

Health

Healthy Solutions from
Excellent Science

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Where innovation starts



TU **e** Technische Universiteit
Eindhoven
University of Technology

Where innovation starts





Where innovation starts

Eindhoven University of Technology (TU/e) is an internationally renowned research university specialized in engineering science and technology. The challenges of our present day society inspire our scientists and students to pursue exciting educational programs and breakthrough innovations that are beneficial for all. Our activities are embedded in strong partnerships with industry, governments and knowledge institutions worldwide. TU/e is situated in the Brainport region, the technological heart of the Netherlands.

Our society faces tremendous challenges in the fields of energy, climate, safety, sustainability, healthcare, mobility and communication. We believe technology is crucial for finding solutions, and it is our aim to contribute significantly to doing just that with our research and innovation activities. We've therefore combined our research into three strategic areas to help us maximize strengths. These areas are: Energy, Health and Smart Mobility, themes that also play an important role in the areas of education and knowledge valorization.

TU/e is helping to build a sustainable world. Efforts to that end include people-oriented technology, science for society. Less pollution and fewer unexpected traffic jams, chemotherapy with fewer side effects, and solar power that charges your phone and lights your offices.

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Our society faces numerous challenges in the field of healthcare. These include an ageing population, a growing number of people with lifestyle related diseases like obesity and diabetes and other chronic diseases, as well as rapidly rising staff shortages. These challenges require new products and services in the healthcare industry and technology can play a crucial role in addressing those challenges.



Healthy Solutions from Excellent Science

That is why Health has been a key focus at TU/e for many years. In fact, TU/e was the first Dutch university to offer a bachelor's degree in Biomedical Engineering, and Health is now one of TU/e's three strategic areas, positioning the university as a leader in this field.

