordinary aptitude for joiuntly creating digital teaching and learning concepts and holding almost all classes online.

The positive experiences included the fact that students were enabled by access to significantly more recordings of classes to learn more independently at their own pace. At the same time all teachers, students and staff were aware of the value of in-presence learning. On the basis of the conviction that personal exchange and discussion are an indispensable element of university teaching the Academic Senate issued on September 23, 2021 a statement on in-person teaching and the future importance of digital teaching formats.

"The University has always been a place of encounter and must on no account lose this significance for students and teachers.

The Executive Board and the Academic Senate of the TU Hamburg share the conviction that personal exchange between student and teachers and among themselves is a fundamental and indispensable element of university education that in the long term can only exist at an in-person university.

Digital teaching and exam formats are an important enrichment for university teaching. Their further development will continue actively at our university. They are always to be used when in-person teaching is not possible or if, in the teacher's considered opinion, they not only do justice to achieving the learning targets but improve the likelihood of doing so. Digital content cannot and is not intended to take the place of in-person teaching but in the meantime it is seen aby a large number of students and teachers as a meaningful complement to in-person teaching.

As soon as the dynamics of the pandemic permit, classes at the TU Hamburg will be resumed in lecture theaters, seminar rooms and laboratories. Until that is the case members of the TU Hamburg will continue to do their utmost to help contain the Sars-CoV2 pandemic."

Statement on in-person teaching by the Academic Senate dated September 23, 2021[1]

5.1 TEACHING MISSION STATEMENT

Independently of the Sars-CoV-2 pandemic members of the TU Hamburg have grappled with their understanding of good university study and teaching. At the suggestion of the Committee for Strategy Development in Study and Teaching (ASSL) a teaching mission statement was agreed in a bottom-up process with the participation of professors, academic staff, university employees and students that in the future will determine strategy development and evaluation in university teaching at the TU Hamburg. The Academic Senate of the TU Hamburg approved the following image statement on June 24, 2020.

[1] *You will find the statement in full in German at: https://www.tuhh.de/tuhh/uni/informationen/praesenzlehre.html*

TEACHING AND STUDIES 27

Researching Digital Markets

New digital technologies make everyday life easier. Products can be ordered from various online shops around the clock for doorstep delivery. And thanks to various streaming services countless songs and videos are available anytime, anywhere. Since October 2020 Professor Timo Heinrich has investigated the consequences of these changes for the economy and for human behavior at Hamburg University of Technology's newly established Institute for Digital Economics. "I am interested, for example," he says, "in how artificial intelligence can assist decision making, how people rate extreme risks and how communication makes trading in digital markets easier. I use statistical methods along with laboratory, online and field experiments."

ARTIFICIAL INTELLIGENCE AND CONFIDENCE

With his research, Professor Heinrich aims to improve existing theories of human behavior further. Among other things, he analyzes reputation and communication mechanisms like those that eBay, Uber or Airbnb use. "I analyze the communication between buyers and sellers in order to understand how trust between anonymous actors is built," he explains. In this context he also investigates the role of artificial intelligence in the form of chatbots and virtual agents.

BUILDING DATABASES

A long-term project he would like to pursue at Hamburg University of Technology is setting up an open database for study participants. "Economic experiments," he says, "are increasingly undertaken online. To find participants for their experiments researchers have hitherto used market research institutes, databases of individual experimental laboratories or commercial platforms." A countrywide open database could simplify the process by not only complying with German data protection standards but also digitizing payment processes and recruiting a more diverse range of participants.

PROFESSOR TIMO HEINRICH HEADS THE TU'S NEW INSTITUTE FOR DIGITAL ECONOMICS

Timo Heinrichs graduated from the University of Duisburg-Essen with a PhD in economics in 2011. In addition to stays as a visiting academic in Spain and the U.S. he was an Assistant Professor at Durham University in England and a fellow at the Alfried Krupp Institute for Advanced Study in Greifswald. In Hamburg, Berlin-born Heinrich especially likes the Hafencity and the Elbphilharmonie. He spends his leisure time by the sea or on the football pitch.

FOCAL POINTS OF RESEARCH

- Influence of digitization on markets and organizations
- Behavior in digital markets and decision making under extreme risks
- Microeconomics, industrial economics and economic policy
- Experimental economic research and behavioral economics

Further information at: www.tuhh.de/econ/

THE TUHH IS A PLACE OF EDUCATION. Study with us and you will be preparing for the challenges of the future and learning how to broaden the horizons of technology, science and society. Students acquire comprehensive competences for a successful career.

WE SET HIGH SIGHTS for our teaching, which is based on the unity of research and teaching. We advocate open and respectful behavior and a culture of esteem and equality of opportunity. Commitment in study and teaching enjoy special recognition. Social responsibility, critical thinking and environmental awareness are for us a part of engineering education and an important component of research and teaching. We also prepare our students for the challenges of digitization.

WE ARE an internationally aligned university of technology with a personal supervisory relationship. We make individual learning possible even in large classes, provide cross-disciplinary development perspectives and promote personal development of all TU Hamburg members. The competences and specialized knowledge acquired are applied and deepened inter alia in problem-based classes. Teams work on specific, practice-oriented issues. Digital and innovative teaching and examination concepts enable our students to learn independently and sustainably.[1]

University teaching may have been dominated by the pandemic, but in 2020 the range of study programs was further extended (5.2), a campaign to recruit students was launched (5.3), the Center for Teaching and Learning (ZLL) was permanently repositioned (5.4), work was undertaken to internationalize the TU Hamburg (5.5) and membership of the Erasmus+ Charter was successfully applied for (5.6), a Hamburg Teaching Prize was awarded (5.7) and the campus management system TUNE was introduced (5.8). Much was also accomplished at our partner institutions MINTFIT Hamburg (AMH) and HOOU (5.9).

[2] *The image statement is available in full at: https://www.tuhh.de/t3resources/tuhh/download/lehre/2020-12-09_Leitbild-Lehre.pdf*

5.2 FURTHER DEVELOPMENT OF THE RANGE OF STUDY PROGRAMS

In 2020 work was undertaken on further development of the range of study programs at the TU Hamburg. The schools of study were further professionalized in order to lay firm foundations for continuous work on the study programs and positions equivalent four FTEs were created. In the area of teaching their tasks include life cycle management of study programs, improving the quality of existing programs, reviewing existing programs, drawing up proposals for new programs and coordinating cross-school and interdisciplinary offerings.

In the winter semester 2020 the new **Data Science** study program was launched. It is the first study program at a Hamburg university to combine computer science and stochastics and qualify graduates for work on future-oriented technologies in the field of artificial intelligence. The new program also corresponds to the same focal point of the ahoi.digital alliance. Preparations are under way to add master's classes to the program.

Against the backdrop of climate change there is a strong societal demand for experts in green technologies. Furthermore, since the success of the *Fridays for Future* movement at the latest it has been clear that more and more young people want to tackle the challenges of climate change and environmental problems in a science-based and solution-oriented way. Against this background the TU Hamburg has developed a new fundamental study program, **Green Technologies: Energy, Water and Climate**, designed to appeal to this very target group. The program is interdisciplinary and is taught by teachers from the schools of civil and environmental engineering, mechanical engineering and process engineering. It offers students an opportunity to specialize, after a joint basic program, in energy systems, energy technology or water and bioresource technologies

The **Orientation Program** was developed by the TU Hamburg to reduce possible inhibitions about studying engineering or computer science and help students to choose a specific course of study. It is the first of its kind in Hamburg and was implemented as part of the university's growth concept. The orientation program was launched as a two-semester pilot project in the winter semester 2019/20 funded by the Hamburg-based Joachim Herz Foundation. Twenty-three students enrolled for the pilot phase and 20 completed it successfully in spite of the Covid conditions. Nine of them went on to take up

a regular course of study at the TU Hamburg. A survey of this first cohort revealed that the students were highly satisfied with the program, with 92.6 percent of respondents saying that the orientation study program had lived up to their expectations. For the winter semester 2020/21 the program was offered as a regular study program so that participants are now regular students and qualify for Bafög student loans.

