The first decade
Shifting the perspective from a single- to a multi-dimensional view of research at the doctoral level has been the foundation of our graduate school. A new generation of young researchers, trained by scientists and engineers from TUM and its international partners, has begun to boost interdisciplinary ideas and get unprecedented experience. The concept has become an international role model, acknowledging doctoral training as the first steps of independent professionals, actively fostering collaboration across disciplines, and building up international networks.

“A PhD is a very individual achievement. However, it is even more challenging if your efforts are supported back-to-back with someone else’s research work, having the same focus but drawing on expertise in different disciplines. The experience is priceless!” says Milica Grahovac, 2013 alumna, now Senior Scientific Engineering Associate at Berkeley National Lab in the USA. Milica’s project team, “Building, Users, Climate,” has been a very fruitful cooperation of architects and electrical and computer engineers. The team succeeded in joining forces and developing a brand-new research approach. More than 20 publications and 2 professorships in Germany and the United States are sensational results for a research group that worked in this constellation for the first time. BUC is just one example of more than 100 IGSSE project teams that have been very successful both with regard to accomplished PhD projects and to subsequent research initiatives.

Get an impression of the broad scope of research and people that IGSSE has shaped since 2006 and follow us on our journey from past to future highlights of our graduate school.

Cordially yours,

Prof. Dr. Barbara Wohlmuth
IGSSE Director
Facing the major challenges of society – health, nutrition, energy, climate, mobility, and infrastructure just to name the key topics – universities must provide adequate spaces and resources for cutting-edge research at the interfaces of the classical scientific disciplines. At TUM, we see the potential of connecting our outstanding researchers across all departments – bridging existing gaps between science and engineering. This mindset helped us to win funding from the first German Excellence Initiative in 2006, when we surprised academia with an unprecedented methodological concept: funding for small teams of scientists and engineers who join forces in exceptional research projects plus a distinguished training program for doctoral researchers. This combination proved to be so successful that IGSSE was a winner of the second Excellence Initiative competition in 2012 as well.

To this day, IGSSE has been a unique concept fostering cross-departmental and international collaboration. The graduate school builds bridges irrespective of disciplinary or national borders, fosters dialogue with the public, and accelerates the process from invention to innovation. "Innovative doctoral training," frequently discussed these days, happens exactly within such an environment. IGSSE already spearheaded the modernization of young researchers’ training ten years ago and cleared the path for the overarching TUM Graduate School, established in 2009.

Now, IGSSE is an essential part of TUM’s development strategy and a jewel in its research and doctoral training portfolios.

Gratefully looking back at the last ten years, it is our vision and commitment to continue with IGSSE as the very hub for interdisciplinary research and innovative doctoral training at TUM. We will work even harder to extend and translate the successful IGSSE model into collaborations with renowned partners in academia and industry, in Germany and beyond.

This anniversary gives me the chance to extend my thanks to my dear colleague Professor Ernst Rank, who has elevated IGSSE from a surprising novelty to TUM’s stronghold of interdisciplinary research and modern, team-based PhD training. His successor, Professor Barbara Wohlmuth, will no doubt lead IGSSE to new horizons; and she will receive every support expedient to that end from the university.

Happy anniversary IGSSE, and we look forward to the next decade! We are proud of you.

Prof. Dr. Dr. h.c. mult. Wolfgang A. Herrmann
President Technical University of Munich (TUM)
Other than thematically focused graduate schools, IGSSE is open to any scientific idea bridging the gap between the classic academic disciplines. Research at our graduate school has a strong quality of interdisciplinary and international cooperation, ranging across all TUM departments. Cast into the structure of IGSSE project teams, our graduate school’s concept fosters high-potential research and sustainable networks of upcoming and senior researchers. In a decade, more than 100 scientific journeys off the beaten tracks have begun.

Cutting-edge research needs people dedicated to realizing and pushing forward ideas. In IGSSE project teams, senior researchers combine the potentials of their expertise, postdoctoral researchers coordinate the collaboration, and doctoral researchers pick up invaluable communication competences along with their scientific work. With one call for proposals every year, IGSSE has seen ten project-team cohorts so far. All had to pass a highly competitive, international peer-review evaluation procedure, securing the highest scientific standard in each project proposal.

Seizing an unrivaled opportunity

Principal Investigators
At least two principal investigators (senior researchers of divergent TUM departments or international partner institutions) propose a research cooperation. Given a positive peer-reviewed evaluation, the IGSSE Board grants the project.