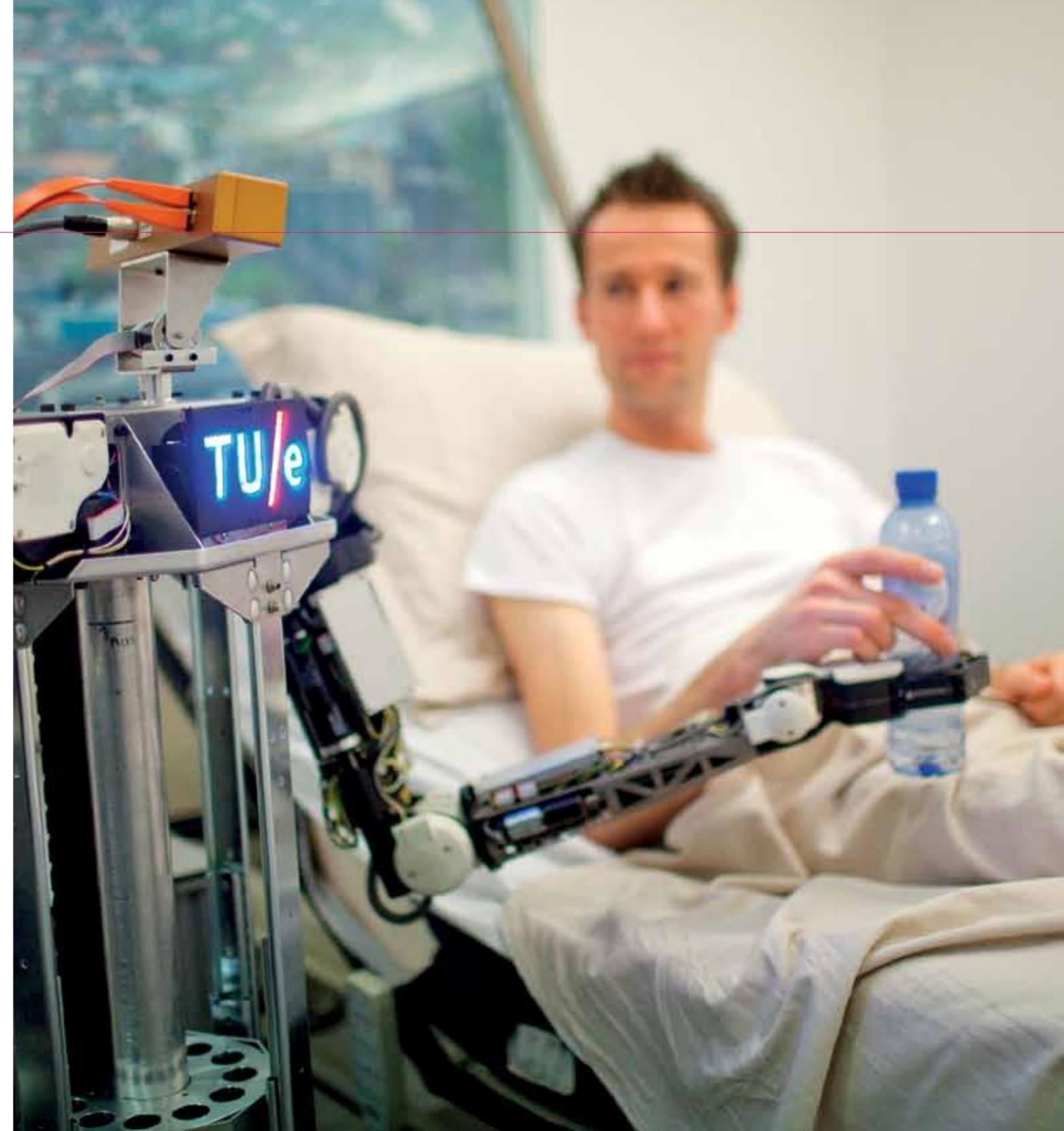
Technology with a human face

TU/e aims to develop technology that revolves around people, technology that is self-explanatory and user-friendly. Two things are pivotal in this:

- We use our high-end technical knowledge as the basis for developing suitable technological solutions for people, not only to improve care in the complex and expensive hospital environment, but also, more importantly, to ensure that these improvements are introduced in first-line care and even self-care. The ultimate goal is to lower costs for everybody and increase quality of life.
- The organization of care and the associated IT systems revolve around increasing patient independence. We want to make technology more accessible, which, in turn, will make self-care easier.

This goal is achieved, in part, through open innovation and sharing knowledge. We take an integrated approach to research, working together with other universities, medical centers, hospitals, care facilities, healthcare insurers, companies, and governments – both nationally and internationally.

Over 300 researchers from nine different departments have come together in the strategic area Health and are committed to the prevention, earlier diagnosis, and more effective treatment of diseases, as well as to promoting healthy lifestyles and living environments. The focus is on three research themes: smart environment, smart diagnosis, and smart interventions.





‘A healthy life which lasts a lifetime!’

“To provide people with a lifetime’s worth of the care they deserve, allowing them to remain independent from the cradle to the grave: that is TU/e’s vision. Technology can play an important role in this, because the challenges are huge. As the population ages, more chronic diseases and lifestyle-related diseases have resulted in spiraling healthcare costs. And we may be facing a dangerous shortage of medical personnel.

We want to put patients first, to create more efficient care that increases the patient’s quality of life. One of the ways we can do this is by developing advanced technology for quickly identifying and treating disorders. Our goal is to create hospitals with fewer beds, since our ultimate aim is to treat diseases in a non-invasive manner. Some of the other advancements in this area include developing ways to treat bone disease with cultivated bone tissue from the patient’s body and creating incubators for premature babies with long-range sensors, increasing both the mother’s and the baby’s wellbeing.

Also included in our efforts are the systems for healthcare management. We are designing more patient-oriented systems that will dramatically increase patient independence. This might involve expert care provided through an internet connection or at houses that have been specially furnished to help the elderly remain independent longer. Or it could be as simple as developing small, user-friendly medical devices, medication doses or dietary habits – information that can then be passed on to the medical specialists in hospitals.