5.3 STUDENT RECRUITMENT: THE 2020 CAMPAIGN

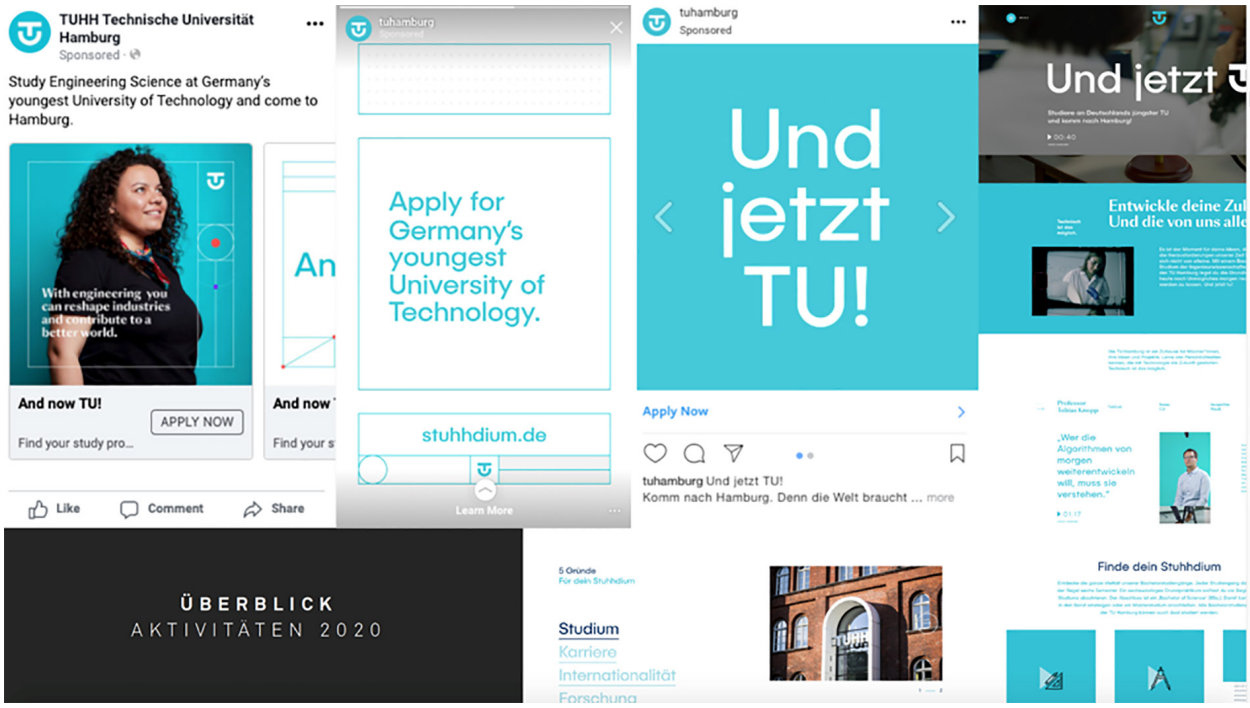
The application period for the winter semester 2020/21 was delayed due to Covid and accompanied from June to September 2020 by an additional campaign to recruit prospective students. The greatest uncertainty factor was whether the ongoing quarantine regulations and study restrictions would have an effect on readiness to enroll as a student.

The central component of the campaign was a film focusing on this key issue to motivate prospective students to enroll at the TU Hamburg. It was used in parallel with the updated landing page www.stuhhdium.de, on which a chat was offered and moderated by trained tutors supervised by Student Counseling Center. In the course of the campaign stories, posts and additional content were added, mainly via Instagram, Facebook and YouTube. Strongly interlocked with the media campaign, this content dealt with special topics such as green technologies, digitization and engineering solutions for the future.

The media campaign was a mixture of Google-sponsored keywords, banner placements via InRead and the use of social media (Facebook & Instagram ads). Between them they generated 26.4 million impressions. Despite a budget reduction compared with the previous year very good results were achieved. Mention must be made of the special importance of Instagram in communicating with the target group. Instagram is the driver of advance information and further or in-depth research about studying at the TU Hamburg. Since January 2021 communication has accordingly been by means of posts and stories in German and English.

5.4 CONSOLIDATION OF THE CENTER FOR TEACHING AND LEARNING

For quality teaching and innovative teaching formats teachers need, for one, further-reaching skills in university didactics and, for another, access to personal advice. That is why the Center for Teaching and Learning (ZLL) was set up at the TU Hamburg back in 2013. By training academic staff, net-



Where Bats Meet

"I always wanted to be a researcher," Alexander Kölpin recalls. "As a child I tinkered away at my model railway in order to understand how the technology works." To this day the research scientist is especially fascinated by the interface between research and application. He would like to pass this passion on to young scientists at Hamburg University of Technology. "My aim," he says, "is to show students how to put theory into practice."

Since March 1, 2020 Professor Kölpin has been Director of the Institute of High-Frequency Technology at the TU Hamburg. The main focus of his research is on wireless communications systems and radar technology, including wireless sensors for use in difficult environmental conditions. With these systems information can be gathered on the move using a minimum of resources and retransmitted wirelessly.

SMALLER THAN A ONE-CENT COIN

In this context his research, funded by the German Research Foundation (DFG) and undertaken in interdisciplinary collaboration with scientists at several other universities and the Museum für Naturkunde (Leibniz Institute for Evolution and Biodiversity Science) in Berlin, involves miniaturized sensor systems that determine their position in difficult circumstances and transmit precise readings of ambient conditions wirelessly. The system has been tested on, inter alia, vampire bats in Panama. Wireless transmitters were glued to the animals' backs. "To enable them to fly unhindered the sensors must be as small and lightweight as possible. That is why we designed the sensor nodes to be smaller than a one-cent coin and to weigh no more than a DIN A5 sheet of paper," Professor Kölpin says. In the course of the project the research team has succeeded in recording important data wirelessly—data such as the temperature, the flight altitude and even the social contacts of bats and their cardiovascular activity in the form of an ECG. "These results are profitable not only for biological analyses; they also demonstrate successful complexity in high-frequency technology in even the smallest form. I would like to pursue this research further with my institute at Hamburg University of Technology," the TU researcher says.

ALEXANDER KÖLPIN, PROFESSOR AND HEAD OF THE INSTITUTE OF HIGH-FREQUENCY TECHNOLOGY AT THE TU HAMBURG.

Alexander Kölpin studied electrical engineering, electronics and information technology (EEI) at Erlangen-Nuremberg University, where he graduated in 2010 with a PhD thesis on "The Enhanced Six-Port Receiver." After a chair at the Brandenburg Technical University (BTU) in Cottbus-Senftenberg he is now a professor at the Hamburg University of Technology.

VAMPIRE BAT WITH SENSOR NODE

FOCAL POINTS OF RESEARCH

- Wireless communications systems
- Radar technology

Further information at: https://www.tuhh.de/et3/

working professors, putting innovative teaching projects out for tender and providing teachers with individual advice the ZLL has made a significant contribution toward improving the quality of teaching at the TU Hamburg. In particular, it has helped to ernable more and more classes at the TU Hamburg to be offered in problem-oriented and research-related formats. In addition, together with teachers the ZLL develops new digital teaching and exam formats and helps teachers to develop their classes further. These ZLL measures make a major contribution toward achieving the requirements of university teaching at the TU Hamburg formulated in the teaching mission statement.