Doctoral Researchers
Four doctoral researchers conduct research, foster scientific and international exchange, and participate in specialized trainings. IGSSE fully funds up to two; the chairs co-fund an equal number. All receive travel and training funds.

TUM Departments — the foundation for research excellence at IGSSE

Master's Students
Senior students at master’s level support the project teams’ research and get initial insights into the clockwork of interdisciplinary collaboration.
One of the first teams to win IGSSE funds has been the **Modeling of Fibrous Composites** group, working across the fields of cell biophysics and numerical mechanics. Their research concerned the mechanical properties of the cytoskeleton of cells, as the mechanics are intimately linked to many biological functions and act as a sensitive indicator for health or developmental state of the cells. Novel finite-element simulations of biopolymer networks – developed by team members from the computational mechanics chair and validated via comparison with experiments of team members from the biophysics chair – unraveled astonishing insights into the physical processes of structure formation and the resulting mechanics. Through the combination of techniques, it has become possible to visualize and to correlate the mechanical response with the underlying structural changes.

“The novel finite-element simulations of biopolymer networks are an important step forward in the field of biomechanics. Close collaboration between biophysicists, trained to identify the essential features of a complex phenomenology, and engineers, undaunted by material complexity, made this progress possible” say Principal Investigators Professor Wolfgang A. Wall and Professor Andreas R. Bausch.

To me, one of the most fascinating aspects of this project was to work together with experts from both engineering and physics in this thriving and, at least for engineers, very unconventional field of cellular biophysics.

Dr. Kei Wieland Müller
2015 alumnus

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Earth is a heavy, slowly rotating, almost rigid body. However, its fluid envelope affects the atmosphere – the oceans, continental water, the ice of glaciers or the big ice shields of Greenland and Antarctica. They are important indicators of climate change and manifest themselves as, albeit very small, changes of gravity.

The Gravity-satellite-mission GRACE has been specifically designed to measure these changes and since its launch in 2002 it has delivered crucial evidence of global ice-mass loss and sea-level rise. GRACE is now in its final days and a follow-on mission is not yet in orbit. The motivation for the team therefore was to look into the feasibility of extracting “mass transport” signals from other satellite missions not tailored to observe Earth’s gravity field as their primary objective. The ESA magnetic-field-mission SWARM seemed to be an optimal choice to do that. SWARM, launched in 2013, consists of three satellites in near-Earth orbit and measures Earth’s inner and outer magnetic field. The team combined engineering, i.e. the design of the satellite mission and its sensors, with several fields of Earth sciences to use SWARM for a new purpose. Results showed that temporal variations of Earth’s gravity field can indeed be deduced from SWARM’s orbits, good enough to bridge the gap from the current time series to those from potential follow-up missions.

MTSE’s (acronym for Mass Transport in the System Earth) setup capitalized on an international cooperation between Professors Reinhard Rummel and Eigil Friis-Christensen of the Danish Technical University, Copenhagen. IGSSE has supported an additional 48 international project teams since then.
So choices have to be made today to be ready for an energy system dominated by renewable-energy sources twenty years from now. That demand and generation are not well matched in an electricity system with a very high degree of renewable energies penetration is acknowledged. Generation is bound to outweigh demand during an increasing number of hours. Optimal integration of renewable energies therefore requires flexibility of the whole system, including for example fast ramping up and down of powerplants, reinforcement of the electricity grid, and the extension of energy storage capacities.

Team members of IREG (acronym for Integration of Renewable Electricity Generation) are working toward a holistic methodology to optimize the build-up of power plants, transmission networks, and storage facilities in an electricity system under economic considerations. Their cooperation has combined electrical engineering and economic aspects with modern mathematical approaches to develop and evaluate mathematical models and algorithmic tools for long-term infrastructure planning.

"IGSSE was instrumental in fostering a sustained cooperation of the two working groups," say Principal Investigators Professor Peter Gritzmann and Professor Thomas Hamacher. This effort was so successful that the German Federal Ministry for Economic Affairs and Energy funds a follow-up project from 2016 through 2019.