In the future, healthcare will be organized around the patient. With prevention, screening, and a quick and precise diagnosis, followed by a quick and pain-free operation, and rounded off with excellent follow-up care. This will allow us to move from acute care in hospitals to home care, because we deserve the best possible care – throughout our lives.”

Roel Fonville, Director Strategic Area Health
Formerly Senior Vice President and Chairman of the Board for Philips Healthcare Netherlands and Chairman of the Topteam Life Sciences & Health



Research themes

The strategic area Health is divided into three multidisciplinary research themes.



Smart Environment

Smart Environment focuses on creating healthcare that revolves around people: informed citizens, who are linked to one another, aware of their health needs, and know how to improve their wellbeing. Our scientists are developing technologies that will allow people to continue living independently as long as possible and therefore drastically reduce the number of hospital beds. These technologies include wearable sensors and people-oriented information systems.

The Smart Environment theme encompasses two research areas:

- Empowerment for healthy living
- Patient-oriented efficient processes

Smart Diagnosis

The focus of the research in Smart Diagnosis is to provide guaranteed certainty when it comes to determining what medical procedures are needed, resulting in huge cost savings and greater patient comfort. Using imaging in the diagnosis of prostate cancer, for example, would do away with the need for biopsies, which are invasive and often inaccurate. Another area of promise involves using internet technology to provide patients with expert care from specialists in the comfort of their home, for instance through sensors in their clothes.

Smart Diagnosis consists of four research areas:

- Remote sensing
- Remote diagnostics
- Homecare infrastructures
- Medical imaging

Smart Interventions

The goals of Smart Interventions are to help the body repair itself and to develop smart, pain-free medical procedures. Current developments include living heart valves able to grow within the body and the use of medical plasmas to accelerate the healing process in burn wounds.

Smart Interventions consists of four research areas:

- Molecular, cell, and tissue engineering
- Image-guided minimal and non-invasive interventions
- Plasma medicine
- Virtual physiological human (VPH)



"We develop environments that have a stimulating effect on personal and social health and wellbeing. We want people to be in charge of their own healthcare."

*Prof. dr. ir. Caroline Hummels,
Theme Leader Smart Environment*



"Our goal is to generate reliable real-time information on a patient's health, with minimal stress for that patient."

*Prof. dr. ir. Peter de With,
Theme Leader Smart Diagnosis*



"We want to cure people with smart solutions that are minimally invasive and last a lifetime."