Until 2020 the ZLL's funding came mainly from the "Teaching Quality Pact" and University Pact and was awarded on a project basis. In the course of growth the funding was evaluated and since 2020 the ZLL has been financed permanently by growth funding in view of its positive results. For this purpose permanent positions equivalent to five FTEs were created. They ensure that continuous training and advice for teaching staff are available in state-of-the-art university didactics. In addition, this established an effective platform for securing external funding from, say, the *Innovation in University Teaching Foundation*.

As part of the I^{3}ProTeaching qualification program academic staff were offered a wide range of 35 workshops that promoted in digital teaching practice competence development in university and subject didactics and research-related teaching and learning by research. The program facilitates flexible further qualification geared to individual interests. As part of the program academic staff are also engaged in individual projects to develop their class further. I^{3}ProTeachING was taken smoothly into online operation in Covid pandemic conditions in 2020. The I^{3}ProTeaching program ensures that an even higher proportion of classes at the TU Hamburg is taught by staff with qualifications in university didactics.

To familiarize professors with new developments in university didactics and promote discussion between professors on matters of high-quality teaching the ZLL also holds at least four professorial lounges a year Jahr. All of the ZLL's university didactics workshops for tutors, academic staff and senior engineers were converted from in-person to online formats and their content adapted for digital and hybrid teaching. University didactics workshops on good online teaching also deal witrh using the video conference tool Zoom and the learning platform ILIAS.

5.5 INTERNATIONALIZATION

A university that is strong in research and future-oriented is inconceivable without internationalization. One of the ways in which the TU Hamburg strengthens its international alignment is by means of its membership of the ECIU University, within the framework of which the TU Hamburg plays an active part in establishing innovative teaching formats and shaping a visionary European university space. The TU's international alignment is reflected in its large proportion of international students, which is 25 percent higher than the German average for universities of technology. Since the winter semester 2020/21 the TU Hamburg has also offered its first bachelor's study program in Engineering Science taught entirely in English. The course makes the TU Hamburg more attractive for international exchange students.

Membership of the European Consortium of Innovative Universities (ECIU), founded in1997 with twelve European universities and an associated partner university in Mexico, additionally offers ideal preconditions for increasing student mobility and achieving even stronger networkin with partner universities. In 2019, with its partners in the ECIU, the TU Hamburg was the only Hamburg university to secure project funding from the European Commission for the visionary design and establishment of a European university—the ECIU University. Its aim is to rethink innovative teaching by means of the challenge-based learning (CBL) concept and at the same time to promote international student exchange between ECIU universities.

In CBL classes, students develop jointly with actors from science, governments, companies or civil society groupings innovative solutions to societally relevant and real challenges. Students from all ECIU universities can apply to take part in these challenges with the result that learning always takes place in interdisciplinary and international teams. In order to work on the challenges the team can acquire relevant micro-credentials from the courses offered by ECIU member-universities to gain additional knowledge or skills that contribute to work on the challenges. At the end of the process a number of academic credits (micro-credentials) or a certificate can be gained. In the pilot phase the challenges to be tackled are oriented to the UN's eleventh sustainable development goal: sustainable cities and communities.

Classes within this framework were first offered at the TU Hamburg in the winter semester 2020/21. With assistance from the team at the Institute of Human Resource Managenment and

Organizations students from the TU Hamburg and the University of Trient in Italy worked on a challenge posed by the Swedish region of Östergötland to search for sustainable transportation infrastructures against the background of population growth. Based on that further CBL classes are to be firmly integrated into the TU Hamburg curriculum in, for example, the area of non-technical complementary courses (NTA) so that ECIU University modules and courses are offered continuously.

Offering these challenges extends the range of courses for students at the TU Hamburg and increases student mobility and the attractivess of the TU Hamburg in the context of other student exchange programs. At the same time students are prepared for increasingly project-based work at companies. Corresponding concepts for the ECIU University and university didactics support for teachers are developed by the Center for Learning and Teaching (ZLL).

5.6 ERASMUS+ CHARTER FOR THE TU HAMBURG

In connection with the new Erasmus+ program generation the TU Hamburg has successfully applied for the ECHE (Erasmus Charter for Higher Education 2021-2027) quality certificate and by scoring the highest number of points has demonstrated that it has put in place all the prerequisites for implementing the program successfully at the TU. The ECHE is for European universities the statutory requirement for applying for funding for all types of mobility and program and and also determines the quality framework for cooperation activities. The new program generation is focused mainly on digitization, Green Erasmus, and social participation, The Erasmus+ program is an important part of the internationalization of German universities and, in addition, a symbol of the European community and European values.

5.7 HAMBURG TEACHING PRIZE 2020

Dr. Dennis Clemens won the 2020 Hamburg Teaching Prize at the TU Hamburg for his Math Revision I and II classes. Hamburg university teachers are awarded this prize by the city for outstanding teaching methods and innovative communication concepts. The prize was awarded for the twelfth time and comes with € 10,000 in cash. Candidates are nominated by Hamburg students and evaluated by a university jury together with the students in a public debate with a focus on a high level of subject and didactic competence, innovative teaching methods, quality assurance via feedback systems, and ability to motivate and establish links with subject- or career-related practice.

Dr. Clemens proved that extraordinary innovation in teaching is possible and demonstrated it in his classes. Using innovative teaching methods and materials, with his interdisciplinary approach and practical orientation he contributed to a high level of learning motivation on the part of his students and to a better understanding of the challenging content. The content was prepared and made understandable by many examples and different methods, such as online exercises. It earned him a unanimous vote by the TU jury.

5.8 IN THE HOME STRAIGHT – TUNE CAMPUS MANAGEMENT

The requirements of university teaching and learning laid down in the teaching mission statement demand effective and efficient assistance of teachers and students by Academic and Student Services. To better do justice to these requirements an upgrade of class and examination management as a mainstay of the integrated campus management system TUNE was completed in 2020 despite the pandemic conditions. The TU Hamburg thereby largely accomplished the transition to modern, sustainable campus management in a little over five years by means of a comprehensive rebuild of its IT infrastructure and systems.

In 2021 the project team will further optimize class and examination management. A business intelligence system will also be established to provide the schools of study and heads of study programs in a data cockpit with continuous supply of of updated statistics on their courses. So in addition to the completion of TUNE other mainstays of quality management will be implemented at the TU Hamburg. A systematic further development process will ensure that the TU Hamburg continues to have a high-powered, modern campus management in the future. Challenges will be implementation of the Online Access Act and the development of a document management system for the electronic student file.

Calculating the Most Ecological Process

Like many school leavers, Professor Mirko Skiborowski went to university with no clear idea about a career choice but was soon enthusiastic about the math, informatics and engineering course contents. He now feels his choice of computational engineering science was a lucky one. North Rhine-Westphalian by birth, he has since April 2020 been Hamburg University of Technology's new Professor of Process Systems Engineering and head of the institute of the same name. With his research he would like to develop more energy-efficient processes and make a contribution toward more sustainability.

MORE COMPLEX THAN ROUTE PLANNING

The optimization problems he investigates also exist in everyday life. "Just as navigation systems for cars calculate in seconds the shortest, fastest or most economical route to a destination, similar methods of applied mathematics can be used to optimize process technology in, say, the production of chemicals," he says. "And unlike navigation systems these processes have often not yet been described in full and are frequently more complex than route planning to model." That is why Professor Skiborowski uses mathematical tools to find out the conditions in which a process functions as efficiently as possible and which properties need to be enhanced as required. In the best case this can accelerate the development of new and sustainable technologies that deliver genuine added value for humankind. "Asking the right questions always requires the expertise of different disciplines. This indispensable interdisciplinarity is important for me personally because it challenges you time and again to break out of your comfort zone, tackle new and exciting tasks and always learn something new. I would like to pass on to future generations of engineers at Hamburg University of Technology this openness for different approaches."