The anchorage of the tendon in the bone tolerates extremely high-magnitude forces, exceeding a multiple of the body weight at varying angles, making it a very vulnerable yet research-provoking part of the human body. EHASOI (acronym for The Enthesis: Nature’s Solution for a Hard-Soft Junction) investigates the microstructure- and force-dependent deformation of the tissue and is on its way to gaining a clearer picture of how entheses manage to stay intact and do their job under great, repetitive load. From the medical point of view, EHASOI aims at providing new directions for the development of treatment strategies to heal injuries. From the biophysical point of view, the understanding and explanation of natural materials’ complexities start on biomolecular level. First results have shown that the tissue modifies both its structure and composition before adhering to the bone, leading to a reduction of stress on the enthesis. These findings eventually generate the development of quantitative mechanical models, which in turn could contribute to the treatment of enthesiopathies or to reconstructive surgery, improving the fixation of soft tissues to hard tissues.
From a therapeutic perspective, restricting patients’ movements to control their fall risk in dynamic postural activities is inadequate for practicing body balance control. A more promising strategy is to provide balance support in a “light touch” fashion, such as lightly resting a hand on the patient’s back or shoulder without supporting his or her weight. Given that expert healthcare providers’ efficient provision of adaptive support is linked to their ability to anticipate a patient’s dynamics, the scientific aim of ROLITOS (acronym for Robotic LIght TOuch Support during locomotion in balance impaired humans) is to improve understanding of the interpersonal dynamics of light touch in general and of the caregiver-patient interaction in particular. The team’s engineers translate these principles into a robotic solution. The ROLITOS team has commenced investigating the frameworks of haptic and robotic light-touch support in healthy young adults as well as in children and adolescents with cerebral palsy.

With novel drought modeling approaches, DMSAM (acronym for Drought Modeling and monitoring by novel Statistical and Analytical Methods) aims at enhancing the temporal and spatial characterization of drought events and validating the impacts of past events on the biosphere. The team has developed a new, statistically motivated method for drought quantification that is based on so-called vine copulas. It is used to flexibly model the dependence of several user-selected drought-relevant variables. Novel standardized drought indices summarize the information captured in these variables. Many scientific fields, such as agriculture, forestry, hydrology, and meteorology to name only a few, may profit from DMSAM’s development.

Using tree rings as proxies, the team has also shown that vegetation drought response varies spatially with previous- and current-year conditions, bioclimatic zone, drought time scale and elevation. DMSAM’s discoveries resulted in a recommendation of specific drought indices to establish climate-growth relationships based on objective criteria. Novel standardized drought indices summarize the information captured in these variables. Many scientific fields, such as agriculture, forestry, hydrology, and meteorology to name only a few, may profit from DMSAM’s development.

Professional caregivers provide manual support during locomotion to patients with impaired body balance. What can robots learn from them?

It is great to see that my studies contribute to improve patient-caregiver interactions, thus generally having an impact on our society. Personally, I am very grateful to be a part of this interdisciplinary team and to learn from my colleagues.

Among weather-related disasters, drought affects the most people worldwide. Acknowledging that the frequency and intensity of drought episodes are increasing in many regions of the world, including Europe, a shift from ad hoc strategies toward mitigation-based drought management has become inevitable.

Among the research results will be viable measures of the patients’ state of anxiety about falling, reflecting their acceptance of robotic support.
Dockyard for scientific flagships

Along with traditional calls for new project teams, IGSSE has supported the launch of thematically focused frameworks: the Focus Areas. Comprising approximately eight project teams, an IGSSE Focus Area accumulates the critical mass of principal investigators, postdocs, and doctoral researchers needed to comprehensively promote emerging research areas.

Being part of this extensive but still distinguished interdisciplinary framework holds great networking opportunities from master student to professor. It also serves as a dockyard for international research training groups or even as an opportunity to launch emerging research areas.

More than 50 principal investigators, 30 project team leaders and 100 doctoral researchers have worked in IGSSE’s five focus areas so far.

Focus Areas

Dockyard for scientific flagships

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Focus Areas since 2009

Munich Centre of Advanced Computing, MAC – 2009

Green Technology, GreenTech – 2012

Biomaterials – 2013

Water – 2014

Alberta Technical University of Munich International Graduate School for Hybrid Functional Materials

DFG RTG 2022 – 2015

ATUMS – 2015

Focus Area

Advanced computing challenges scientific frontiers

IGSSE’s first focus area has paved the way for many German and international research initiatives in simulation and digitalization.

A s a late starter within TUM’s Excellence Initiative projects, MAC (Munich Centre of Advanced Computing) started its activities in 2009, opening up research opportunities for doctoral researchers in 11 projects. Forked into two funding lines with MAC/IGSSE (supported by matching funds from the State of Bavaria and MAC@KAUST putting TUM’s partnership with the King Abdullah University of Science and Technology (KAUST) in Saudi Arabia into practice) MAC’s doctoral training found its home within IGSSE, with all its doctoral researchers joining the graduate school. Meanwhile, more than 30 doctoral degrees have contributed to the IGSSE-MAC success story. MAC’s funding ended in 2015 with the completion of its third KAUST project. However, its mission statement is as up-to-date as ever: Advanced computing in all its forms and manifestations is prevalent in almost every field of science and engineering. Today, terms such as Big Data, Industry 4.0, and Exascale indicate how current and future research opportunities depend on advanced simulation computing. So the success story will continue – and certainly under the auspices of IGSSE as well.