*Prof. dr. Carlijn Bouten,
Theme Leader Smart Interventions*



Successful projects

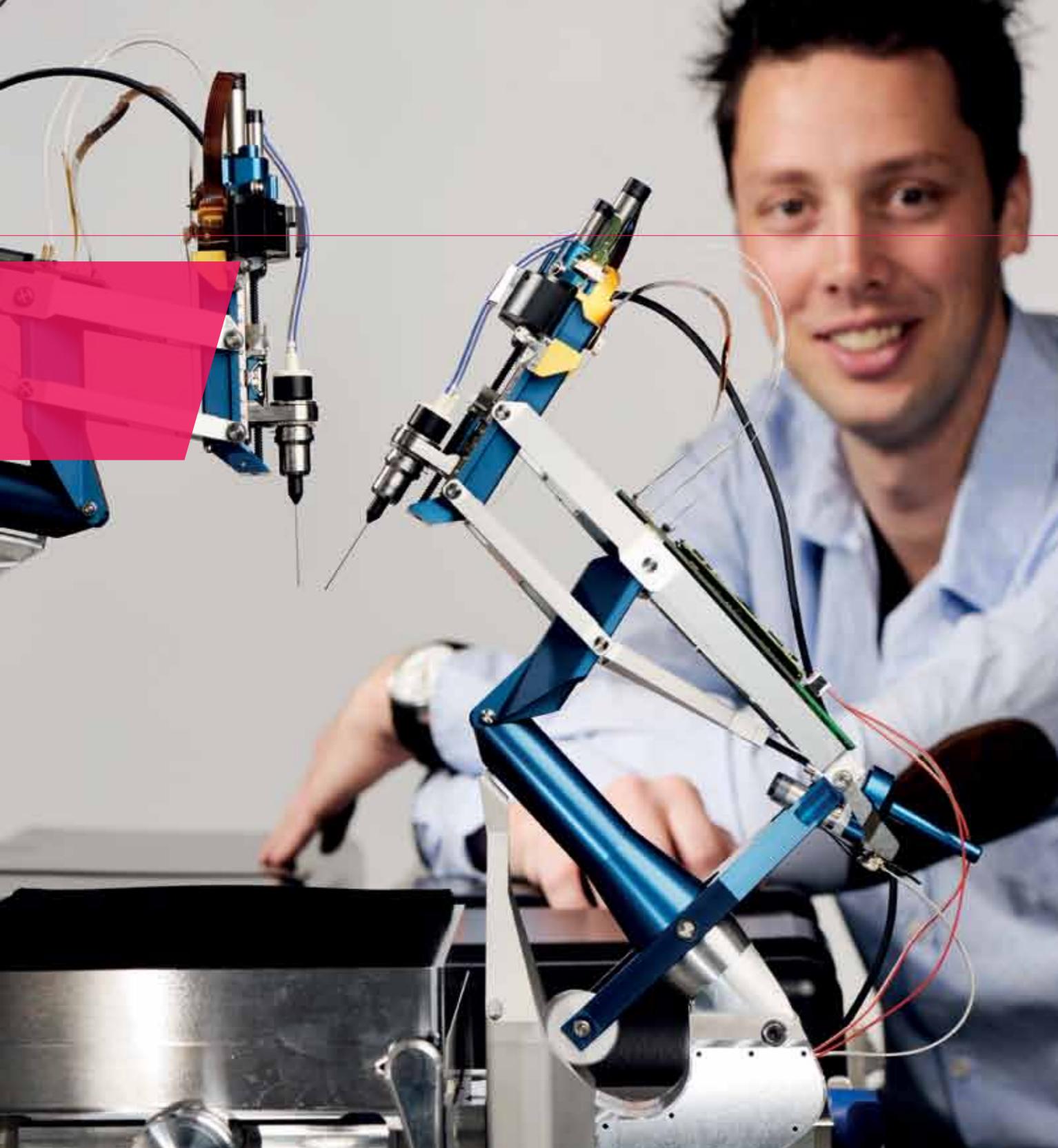
Smart Environment Cuddle chain

Parents of premature babies placed in incubators cannot comfort their children. They are unable to hold their babies, which is unfortunate, since often that is all it takes to reduce a baby's stress levels. TU/e has developed a way for parents to cuddle these babies remotely, using a so-called cuddle chain that is worn around the neck and connected to the incubator by Wi-Fi webcam. The webcam registers any restless movements or sounds the baby makes and passes this information on to the parents through a medallion attached to the cuddle chain. They can then comfort the child by holding the medallion, which causes the mattress to warm up and wrap itself around the baby like a cocoon. This simulates the feeling of a real cuddle.

Smart Environment Smart jacket

Babies in incubators have numerous skin sensors attached to their bodies to monitor heart rate, breathing, oxygen levels in the blood, and body temperature. The stickers used are uncomfortable, and the many wires attached also prevent parents from holding or cuddling their baby naturally. TU/e partnered with the Máxima Medical Centre (MMC) to develop a jumpsuit that can monitor a baby's vital statistics in an incubator without the need for attaching sensors or tubes to their delicate skin. The jumpsuit is fitted with miniscule wireless sensors. With this invention, babies can still receive all the right medical care, in complete comfort, and parents can be close to their babies without complications.