MIRKO SKIBOROWSKI IS DEVELOPING ENERGY-EFFICIENT PROCESSES TO MAKE A CONTRIBUTION TOWARD MORE SUSTAINABILITY

Mirko Skiborowski studied computational engineering science, majoring in energy and process engineering, at RWTH Aachen University, graduating in 2015 with honors. While working as a group leader in process synthesis and process intensification at TU Dortmund's Chair of Fluid Separations he completed in 2019 a second PhD on fluid separations, thereby qualifying as a university lecturer. A year later he moved to Hamburg University of Technology.

FOCAL POINTS OF RESEARCH

- Process synthesis
- Hybrid and reactive separation processes
- Methods of energy integration
- Process intensification
- Hybrid optimization methods

Further information at: www.tuhh.de/psi/

5.9
COOPERATION PARTNERS IN TEACHING – MINTFIT AND HOOU

5.9.1
THE MINTFIT HAMBURG OPERATING UNIT

The MINTFIT Hamburg operating unit was launched in 2013 as a joint project by the HAW Hamburg, the Hafencity University (HCU), the TU Hamburg, the University of Hamburg (UHH) and the University Medical Center Hamburg-Eppendorf (UKE) and has since been funded by Hamburg's Ministry of Science, Research, Equalities and Districts (BWFGB). In 2020 it was incorporated into the TU Hamburg as an operating unit and at the same time given a permanent status. It began work as an operating unit on January 1, 2021.

The Tests/Courses part of the project deals with helping school students to transition from school to university. They are to enable future students to study more effectively and to encourage them to choose a MINT, i.e. a STEM, study program. To do so MINTFIT offers Web-based tests in math, physics, chemistry and computer science on the www.mintfit.hamburg platform. They enable prospective students to test their knowledge in MINT subjects anonymously and free of charge. Additional online courses help bridge knowledge gaps before taking up MINT studies and to refresh what they already know. MINTFIT is one of the largest and, with 250,000 accesses, one of the most-used non-commercial providers of self-assessment tests in Germany. The MINTFIT platform is in future also to be used for targeted study program marketing.

The E-Assessment part of the project aims to promote digital teaching and learning at partner institutions. MINTFIT will primarily provide teachers with digital exercises during a class and assist them with digital module tests. That is done as part of numerous pilot events held at MINTFIT partners. A mobile test center with 110 notebooks and 200 tablets helps with the technical implementation of electronic tests, enabling tests to be held flexibly at different locations. It also enables all concerned to gain wide-ranging experience of technologies and electronic test scenarios. At the TU Hamburg the mobile test center is currently used for about a dozen events. At large-scale events with around 1,000 participants the mobile test center facilitates efficient and automated testing. In future, examination software is to be added to the test center, thereby developing it into an individualized student-centered examination center.

5.9.2
THE HOOU AT THE TU HAMBURG

The HOOU at the TU Hamburg is a hub for redesigning teaching and learning in the digital age. It conducts research and also develops new teaching and learning formats, thereby creating space for experimentation that is intended both to promote a cultural change at universities and to open up academic teaching for civil society. Founding HOOU GmbH in 2020 created a fixed structure for achieving these objectives on a permanent basis at the TU Hamburg and in the group of Hamburg universities.

The HOOU at the TU Hamburg helps teachers and researchers to adopt innovative approaches to shaping learning processes, developing technical learning infrastructures and media arrangements and entering into scientific communication that is suitable for the target group. The TU Hamburg's HOOU thereby help to make research and teaching accessible for a wider public. In 2020 the HOOU projects at the TU Hamburg continued to reflect the didactic, technical and thematic variety of activities at the TU.[1]

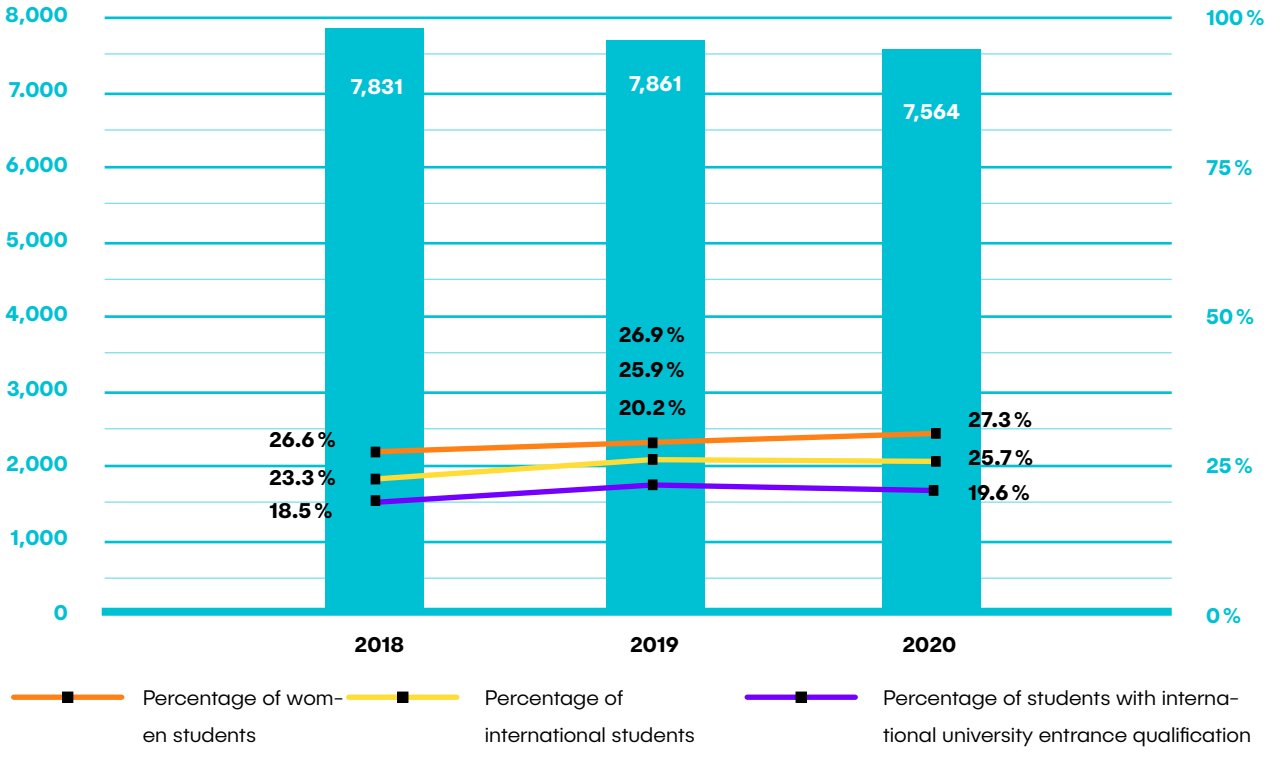
[1]You will find information about HOOU projects on the HOOU website at: https://www.hoou.de/discover?institutions=bb-5f90af-65ad-4b39-97e7-df4e4c39d1b6&query=&types=project