Focus Area GreenTech

A European strategy for research and innovation

Finding solutions to the technological challenges of society, sharing the expertise of four leading European technical universities and providing transnational academic training – these are the hallmarks of the EuroTech Universities Alliance.

T he EuroTech Alliance has placed collaboration in doctoral research at the top of its agenda, resulting in regular meetings of the graduate deans and joint bottom-up initiatives by the doctoral researchers.
**Focus Area Biomaterials**

Translating biological design principles into technology

Living systems differ significantly from state-of-the-art man-made technology: they form from raw materials through self-organization, have the capability for self-reproduction and self-repair, and may decay into raw materials again.

Current scientific methods and engineering approaches allow the workings of biological systems to be studied in detail, sufficient to make their fundamental principles of operation available for biotechnology and materials-science applications. Nature offers solutions that appear very attractive for future use in human technology. Such solutions may include “bio-inspired” approaches to energy conversion and storage, enzyme-like chemical synthesis, and materials with special properties such as low wear or super lubrication. Combining engineering approaches with scientific methods opens new routes to discovery in bioscience, while discoveries made may yield inventions that help meet challenges in human technology. Seven IGSSE project teams with excellent expertise ranging from chemistry, biology, physics, and medicine to engineering are dedicated to analyzing the design principles of biological materials down to the molecular level and translating their findings into technology. In 2015, the scientific success of the Focus Area has contributed significantly to securing German Research Council funds for the new TUM Center for Functional Protein Assemblies.

**Focus Area Water**

Sensible research approaches for a sensitive system

Water research has a long, excellent tradition at TUM – but it is dispersed across the departments of the School of Life and Food Sciences, Chemistry, as well as Civil, Geo and Environmental Engineering.

Joining their forces via IGSSE’s Focus Area in 2013 has resulted in many activities at TUM with wide international visibility and has made an essential contribution toward TUM’s Water Cluster – a new, university-wide research center. Scientifically, the IGSSE Focus Area Water deals with pressing issues related to the water-energy-food nexus: Population growth and demographic shifts, urbanization, non-point and point-source pollution, and impacts of climate change pose significant challenges to the preservation and operation of water-related systems. The topics of the nine project teams range from evaluating and modeling the impacts of climatic extremes, investigations in soil water-holding capacity with regard to agricultural productivity, mitigation of greenhouse gas emissions, energy harvesting from wastewater to the development of monitoring strategies for remote cyanobacteria detection.**

**Focus Area ATUMS**

Revolutions expected

The IGSSE Focus Area ATUMS, officially named IRTG 2022 and funded by the German Research Foundation (DFG), commenced its research in summer 2015 and opened a new chapter of doctoral training and research within our graduate school.

Professor Bernhard Rieger of TUM’s chemistry department has joined forces with former visiting professor and now TUM Ambassador Professor Jonathan Veinot from the University of Alberta in Canada to boost research in hybrid functional materials (HFMs). These are among the most promising systems available to address the current and future needs of society by potentially revolutionizing solar-energy conversion, energy storage, low-cost efficient electronics, and optical communication, among others.

Developing these advanced systems requires an exceptional transdisciplinary network and a new generation of researchers with the technical skills to design, synthesize, understand, and exploit them. ATUMS research efforts are inter- and cross-disciplinary and rely on a coherent path to knowledge from chemical synthesis to final prototype applications. IGSSE’s latest Focus Area is organized into two major research fields embracing five projects in “Optoelectronic Materials” and four projects in “Electrical Materials,” with 18 doctoral researchers in Germany and about 30 in Canada. This successful cooperation also fosters further TUM initiatives with Canadian research organizations and industry.
Die Hohe Schule der Forschung

“A graduate school – what do you want with that? What are you doing here?” That was the first reaction of the German academic establishment when TUM was implementing the IGSSE ten years ago. This skepticism cropped up not least because of the term “school.” Even more so in German than in English, the term “school” is associated with strictly structured schedules and not with independent researchers at the doctoral level.

IGSSE talked to founding director Professor Ernst Rank about an amazing decade of young researcher training at TUM.

Professor Rank, what was the motivation to apply for an interdisciplinary graduate school in 2007?