Smart Interventions

Eye operations with minimal incisions

Eye operations, such as retina repair surgery, require eye surgeons to work with the greatest precision. Since such meticulous work requires hands that do not tremble, most doctors can only perform these procedures up to a certain age. TU/e has developed a smart robot that can perform this kind of surgery and help eliminate this restriction. The robot allows eye surgeons to use two joysticks to operate a set of robotic arms fitted with miniscule operating instruments. The robot also provides the doctor with sensory feedback about any resistance experienced during surgery, by measuring it and passing the information on through the joystick. This feedback also contributes tremendously to the accuracy of such operations.

Smart Diagnosis

Locating tumors without the need for a biopsy

The present methods for detecting prostate cancer are inaccurate and unpleasant. Biopsies can be painful, and two thirds of them turn out to be unnecessary because the blood parameters measured beforehand are unreliable. What's more, one third of biopsies return false negatives, meaning that the patient ends up having prostate cancer, after all. As an attractive alternative, TU/e has developed a novel imaging technique using fluid-contrast ultrasound. This new technology allows physicians to readily recognize tumors, because blood vessels in tumors display a different structure than in healthy tissue. It also enables physicians to perform future biopsies more accurately, resulting in fewer unnecessary or incorrect interventions. The ultimate goal is to determine treatment without using any biopsies at all and decide solely on the basis of diagnostic imaging.

Smart Interventions

Blood in motion

More than half a million people in the Netherlands suffer from chronic renal failure and need to have their blood cleansed several times a week with hemodialysis. This involves hooking up one of the patient's veins to an artificial kidney outside the body. To ensure that the blood supply is sufficient, a permanent entrance to the vein is created by surgically connecting the patient's vein to an artery (arteriovenous fistula). Complications often arise because the site chosen for the fistula is not optimum: the vascular access cannot be used if the blood flow is insufficient. This means the patient will need an additional operation. Complications can also occur if the blood flow is too high, such as too little blood in the hand and too much pressure on the heart (heart failure). New models and tools developed by TU/e allow doctors to make patient-specific prognoses of what the blood flow will be after the operation. Doctors can then better determine the best location for the fistula, thereby preventing unnecessary suffering in patients.

Smart Environment

Managing the complexities of hospitals

The daily treatment in hospitals of vast numbers of patients suffering from different ailments requires an extremely complex system for storing and sharing information. Moreover, there is a huge diversity in business processes used by hospitals. Today's care facilities are also faced with the challenge of recording their, often unstructured, work routines in a structured manner, in an effort to increase efficacy and efficiency. This is why TU/e is developing new software tools for Business Process Management and Data and Process Mining. One newly developed process mining tool, ProM, is being used by hospitals to log their healthcare processes and by companies such as Philips Healthcare to help monitor their clients' medical devices.

Society's need for solutions in the field of healthcare continues to grow, which means there is also a growing demand for specialized health engineers. Our educational programs prepare students and young researchers for a scientific and technical career in the healthcare profession.

Education options in Health at TU/e



We teach students how to work in multidisciplinary teams, where they demonstrate enormous passion in finding technological solutions to the healthcare conundrum. The engineers we train are versatile practitioners who can apply their knowledge and skills in all areas of society.