6 Statistics

6.1 TEACHING

6.1.1 STUDENTS

STUDENTS IN THE WINTER SEMESTER	2018	2019	2020[1]
Degree students (B.Sc./M.Sc./MBA/M.A.)	7,107	6,911	6,788
Teacher training course students	588	620	642
Orientation program, doctoral and exchange students, academic further education, etc.	166	172	134
TOTAL	**7,861**	**7,703**	**7,564**
Percentage of women students	26.6	26.9	27.3
Percentage of international students[2]	23.3	25.9	25.7
Percentage with international university entrance qualification[3]	18.5	20.2	19.6
Percentage of students within the standard study period	66.0	64.1	63.4

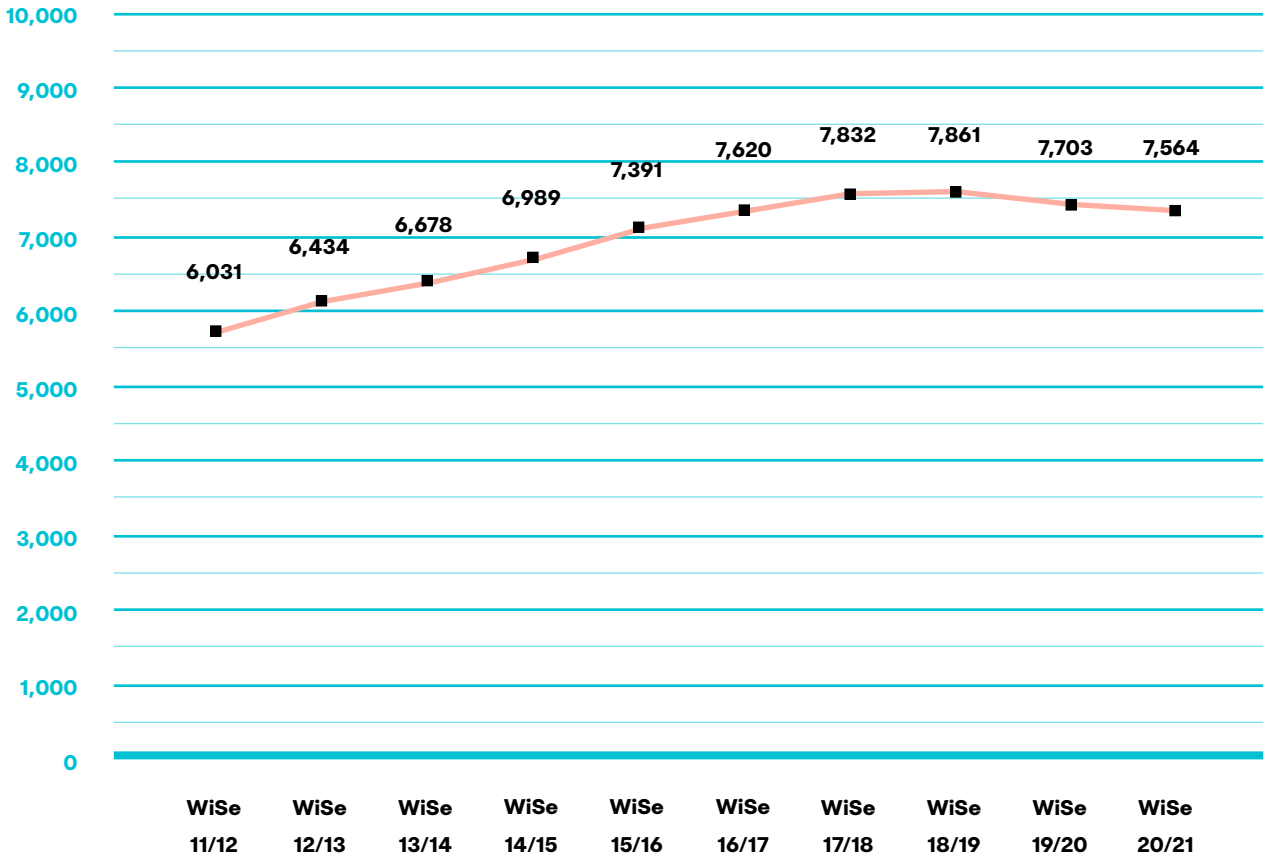


[1] *According to the official statistics for the winter semester 2020/21 (as of December 2020)*

[2] *Students with non-German nationality*

[3] *Students with non-German university entrance qualification*

DEVELOPMENT OF STUDENT NUMBERS



Total student number, including students on leave, orientation program, doctoral and exchange students

6.1.2 BACHELOR'S

BACHELOR'S STUDENTS	Number[1]	Percentage of women students	Percentage of international students[2]	Percentage with international HZB[3]	Percentage within RGZ[4]
TOTAL	**4,158**	**24**	**17**	**9**	**65**
Allgemeine Ingenieurwissenschaften	433	27	10	4	77
Civil and Environmental Engineering	607	37	18	10	66
Bioprocess Engineering	100	55	16	9	71
Computer Science	422	13	19	10	71
Data Science	22	23	0	0	100
Electrical Engineering	190	11	17	10	0
Energy and Environmental Engineering	165	33	12	7	69
Engineering Science	20	25	50	45	100
General Engineering Science	84	27	57	49	58
Computer Science and Engineering	311	17	26	16	73
Logistics and Mobility	398	37	15	4	53
Mechanical Engineering	947	14	14	6	58
Mechatronics	147	10	29	19	66
Naval Architecture	80	16	23	14	61
Technomathematics	79	33	6	3	81
Process Engineering	153	30	15	10	54

[1] *Winter semester 2020/21*

[2] *Percentage of students with non-German nationality*

[3] *Percentage of students with non-German university entrance qualifications (HZB)*

[4] *Percentage of students within the standard study period (RGZ)*

SCHOOL OF STUDY	Number[1]	Percentage of women students	Percentage of international students[2]	Percentage with international HZB[3]	Percentage within RGZ[4]
TOTAL	**4,158**	**24**	**17**	**9**	**62**
of which[5]					
B	607	37	18	10	66
E	1,024	15	32	11	60
M	1,027	24	25	6	58
V	253	17	6	9	71
W	398	24	10	4	53
FIT	849	35	27	12	72

[1] *Winter semester 2020/21*

[2] *Percentage of students with non-German nationality*

[3] *Percentage of students with non-German university entrance qualifications (HZB)*

[4] *Percentage of students within the standard study period (RGZ)*

[5] *Schools/Areas of Study: (B) Civil Engineering; (E) Electrical Engineering, Computer Science and Mathematics; (G) Vocational Subject Education; (M) Mechanical Engineering; (V) Process Engineering; (W) Management Sciences and Technology; (FIT) Interdisciplinary Engineering Sciences and Technologies*

6.1.3 MASTER'S

MASTERS' STUDENTS[1]	Number[1]	Percentage of women students	Percentage of international students[2]	Percentage with international HZB[3]	Percentage within RGZ[4]
TOTAL *(German- and English-language)*	**2,629**	**26**	**41**	**38**	**56**
MASTER'S STUDY PROGRAMS *(in German)*					
TOTAL	**1,537**	**26**	**14**	**9**	**59**
of which[5]					
B	247	38	22	17	67
E	258	10	15	9	53
M	538	21	14	9	55
V	169	38	14	9	59
W	283	31	8	5	63
FIT	42	31	5	0	69
MASTER'S STUDY PROGRAMS *(in English)*					
TOTAL	**1,092**	**26**	**79**	**78**	**53**
of which[5]					
B	92	45	97	96	48
E	302	33	83	82	59
M	435	9	76	74	48
V	116	39	100	100	49
W	54	41	74	74	83
NIT	93	37	43	43	47

[1] Winter semester 2020/21

[2] Percentage of students with non-German nationality

[3] Percentage of students with non-German university entrance qualifications (HZB)

[4] Percentage of students within the standard study period (RGZ)

