DISCLAIMER
Although this brochure was compiled with the utmost care, no rights can be derived from its contents.
Computational Science and Engineering (CSE) is a young discipline, dealing with the development, implementation, testing, optimization, and application of numerical models and simulations. This is often connected with high-performance computing, in order to solve complex physical, mechanical, environmental or geotechnical problems arising across various disciplines.

According to Wikipedia, CSE has been described as the new “third mode of discovery” (next to theory and experiments). In many fields, computer simulation contributes to solving challenges that cannot be addressed by either experiments or theory alone. Therefore, computer simulation is not just essential to the industry and business community, but also poses many scientific challenges in modern research.

Personally, I started studying computational science and engineering in 1985, with help of some traditional computers. Thus, I have contributed to some of the developments over the last three decades. I have developed myself along with the discipline and will make all possible efforts to ensure that CSE at the Twente Graduate School will lay the foundations for modern young people to learn and grow and to make their own contributions.

Prof Dr rer.nat. Stefan Luding
Leader Computational Science and Engineering graduate school

COMPUTER SIMULATION POSES MANY SCIENTIFIC CHALLENGES IN MODERN RESEARCH
TWENTE GRADUATE SCHOOL

TWENTE GRADUATE SCHOOL OFFERS HIGH-QUALITY EDUCATIONAL PROGRAMMES BASED ON SUBJECTS CLOSELY RELATED TO THE WORK OF THE UNIVERSITY’S RESEARCH INSTITUTES AND TAUGHT AND SUPERVISED BY EXPERT RESEARCHERS FROM THESE SAME INSTITUTES. IT OFFERS AN INCREASING VARIETY OF INTEGRATED MASTER’S AND PHD PROGRAMMES FOR OUTSTANDING GRADUATE STUDENTS WHO ARE KEEN TO PURSUE A CAREER IN SCIENTIFIC RESEARCH.

TGS PROGRAMMES
TGS programmes are set up in collaboration between the university’s faculties and research institutes. Their broad selection of compulsory, discipline related and elective courses enable students to specialize in a research area they are interested in while broadening their perspective on the societal context of technology and research. All these aspects are integrated into the Twente Graduate School, which aims to be a springboard for research talent.

INVOLVED RESEARCH INSTITUTES
Both the MESA+ Institute for Nanotechnology as well as MIRA Institute for Biomedical Technology and Technical Medicine are involved in the Computational Science and Engineering programme.

MESA+ INSTITUTE FOR NANOTECHNOLOGY
MESA+ of the University of Twente is one of the world’s largest nanotechnology research institutes. The institute ranks number 7 on the list of the biggest research and knowledge centres in the Netherlands. 525 researchers work together on cutting-edge research at the highest level, including research in the fields of materials science, lab-on-a-chip technology, nanophotonics, nanoelectronics and nanofluidics. The aim for excellence is always the focal point when publishing scientific articles in leading international journals. On average, every single day, one article is published by a MESA+ scientist. Multidisciplinary collaboration between the various research directions of MESA+ is stimulated by the unique structure of Strategic Research Orientations (SROs), in which a large number of researchers collaborate in a specific research programme. This method of interdisciplinary research leads to ground-breaking results, it reinforces the cohesion between ongoing high-quality research and it provides excellent opportunities for external partners.

MESA+ offers a state-of-the-art NanoLab with a floor area of 1250 square meters. Users are offered a unique laboratory with a wide variety of technologies and equipment to develop an almost unlimited number of applications. In addition to the scientific researchers, 40% of the laboratory space and equipment of the MESA+ NanoLab is used by industrial partners.

MANPOWER
525 RESEARCHERS

INTERNATIONAL EMPLOYEES
40%

TURNOVER
50 M. €

NUMBER OF SPIN-OFFS
OVER 50

STRATEGIC RESEARCH ORIENTATIONS
1 APPLIED NANOPHOTONICS
2 NANOMATERIALS FOR ENERGY, MICROSOFT, NOKIA
3 ENABLING TECHNOLOGIES
4 NANOTECHNOLOGY FOR INNOVATIVE MEDICINE
MIRA INSTITUTE FOR BIOMEDICAL TECHNOLOGY AND TECHNICAL MEDICINE

MIRA Institute for Biomedical Technology and Technical Medicine at the University of Twente is a trend-setting and rapidly growing research institute in the field of Biomedical Technology and Technical Medicine and ranks eighteenth on the list of the largest research and knowledge centres in the Netherlands.