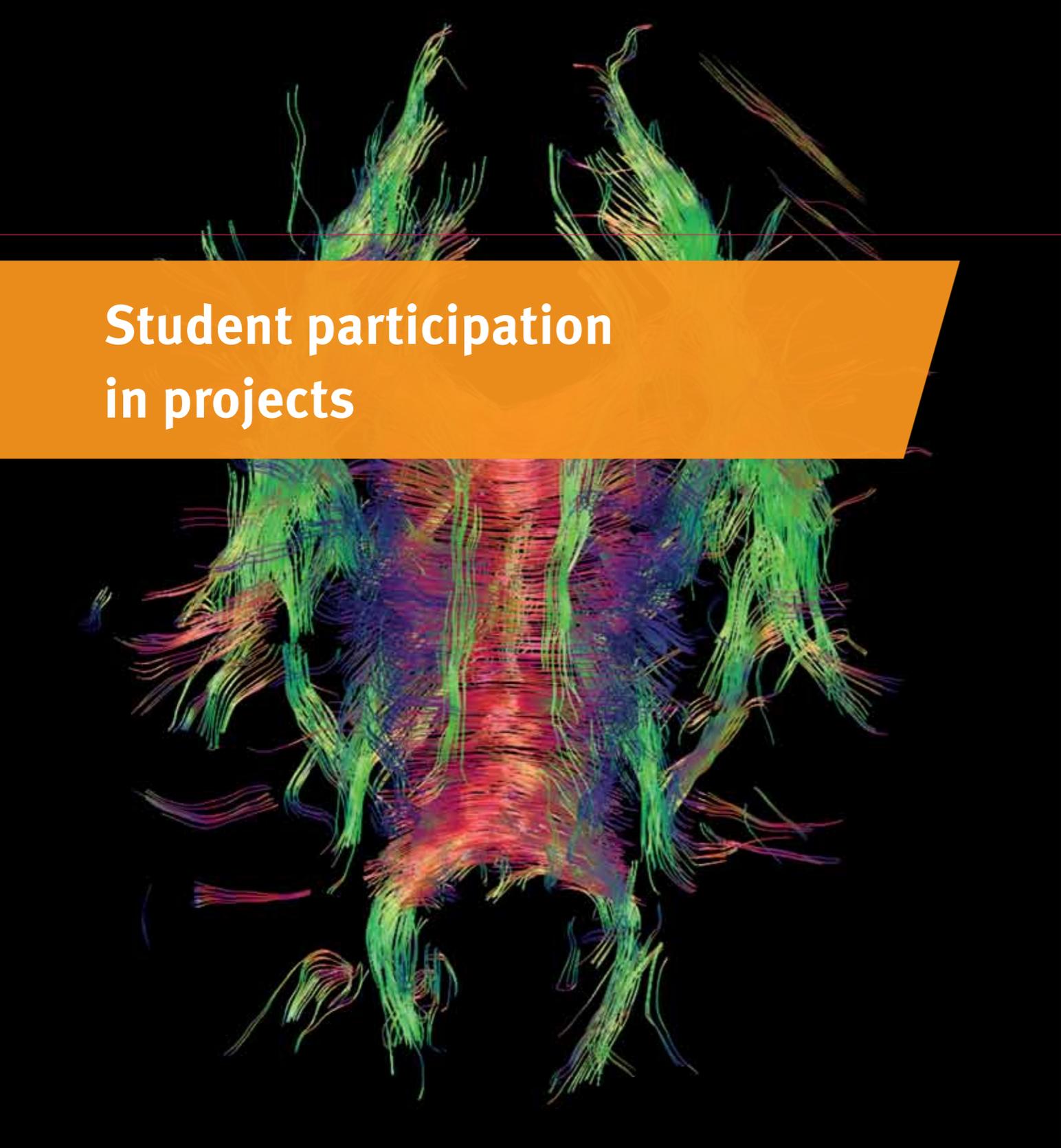
TU/e offers an interesting range of courses and programs within the domain of Health at its TU/e Bachelor College. Students at the Bachelor College can design their own curriculum based on their interests and ambitions. Students following an education in a specific discipline are also able to take various electives.

In the Health domain, TU/e offers three Bachelor programs, four Master programs/tracks, and three Designer programs. Approximately 25% of TU/e's students take part in Health-related subjects during their education. TU/e has been collaborating with Maastricht University and the Maastricht University Medical Centre for a number of years, as well. They are involved in our Bachelor programs in Biomedical Engineering and Medical Sciences and Technology, as well as the four Master programs. In 2011, TU/e also entered into a strategic alliance with Utrecht University and the University Medical Center Utrecht. The focus of this collaboration is on regenerative medicine and medical imaging.