[5] Schools/Areas of Study: (B) Civil Engineering; (E) Electrical Engineering, Computer Science and Mathematics; (G) Vocational Subject Education; (M) Mechanical Engineering; (V) Process Engineering; (W) Management Sciences and Technology; (FIT) Interdisciplinary Engineering Sciences and Technologies; (NIT) Northern Institute of Technology Management

6.1.4 TEACHER TRAINING

STUDENTS OF VOCATIONAL SUBJECT EDUCATION *(Bachelor and Master)*	Number[1]	Percentage of women students	Percentage of international students[2]	Percentage with international HZB[3]	Percentage within RGZ[4]
TOTAL	**642**	**57**	**11**	**1**	**79**
of which					
Work study/Technology	371	81	18	1	76
Construction & wood technology	92	17	11	0	76
Electrical engineering/ Information technology	23	13	9	0	78
Media technology	46	48	4	0	74
Metal technology	81	15	0	0	100
B.Sc./M.Sc. of Education	29	31	0	0	90

[1] *Winter semester 2020/21*

[2] *Percentage of students with non-German nationality*

[3] *Percentage of students with non-German university entrance qualifications (HZB)*

[4] *Percentage of students within the standard study period (RGZ)*

6.1.5 FRESHMEN

NEW STUDENTS IN THE WINTER SEMESTER	2018	2019	2020
TOTAL	**1,415**	**1,248**	**1,066**
IN BACHELOR'S STUDY PROGRAMS (B.SC.)	**1,302**	**1,124**	**1,011**
Percentage of women	21.9	24.2	23.0
Percentage of international students[1]	17.6	19.1	15.2
Percentage with international HZB[2]	8.5	9.5	7.9
New students in B.Sc. study programs according to ZLV			
without HSP	1,021	1,182	1,250
with HSP	1,321	1,482	1,550
IN TEACHER TRAINING STUDY PROGRAMS (CROSS-UNIVERSITY)	**113**	**124**	**55**
Percentage of women	64.7	56.6	58.2
Percentage of international students[1]	12.4	3.2	1.8

[1] *Students with non-German nationality.*

[2] *Students with non-German university entrance qualification.*

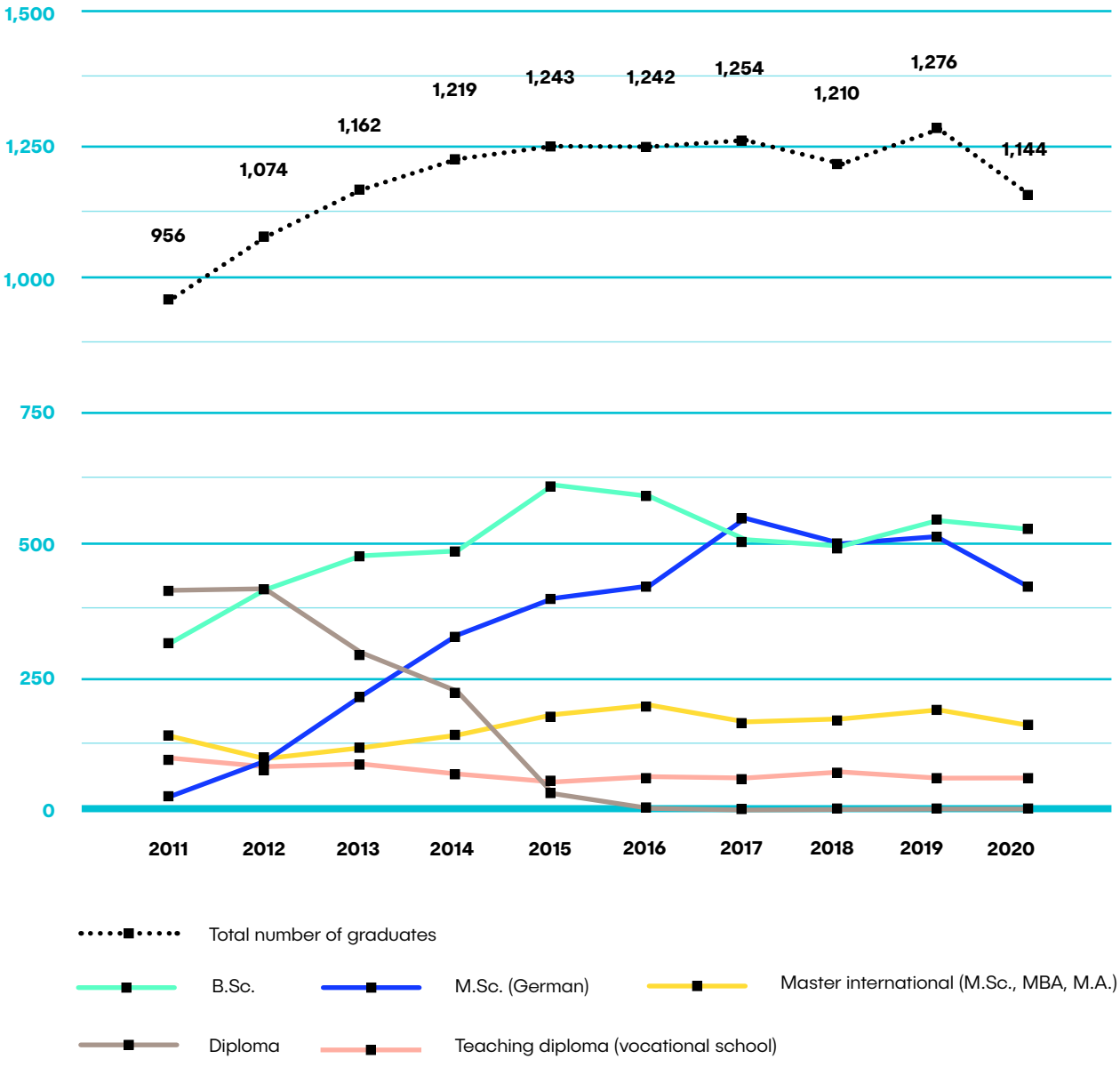
COMPLETED ADMISSIONS BY B.SC. STUDY PROGRAM[1]	2018	2019	2020
TOTAL	**1,302**	**1,124**	**1,011**
of which			
Allg. Ingenieurwissenschaften	131	121	120
Civil ad Environmental Engineering	155	172	163
Bioprocess Engineering	26	31	29
Computer Science	152	135	102
Data Science	.	.	22
Electrical Engineering	55	45	42
Energy and Environmental technik	54	48	47
Engineering Science	.	.	19
General Engineering Science	36	28	.
Computer Science and Engineering	85	102	87
Logistics and Mobility	141	89	77
Mechanical Engineering	311	230	186
Mechatronics	57	43	37
Naval Architecture	34	18	18
Technomathematics	33	31	26
Process Engineering	32	31	36

[1] *Final statistics on admissions for the winter semester.*

6.1.6 GRADUATES / DEGREES

GRADUATES	2018	2019	2020
TOTAL	**1,210**	**1,276**	**1,144**
of which			
in B.Sc./M.Sc./MBA/M.A. study programs	1,145	1,220	1,091
in teacher training study programs (cross-university)	65	56	53