Rank: The ultimate goal was to optimally support doctoral researchers; the direct occasion was that the German Research Foundation issued a call for large and interdisciplinary research centers: Professor Rank, what was the motivation behind this call?

Rank: The German Research Foundation issued a call for large and interdisciplinary research centers. Our idea was to create small, flexible doctoral training centers. Our idea was to establish a number of small doctoral training centers.

What Ernst Rank started more than a decade ago is now in a position to act as a nucleus for future coordinated research training groups as well as for collaborative research centers. Constantly changing intersections between the disciplines require novel concepts to train and to teach the next generation of leaders in academia, industry, and government. The IGSSE team is well prepared to face these new challenges. I would like to thank Ernst Rank for his continuous support and long-lasting commitment, and I am looking forward to joining forces with the fantastic IGSSE team.

Rank: It was a pleasure for me to serve as the IGSSE Director for more than a decade. I wish all the best to Barbara and IGSSE!

IGSSE talked to founding director Professor Ernst Rank about an amazing decade of young researcher training at TUM.

IGSSE: What were the key ideas behind the establishment of the IGSSE?

Rank: Key ideas included the establishment of a novel training center and the introduction of a sustainable funding model. The financial support was gratefully acknowledged. For sure, all of us will do our best to maintain the IGSSE spirit and to form new international and intersectorial alliances. IGSSE is designed to provide precisely the organizational structure, leadership, and scientific environment to make truly interdisciplinary thinking and outstanding research possible. We will expand our collaboration model, enrich its diversity, and open for new application-driven project teams.

Rank: I would like to thank Ernst Rank for his continuous support and long-lasting commitment, and I am looking forward to joining forces with the fantastic IGSSE team.

IGSSE: What are your goals for the future of the IGSSE?

Rank: IGSSE is now in a position to act as a nucleus for future coordinated research training groups as well as for collaborative research centers. Constantly changing intersections between the disciplines require novel concepts to train and to teach the next generation of leaders in academia, industry, and government. The IGSSE team is well prepared to face these new challenges. I would like to thank Ernst Rank for his continuous support and long-lasting commitment, and I am looking forward to joining forces with the fantastic IGSSE team.
“IGSSE is pioneering many transformations in graduate education,” the American Council of Graduate Schools (CGS) acknowledged in 2010. The Council was especially impressed that the IGSSE training concept served as a role model for the faculty-spanning TUM Graduate School, founded in 2009. Six years later, 53 leading European universities of science and technology picked IGSSE’s training program as an outstanding example of doctoral training in their joint position paper “Innovative Doctoral Training” presented to the European Commission in Brussels.

Developing doctoral researchers’ personalities, broadening their scientific qualifications beyond their individual research projects, and strengthening their sense of responsibility for society have been the aim of the IGSSE training since 2006. Launching from a strong disciplinary foundation and acting across disciplines in the project teams, the IGSSE training program supports aspiring candidates while taking their first independent steps within the international research community. With the individual doctoral research project staying at the core of their training, participation in the training program in four modules adds valuable skills to the young researchers’ academic profiles. Still, IGSSE doctoral researchers are free to arrange seminars and courses according to their individual obligations, timelines, and agreements with their supervisors.

Two training program modules (disciplinary training, scientific skills training) explicitly recognize and credit our member’s scientific merits as required by their respective chairs and departments, two more (transferable skills and international research stay) mirror IGSSE’s special qualification approach.

Transferable skills
Communication and leadership skills, responsibility, and cultural awareness – IGSSE addresses and acknowledges personal competences that are rarely specifically trained but help with developing a competent researcher’s mindset.

Scientific skills
Proficiency in academic teaching and coordination of scientific events, peer-reviewed publication, or presentation of research results are a vital part of a scientists’ development. Via this module, IGSSE acknowledges the scientific activities of the graduate school’s members.

International research phase
Adding new perspectives and benefitting from strategies, techniques, or equipment of partner institutions helps to lift individual research into international contexts. IGSSE supports and credits research in foreign labs.

Subject-specific skills
Improving disciplinary expertise – also true for interdisciplinary set-ups – is essential for doctoral training. IGSSE recognizes all advanced training courses, meetings, and workshops via this module.
Fostering international exchange and cooperation

Dr. Tobias Weinzierl
Lecturer at Durham University / UK
Visited University of Utah / USA in 2007

“I still have international connections to fellow colleagues from my IGSSE time and I very much appreciate that I am familiar, through the exchange, with diverse academic environments that I would otherwise never had experienced. This is something I profit from frequently.”