Technological science is the catalyst for innovation in health care. MIRA combines fundamental and applied research with clinical practice. This unique scientific path stimulates the successful application of fundamental concepts and enables the health care sector to rapidly introduce new treatments. MIRA works in close cooperation with hospitals, the business community and governmental organizations with the aim of securing its leading position in Europe.

Our multidisciplinary approach enables us to make innovative contributions across a wide spectrum within the health care sector. MIRA’s research will result in the development of new techniques to repair damaged tissue, such as bone and skin. It helps to create drugs that are targeted in their effects and enables physicians to diagnose more effectively by using improved imaging techniques. Furthermore, MIRA offers patient-focused solutions in Rehabilitation Technology.

What distinguishes MIRA from other research institutes in Europe are the entrepreneurial chairs. One entrepreneurial chair is or will be appointed per Strategic Research Orientation (SRO). As economic and time factors are crucial for the incorporation of new clinical methods into society, MIRA’s organizational set-up effectively assists in bringing technology to the patient.

MANPOWER
275-300 RESEARCHERS

INTERNATIONAL EMPLOYEES
33%

TURNOVER
22 M. €

NUMBER OF SPIN-OFFS
9 SPIN-OFF COMPANIES, 5 LICENCE AGREEMENTS, 16 NEW PATENT APPLICATIONS SINCE THE ESTABLISHMENT IN 2009

STRATEGIC RESEARCH ORIENTATIONS
1 TISSUE REGENERATION
2 IMAGING & DIAGNOSTICS
3 NEURAL & MOTOR SYSTEMS
COMPUTATIONAL SCIENCE AND ENGINEERING

PROGRAMME LEADER:
PROF DR STEFAN LUDING

CONTACT PERSON:
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RELATED UT MASTER’S PROGRAMMES:
APPLIED MATHEMATICS, APPLIED PHYSICS, CHEMICAL ENGINEERING, MECHANICAL ENGINEERING

During the past decades, Computational Science and Engineering has become an increasingly important component in understanding and controlling the key mechanisms in the natural, biological and technical sciences. This interdisciplinary and multidisciplinary field of research consists of the combination of mathematical and physical modelling and analysis, large-scale simulations, and the development as well as application of accurate high-performance computational algorithms. One of the major future challenges in Computational Science and Engineering concerns the design and analysis of methods in which physical, chemical and biological processes at a wide range of length and time scales are simultaneously and consistently integrated.

COMPUTATION SCIENCE AND ENGINEERING PROGRAMME
The Computation Science and Engineering programme will provide an academic context for interested, successful researchers in a broader sense, combining aspects of mathematics, physics, chemistry, mechanics, and computer science. Many of the applications require a deep understanding of non-linear phenomena, their interactions at various scales and the sensitivity of model predictions. This combination of issues is also reflected in the design of the course programme, which is fully embedded in the MSc programmes of Applied Mathematics, Applied Physics, Chemical Engineering, and Mechanical Engineering.
MAIN CHALLENGES IN COMPUTATIONAL SCIENCE AND ENGINEERING
The main challenges for teaching and research in Computational Science are:
- to arrive at a systematic ‘first principles’ approach to modelling, simulation, analysis and control of complex, non-linear, dynamic behaviour with particular attention to problems evolving on many length and time scales simultaneously;
- to include and interpret the full variety of interacting physical mechanisms governing the multiple physical processes that take place, as well as their coarsened approximations in heterogeneous multi-scale formulations;
- to combine and thus achieve leading capability in high-performance computing and highly accurate numerical methods;
- to apply computational modelling methods to multi-disciplinary problems of factual practical relevance, linked to a variety of problems and applications in the natural, biological and technical sciences and in engineering.

For the teaching and training of students, key courses from the contributing Master of Science programmes will be integrated, in order to provide a solid basis for a successful research attitude. Furthermore, one of the activities is the MESA+ & MIRA Computational Science and Engineering Lecture series established in 2012, for which all Master and PhD students are invited to join the research staff.

Examples of research schools for deepening courses: J.M. Burgers Centre (JMBC), Graduate School on Engineering Mechanics (EM), Mathematics Research Institute (MRI), Dutch Institute on Systems and Control (DISC), Netherlands Research School in Process Technology (OSPT).
**ARE YOU CURRENTLY A BACHELOR’S STUDENT?**

- BSc
  - You have already obtained your Bachelor’s degree

- MSc
  - Two-year programme with discipline related courses, 120 credits
  - Opportunity to start an integrated MSc/PhD programme in the second year

- PhD
  - PhD research
  - Deepening, broadening, academic skills and career development courses, 30 credits

If you are currently a Bachelor’s student or if you have recently obtained your Bachelor’s degree, and if you are interested in pursuing a PhD through one of the integrated research programmes TGS offers, please have a look at our Master’s programmes.