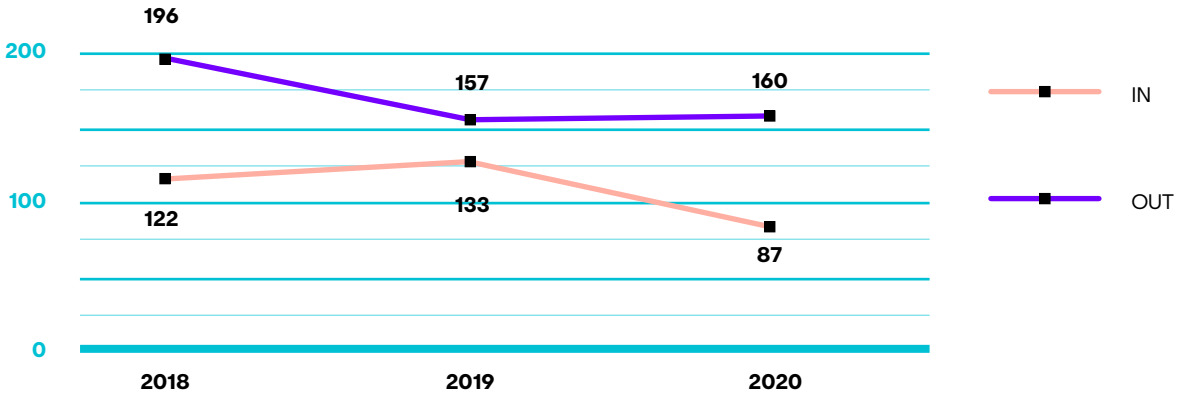
6.1.6 DEVELOPMENT OF GRADUATE NUMBERS



SCHOOL/AREA OF STUDY[1]	TOTAL	BACHELOR'S	MASTER'S	of which German-language	of which English-language
B	158	76	82	61	21
E	175	80	95	62	33
G	53	30	23	23	0
M	388	159	229	158	71
V	95	27	68	51	17
W	142	62	80	78	2
FIT	133	115	18	18	0
TOTAL	**1,144**	**549**	**595**	**451**	**144**

6.1.7 STUDENT EXCHANGES

DEVELOPMENT OF MOBILITIES ACHIEVED FROM THE TUHH (OUT) AND TO THE TUHH (IN)



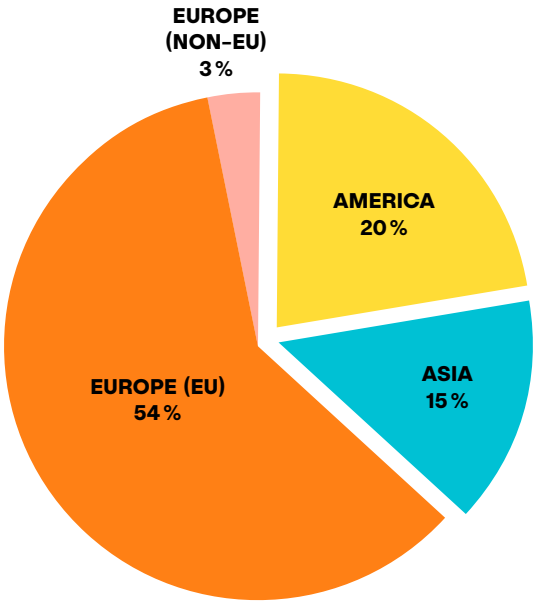
[1] *Schools/Areas of Study: (B) Civil Engineering; (E) Electrical Engineering, Computer Science and Mathematics; (G) Vocational Subject Education; (M) Mechanical Engineering; (V) Process Engineering; (W) Management Sciences and Technology; (FIT) Interdisciplinary Engineering Sciences and Technologies*

REALIZED STUDENT MOBILITY

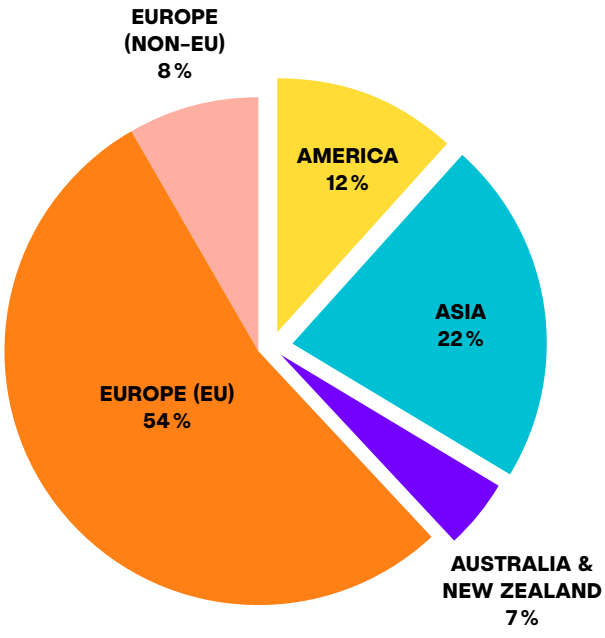
	INCOMING (TOP 5)	BACHELOR	MASTER	TOTAL
1	France	9	11	20
2	Spain	7	5	12
3	Italy	2	7	9
4	Turkey	4	2	6
5	Mexico	5	0	5

	OUTGOING (TOP 5)	BACHELOR	MASTER	TOTAL
1	Sweden	9	10	19
2	Netherlands	3	7	10
3	Italy	0	9	9
4	Singapore	3	5	8
5	Japan	2	6	8

INCOMING



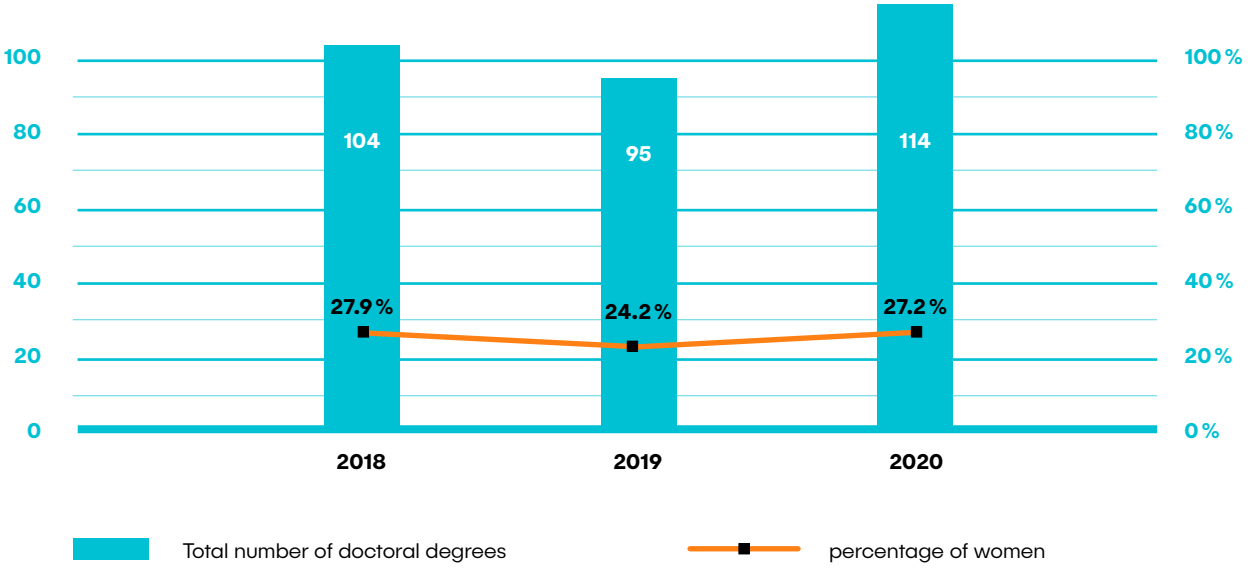
OUTGOING



6.2 RESEARCH

6.2.1 DOCTORAL DEGREES AND HABILITATIONS

NUMBER OF DOCTORAL DEGREES COMPLETED	2018	2019	2020
TOTAL	**104**	**95**	**114**
Percentage of women	27.9	24.2	27.2
Doctoral degrees per occupied professorship (W2/W3)	1.2	1.1	1.2
NUMBER OF HABILITATIONS COMPLETED	**2018**	**2019**	**2020**
TOTAL	**1**	**2**	**1**
Percentage of women	100	50.0	0.0