Dr. Dominik Schilling
Assistant Professor at University of Minnesota / USA
Visited University of Texas at Austin / USA in 2011

“The multitude of truly new and innovative ideas that are popping up in this group every day is unbelievable from a newcomer’s point of view. This great opportunity has turned out to be a boost for my academic career.”

Andreas Poschenrieder
Doctoral researcher
Visited UPC Barcelona / Spain in 2015

“I highly appreciate international exchanges and am happy that through IGSSE, too, they bring together people with all kinds of different cultural backgrounds in a peaceful environment.”

Ekaterina Chuprikova
Doctoral researcher
Visited National Geomatics Center Beijing / China in 2015

“It was a remarkable experience that helped me in my research and broadened my knowledge about another culture.”

The IGSSE program prepares a new generation of researchers to meet the increasing demand for people with a strong international and interdisciplinary mindset, who are ready to find answers to the global challenges of the future.

Prof. Martin Bandse
Senior Vice President, Dean of Graduate Studies and International Affairs DTU Copenhagen and member of IGSSE Scientific Council

Training

Range from lab visits at universities like Stanford, ETH-Zurich, and Oxford to Technion / Israel or NTU Singapore, IGSSE has especially supported international exchange. Some doctoral researchers have visited their team’s international cooperation partners, others were bold enough to establish contacts with top groups in their field themselves. Perceptible outputs range from several joint publications to initial contact with future employers and postdoctoral positions. To all, going abroad has proven to be a valuable, unforgettable, and enjoyable experience in addition to being an asset their professional and personal development.
A rewarding view across disciplinary borders

A love-at-first-sight story turning into a long-lasting relationship – this, in short, is IGSSE’s history at the Raitenhaslach monastery, now TUM Science and Study Center.

Our graduate school’s annual meeting, the IGSSE Forum, is open to all members and is a vital part of the doctoral training program. It has benefited immensely from the unique atmosphere of this inspiring spot in southeastern Bavaria. IGSSE has come to this site of natural and cultural beauty annually since 2007, nourishing the exchange across project teams, disciplines, as well as all of the members and special guests.

The IGSSE Forum encourages our doctoral researchers to look beyond the borders of their individual research projects and learn about concepts in other fields. Many have taken the chance to develop ideas off the beaten track, all have profited from the opportunity to present their projects to the meeting’s interdisciplinary audience.

In workshops, lectures, and training sessions, the three-day symposium sees principal investigators, project team leaders and doctoral researchers exchanging ideas with each other and with international guests. Successful alumni and internationally renowned keynote lecturers have joined the meeting in past years, introducing cutting-edge research topics and views from the outside. Past speakers have included Professor Wolfgang Heckl, director general of the Deutsches Museum, Professor Bert Sakmann, Nobel Prize laureate, and Professor Raul Weller, founding president of the EU Chapter of the Club of Rome.

By varying leitmotifs such as “Science to society,” “Careers in the 21st century,” or “Smart cooperation – science in, with, and for society,” the doctoral researchers have been trained in media relations, professional skills in academia and industry, as well as meeting expectations of society and politics.

"It was at an IGSSE Forum where learned about a helpful method unknown to me before from a fellow doctoral researcher. Applying it led to even more great ideas and nourished a new cooperation. If it had not been for IGSSE, I think I would not have come across this great input."  

Almut Glinzer  
Doctoral researcher and Speaker of Graduate Council 2015 – 16
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hapling the paths of IGSSE, deciding on strategic topics, and assessment of research proposals evaluated in an international peer-review process ultimately lie in the hands of the IGSSE Board. Seven TUM professors, representing the TUM departments, a speaker for each Focus Area as well as one project team leaders’ and one doctoral researchers’ representative form the committee ensuring the scientific, interdisciplinary, and doctoral training aspects of new project teams. For both the doctoral researchers and the project team leaders, the board also serves as an opportunity to address and discuss career development issues within the TUM framework.

Last but not least, networking across the disciplines in a casual atmosphere or just having fun together also have a long tradition at IGSSE. White-water rafting, event cooking, go-cart racing, or even solving mystery stories have been very popular activities organized by the doctoral researchers in the past years and have been mouthwatering for even more.

Exploring the interface of research, politics, and policies

Where would you meet face-to-face with a researcher preferring a professorship to a director-of-research position at Google or with a scientist who had orbited the earth for ten days? IGSSE’s fireside chats have been small, inspirational meetings at which tandems of TUM Emeriti of Excellence and personalities such as Monika Henzinger and Ulrich Walter gave insights into their research, visions, and strategies.