To be admitted to a Twente Graduate School programme, you must have achieved excellent results in your Bachelor’s degree and have good research skills. Also, you must have gained admission to a relevant Master’s programme. The Twente Graduate School programmes are particularly concentrated on research. Talented students can write their PhD proposal as part of their Master’s degree programme. For more information about the Master’s programmes, the admission requirements, and the tuition fee, please visit our website at: [www.utwente.nl/master](http://www.utwente.nl/master)

**ARE YOU CURRENTLY A MASTER’S STUDENT?**

- MSc
  - You have already obtained your Master’s degree

- PhD
  - PhD research
  - Deepening, broadening, academic skills and career development courses, 30 credits

If you have successfully attained a Master’s degree, you may enter a PhD programme at the Twente Graduate School. PhD candidates may either apply for a PhD position available at one of the research groups or try to obtain their funding themselves.

**VACANCIES**

Unlike in many other countries, most PhD students in the Netherlands are paid employees, often working directly for the university. Research projects are defined by the head of the research group, who subsequently recruits graduate students to carry out these projects. In case a PhD position is offered in the research field of your choice, you are kindly invited to apply to such a vacancy. Vacancies for PhD positions at the University of Twente, including those connected to the Twente Graduate School, are published on the vacancies website at: [www.utwente.nl/vacancies](http://www.utwente.nl/vacancies)
OWN FUNDING
You may also enter a Twente Graduate School programme as a PhD student with your own funding or with an international scholarship. In that case, research projects are initiated on the basis of proposals submitted by graduate students as part of their application procedure. A professor in a relevant field has to express interest in the candidate and the proposed line of research. Before a proposed research plan is taken into consideration, it must be clear that the candidate intends to submit an application for a secured funding scholarship. Please note that the University of Twente is not in a position to offer fellowships or similar funding for PhD students, other than the vacancies mentioned above.

ADDITIONAL INFORMATION
For more information about the Twente Graduate School, please visit the TGS website at: www.utwente.nl/tgs. For more information about the career development courses visit www.utwente.nl/ctd/en/phd
After I had obtained my secondary school diploma in Germany I wanted to return to the Netherlands for my continued education at a university. After visiting the Open Day it was immediately decided that I’d go to Enschede: I really liked the campus with its easy-going atmosphere.

Fast forward to the end of 2012: I was almost finished with my master’s project, but did not yet know what I wanted to do after. During one of our weekly meetings my supervisor, professor Stephan van Gils, asked me whether I would like going up for a doctoral degree after my master’s. I rather liked that idea: the project continued building on my master’s project, which I had enjoyed working on in the past year, and I got along well with the other staff members in the group. There was only one problem: a research proposal had been submitted, but the finances had not yet been fully arranged.

The bad news arrived after a short while: the original research proposal would not be accepted. Luckily, we had a plan B: I had been nominated for the TGS Award, the prize of which was three years of financing for a doctoral degree project. We wrote a new research proposal and I made it to the final round. We had to stand before a multidisciplinary jury, where each candidate had five minutes to present their project in an ‘elevator pitch’. Exciting and especially very informative!

I came in second place, but because the winner, Rindia Putri, had managed to secure external financing, the TGS Award was mine!

By now I’ve been studying for doctoral degree for over a year in the ‘Applied Analysis’ department of applied mathematics within the computational science programme. We try to gain better insight into the function and dysfunction of our brains with the help of mathematical models, and are especially interested in pathological conditions such as epilepsy or Alzheimer. My specific project is about modelling brain activity during acute hypoxia after a stroke or severe brain damage; a very interesting and interdisciplinary subject that combines ‘real maths’ with immediate social relevance and which, in addition, also fits in well with the UT’s motto of ‘High Tech Human Touch’.
In addition to academic development a doctoral education also provides plenty of opportunities to develop on a personal level, for example through the so-called ‘broadening courses’ offered by the TGS. During the two-day ‘TGS Introduction and Research Management Workshop’ I had the opportunity to become acquainted with several of these courses and I am certainly of a mind to attend some of them. There is also a large variety of courses on the professional level. For example, in the past half year I travelled to Utrecht one day a week in order to attend a course on numerical bifurcation theory.

In closing I can say that doing doctoral research provides you with the opportunity and freedom to intensively immerse yourself in one particular subject for a few years, an opportunity that will most likely not come a second time in the span of your career. However, it is very important that you are interested in the subject and that you derive pleasure from working independently. As always, that’s the best guarantee for success.