DOCTORATES BY SCHOOL OF STUDY[1]	2018		2019		2020	
	Number	Percentage of women	Number	Percentage of women	Number	Percentage of women
B	6	33	7	43	10	30
E	17	29	15	7	19	11
G	6	33	3	33	5	20
M	37	14	45	16	43	26
V	24	38	19	53	25	36
W	14	43	6	17	12	42
TOTAL	**104**	**28**	**95**	**24**	**114**	**27**

DOCTORATES PER OCCUPIED PROFESSORSHIP *(W2/W3) by School of Study*[1]	2018	2019	2020
B	0.7	0.8	1.0
E	0.7	0.6	0.7
G	1.5	0.8	1.3
M	1.3	1.6	1.5
V	2.4	1.9	2.3
W	1.1	0.5	0.9
TOTAL	**1.2**	**1.1**	**1.2**

[1] *(B) Civil Engineering; (E) Electrical Engineering, Computer Science and Mathematics; (G) Vocational Subject Education; (M) Mechanical Engineering; (V) Process Engineering; (W) Management Sciences and Technology*

6.2.2 RESEARCH PROJECTS AND RESEARCH RESOURCES

KEY FIGURES (TU HAMBURG AND TUTECH INNOVATION GMBH BUSINESS DATA)	2018	2019	2020
Number of third party funded research projects	676	757	784
of which funded by			
DFG	126	145	132
Federal Government (BMBF, BMWi et al. ministries)	181	176	197
Federal state	43	67	38
EU, International	40	45	36
Other (e.g. DAAD, Fraunhofer Society, German Federation of Industrial Research Associations, Volkswagen Foundation)	126	87	66
Direct industrial research (Tutech Innovation GmbH)	160	237	315
Newly approved third-party funding in EUR '000	50,187	45,241	57,004
Third-party funding income in EUR '000	42,939	45,368	46,152
of which DFG in EUR '000	8,580	9,257	9,827
Third-party funded employees (FTEs, preliminary figures)	399	412	414.1
of which scientific staff	374	386	393.2

RELATIVE FIGURES	2018	2019	2020
Income from third-party funding and other earmarked income (excl. HSP) per occupied professorship (W1, W2, W3) in EUR '000	467	482	465

6.2.3 TECHNOLOGY TRANSFER AND PUBLICATIONS

TUTECH INNOVATION GMBH – KEY FIGURES	2018	2019	2020
Newly approved orders in cooperation with the TU Hamburg in € '000	9,188	8,020	4,562
Income in connection with TU Hamburg departments in € '000	8,031	8,934	6,670
Funding from the R&T framework program and other EU programs (approved TU Hamburg applications)	11	12	6
Tutech ACADEMY events (number/attendees)	17 / 271	10 / 140	22 / 407

PUBLICATIONS IN 2020 BY SCHOOL OF STUDY[1]	B	E	G	M	V	W	TOTAL
Publications in scientific journals	48	138	37	203	146	47	602
Articles in conference reports	5	80	10	81	5	37	205
Conference reports	0	0	0	2	2	2	4
Articles in specialist books	5	6	3	20	23	10	64
Specialist books	0	1	2	4	2	3	12
Open Access publications (all types)	33	70	35	124	74	48	382

[1] *Publications with several authors have multiple mentions if authors are from different Schools of Study. For the TU Hamburg overall these publications are counted only once.*

6.3 PERSONNEL AND FINANCES

6.3.1 OCCUPIED POSTS IN 2020

OCCUPIED POSTS IN 2020	FTES
Professorships	99.1
Of which junior professorships	4.0
Scientific personnel (budget, incl. senior engineers, Tutech)	742.6
Of which	
Budget (incl. senior engineers)	349.4
External funding (incl. Tutech)	393.2
Technical, library and administrative staff	610.5
Of which	
Executive Board, EB department and administration, Works Council	194.5
Library	32.2
Technical Service	56.0
Academic and Student Services	57.4
Computer Center	68.0
Schools of Study	202.4

OCCUPIED POSTS IN SCHOOLS OF STUDY (BUDGET)

OCCUPIED POSTS	2018	2019	2020
Professorships	87	89	95.1
Junior professorships	5	5	4
Senior engineers	60.7	60.5	66.3
Scientific employees	262.9	252.8	283.1
Technical and administrative staff	185.3	180.4	202.4

ACADEMIC PERSONNEL IN SCHOOLS OF STUDY (BUDGET)

OCCUPIED POSTS[1]	B	E	G	M	V	W	TOTAL
Professorships	10	27.1	4	29	11	14	95.1
Junior professorships	0	1	0	2	1	0	4
Senior engineers	9.6	15	3	22.7	10	6	66.3
Scientific employees	25.7	87.5	12.8	75.5	46.4	35.3	283.1

[1] *(B) Civil Engineering; (E) Electrical Engineering, Computer Science and Mathematics; (G) Vocational Subject Education; (M) Mechanical Engineering; (V) Process Engineering; (W) Management Sciences and Technology*

6.3.2 THIRD-PARTY FUNDING

EXTERNAL FUNDING IN € '000	2020
Total income from transfer payments (third-party funding)	46,152
of which Tutech Innovation GmbH in cooperation with Institutes	6,670

6.3.3 TU HAMBURG BUSINESS PLAN

PROFIT PLAN *(figures in € '000)*	RESULT 2020	PLAN 2021
INCOME		
Income from business activity	105,832	104,374
of which operating subsidy for ongoing commitments	76,789	74,532
of which income from tuition fees	0	0
Income from transfer payments (third-party income)[1]	32,574	39,942
Other income	9,677	10,345
of which income from release of special item for investment grants	7,738	7,995
TOTAL INCOME	**148,083**	**154,661**
EXPENDITURE		
Expenditure on business activity (incl, third-party funding and student fees)	15,028	16,623
Personnel expenditure (incl, third-party funding and student fees)	108,050	109,808
Expenditure on transfer payments	3,528	–
Depreciation	8,919	9,295
Other expenses	10,539	18,935
TOTAL EXPENDITURE	**146,064**	**154,661**

[1] *excluding Tutech.*

ABBREVIATIONS

B

BMBF · Federal Ministry of Education and Research
BMWi · Federal Ministry of Economic Affairs and Energy
BWFGB · Hamburg Ministry of Science, Research, Equalities and Districts

C

CIMMS · Center for Integrated Multiscale Materials Systems

D

DESY · German Electron Synchrotron
DFG · German Research Foundation
DLR · German Aerospace Center
DZHW · German Center for University and Scientific Research

E

ECIU · European Consortium of Innovative Universities
ESF · European Social Fund

H

HamburgX · A Funding line of Hamburg's state research funding
HAW · Hamburg University of Applied Sciences
HCU · HafenCity University of Hamburg
HI · Hamburg Innovation
HIP · Hamburg Innovation Port
HOOU · Hamburg Open Online University
HOS · Hamburg Open Science
HSU · Helmut-Schmidt University
HZG · Helmholtz Center Geesthacht

I

I^3 · Innovation and Interdisciplinarity in Engineering (TUHH-research contest)

P

PVA · Patent Agency Hamburg

S

SFB · Collaborative Research Center (DFG)
SUB · State and University Library Hamburg

T

TORE · TUHH Open Research
tub · TU Hamburg University Library
Tutech · Tutech Innovation GmbH

U

UHH · University of Hamburg
UKE · University Medical Center Hamburg-Eppendorf

Z

ZSP · Center for Students and Doctoral Studies