The guests talked about the how-tos of their networking strategies and career pathways covering academic, international, and industrial chapters. With topics like “Emotional cars and robots,” “Ideas and their realization,” “How to be a successful computer scientist,” or “Space exploration and the future of the universe” they shared the concepts of their personal and scientific past, present, and future, encouraging our doctoral researchers to follow curiosity and foster scientific passion.

Having been a representative of the IGSSE Graduate Council for three years, I had the chance to bring ideas and concerns of doctoral researchers forward to the IGSSE Board. The look behind the scenes of IGSSE was worthwhile, especially with regard to the approval of new projects.

Dr. Sarah Abelen
2016 alumnus and Speaker of Graduate Council 2011–13

In 2010 and 2015, IGSSE seized the opportunity to visit Scientific Board Member and MEP Dr. Angelika Niebler in Brussels. Meeting with her, lobbyists at the EuroTech offices and decision makers at the European Parliament and Commission helped to improve the participants’ perception of complex international networks, policies, and politics. Three IGSSE Forums — 2012, 2015, and 2016 — have complemented this approach, addressing the interdependencies of scientific endeavors and society.

Only interdisciplinary research can provide us with solutions for the challenges of the years to come. I hope that in the future, IGSSE will also increasingly profit from European research funds.

Dr. Angelika Niebler
MEP and member of IGSSE Scientific Council

IGSSE and TUM’s Junge Akademie with Scientific Board Member Dr. Angelika Niebler (front row, 3rd from left) at the European Parliament in Brussels in 2015.

Talking about the secrets of success: Professors Monika Henzinger and Georg Fischer with doctoral researchers at the 2nd fireside chat in 2009.

Field work, networks, clockworks

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Dr. Angelika Niebler
MEP and member of IGSSE Scientific Council
Preparation of doctoral researchers for careers and leadership positions has been a major intention of the IGSSE doctoral training program since the beginning. However, our graduate school’s setup has also grown into a perfect tool for supporting young postdocs who act as leaders of project teams. Much of an IGSSE project team’s success depends on the support of the doctoral researchers and management of the teamwork. IGSSE has been rewarding this effort with extra funds since 2012 with the intent to facilitate their next career steps. To especially support women’s careers, our graduate school awards a one-year fellowship to female postdoctoral researchers annually. Both newly graduated doctoral researchers and project team leaders have profited from this unique opportunity to advance their individual research path.

Taking off from the IGSSE runway

Doctoral researchers and project team leaders profit from the special career development schemes at IGSSE. While the IGSSE doctoral training concept helps to pave the way for independent and consciously acting personalities, project team leaders profit from the opportunity to collect valuable management skills and to employ IGSSE funds to foster their individual research profile and scientific career. Some of our doctoral researchers have evolved into project team leaders or even returned as principal investigators—especially enthusiastic about the project-team setup and the qualification program.

I highly appreciate that IGSSE sets young researchers up for success in their scientific discipline while at the same time fostering the team work needed to give them a holistic view of the application context of their work.

Dr. Carlos Härtel
CTO GE Europe and member of IGSSE Scientific Council

Looking back on their time at IGSSE, alumni say that the competences obtained within the IGSSE environment have helped them tremendously with their careers. Numerous managing positions in renowned international companies, director’s positions in successful start-ups, and—thus far—ten professorships reflect this. With an even percentage of both academic and industry career paths, our alumni are prepared to pursue their individual career concepts.

Interdisciplinary communication
Ability to understand the language and the intellectual pathways of experts from other scientific backgrounds.

Team-oriented collaboration
Establishing and developing unprecedented collaboration and securing success across well-established research groups.

Research excellence
Employing the outstanding scientific infrastructures of TUM, one of Europe’s leading universities.

International networks
Experience with, and adaptation to, medium-term assignments in foreign laboratory and office environments.
Females’ careers in academia
Fostering a role model

Looking at the so-called “leaky pipeline” – stating the loss of female researchers to the academic world after their doctorate – IGSSE is geared to stop the decrease in the number of women in leading academic positions. Our graduate school acknowledges fast trackers as well as family responsibilities, supports excellent international networks and management of institutional research strategies. Impossible? Get an impression of three outstanding female researchers who completed their doctorate within an IGSSE project team and who have already made their way to professorship.

Professor Petra Liedl

Since the days of her doctoral training, Petra Liedl has been dedicated to promoting a deeper understanding of the interaction of climate, buildings, energy, and comfort. The trained architect seized the opportunity to join the IGSSE project team “Building, Users, Climate” in 2007, where doctoral researchers from computational engineering, energy economy, and sustainable energy chairs collaborated closely. The precise identification of their scientific interfaces produced results for her team that served as an invaluable basis for the research results of all team members. For Petra, the team’s collaboration ultimately led to the production of an innovative tool for architects.

The IGSSE experience improved my skills to work in interdisciplinary and international environments. It helped me with the co-supervision the UT/TUM NexusHaus team during the U.S. Solar Decathlon 2015 with more than 70 students from 7 disciplines and 11 countries.

Professor Isabell Nemeth

Construction engineer Isabell Nemeth knows IGSSE by heart – she has been decorated with our graduate school’s certificate in 2011 and took up a project team leader position in 2012. Her IGSSE Project Team “Energy 2030,” composed of civil engineers, economists, and mathematicians, investigated future energy solutions, reflecting exactly the kind of work Isabell especially appreciates: learning and applying the knowledge of other disciplines to create comprehensive solutions for scientific challenges. Apart from her scientific tasks, Isabell acted as a project team leader representative, joining the IGSSE Board to decide on new project proposals and coordinating specialized trainings for IGSSE’s postdocs.

The continuous support from IGSSE helped me to develop from a student into an independent researcher and trained me to work in an interdisciplinary environment. I am convinced IGSSE offered all of the necessary instruments that are optimum for researchers at their early-career stage!

Professor Xiaoxiang Zhu

Xiaoxiang Zhu’s academic career sounds like a fairy tale, but it is certainly the result of an exceptional talent and zeal linked to the opportunities at TUM and IGSSE. Starting out as a doctoral researcher in 2008, only seven years later in the position of a professor, she has now already been able to award a doctorate to the first member of her own project team, “4D City.” During her fast-track career she has received many awards, among them the prestigious Heinz Maier-Leibnitz Award of the Deutsche Forschungsgemeinschaft, and was short-listed for MIT’s “Technology Review "Innovators under 35" (TR35), both in 2015. Her research field – remote sensing in earth observation – is in itself interdisciplinary and relies on geo-information from satellite measurements, physical models of the measuring process, advanced signal processing methodologies in mathematics, and computer vision for parameter inversion among other things. Her findings support cartographers, geophysicists, resource managers, and others in planning and global decision making.

IGSSE has provided me with an extensive interdisciplinary experience, but also with valuable competencies in managing a group, with regard to both motivation and controlling.

Fostering a role model

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Mining the IGSSE experience

Dr. Petra Dorfner
2013 alumna
Now working with Dynamic Biosensors GmbH

“Combining different ways of thinking from material science to chemistry, biology and medicine has been a big challenge and an incredible incentive for me. I am thankful to be a part of the IGSSE family and still benefit from the network I have built up.”

Dr. Rainer Witzig
2011 alumna
Now working with MAN Truck and Bus

“The international and multidisciplinary nature of my PhD research was a challenging journey from beginning to the very end. I have benefited a great deal from the IGSSE training program to crack the multi-disciplinary challenge of my research and foster my academic career.”

Dr. Andreas Maier
2013 alumna
Now working with Adjucor GmbH

“To develop the project from scratch has been great fun and success came quite soon as well. Our group was leading in aneurismal research, probably due to the unique team composition with everyone contributing and shaping the course of the project. The interdisciplinary collaboration experience is essential for the work of my team today.”

Dr. Nina Polous
2016 alumna
Now working with Adjucor GmbH

“Pursuing the common goal, defining the central thread was very challenging and at the same time enlightening. I have become aware that good leadership is pivotal to tackle the challenge of a large team. This is what I really profit from in my current job.”

Four perspectives

Breaking the glass ceiling – share of female careers at TUM and IGSSE

Doctoral researchers since 2006

<table>
<thead>
<tr>
<th>TUM</th>
<th>IGSSE</th>
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<tbody>
<tr>
<td>375</td>
<td>122</td>
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</table>

Alumni since 2006

<table>
<thead>
<tr>
<th>TUM</th>
<th>IGSSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>127</td>
<td>152</td>
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</tbody>
</table>

Days spent at top-five research destinations

<table>
<thead>
<tr>
<th>Destination</th>
<th>Days</th>
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<tbody>
<tr>
<td>USA</td>
<td>5,257</td>
</tr>
<tr>
<td>Italy</td>
<td>568</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>523</td>
</tr>
<tr>
<td>China</td>
<td>676</td>
</tr>
<tr>
<td>Singapore</td>
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