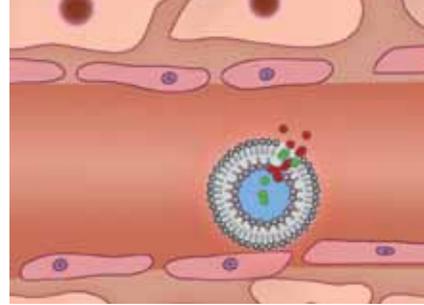
The course options for Health:

- *Bachelor in Biomedical Engineering*
- *Bachelor in Medical Sciences and Technology*
- *Bachelor in Psychology and Technology*
- *Master in Biomedical Engineering*
- *Master in Medical Engineering*
- *Master in Regenerative Medicine & Technology*
- *Master in Care and Cure for Electrical Engineering*
- *Designer Program in Health and Well Being*
- *Post-initial Training Program at the School of Medical Physics & Engineering Eindhoven (SMPE/e)*
- *PhD in Health*





Student participation in projects



Smart Diagnosis

Inside your brain without surgery

Operations on the brain are extremely high-risk and require great precision on the surgeon's part. Students at TU/e have developed an imaging tool that will allow doctors to determine the routes of the brain's neural pathways using MRIs and CT scans. This is of vital importance, for instance, when it comes to accurately positioning stimulation electrodes in the brains of patients with Parkinson's disease to prevent periodic tremors. Students have also developed mathematical algorithms to help reconstruct the neural pathways in the brain using MRIs. These algorithms can be applied during epilepsy surgery.

Graduate student Chantal Tax: "I think this research is extremely interesting, since it covers the common ground between engineering and healthcare. One day I'll be talking to a mathematician about the complicated reconstruction of neural pathways, and the next I'll attend a patient's scan or I'll be discussing the results of a scan with a radiologist."

Smart Interventions

Chemo, only where you need it

Treating cancer with chemotherapy can be tough on the patient, because the chemotherapy drugs (cytostatics) can destroy healthy cells throughout the body, as well. To prevent this from happening, students at TU/e collaborated with researchers at Philips Research to help develop a new technology: localized chemotherapy near the site of the tumor. The medicine is transported to the tumor site using temperature-sensitive molecular fat globules. Doctors can use an MRI scanner to see whether or not the medication has reached the right area. When it has, they warm up that area with an ultrasonic beam and the globules release their medication there, leaving the rest of the body alone. This produces fewer side effects and has less of an impact on the patient's energy levels.





Spin-off: QTIS/e

New businesses are frequently born at TU/e. QTIS/e is one of the latest TU/e spin-offs which develops heart valves using human body tissue. One great advantage of these heart valves is that they do not cause rejection symptoms in the body, which means the patient does not need to take additional medication. Furthermore, the heart valves have the ability to grow with the body, which has great advantages for children, in particular, who no longer need repeated operations to replace the implanted valves as they age. QTIS/e continues to translate the results of its research into specific clinical applications.



Making healthcare more efficient, so that it contributes to a better quality of life, requires new products and services. That is why TU/e is developing new technologies to make care more patient-oriented. TU/e collaborates with a wide variety of industrial and medical partners to help achieve this goal.

Health innovations and valorization

TU/e is firmly embedded in a number of regional networks within the Brainport region. For example, we helped develop the Brainport Health Innovation program together with the healthcare sector, knowledge institutes, the business community, and government agencies. This program focuses on e-files, telehealth, new learning, and electronic communication diagnoses. In another network we are involved in, the *Netwerk Slimmer Leven 2020*, assisted living and wellbeing are the central topics, and education, research, and valorization all play an important role in achieving our goal. The validated solutions we devise are tested in the real world.

On another front, TU/e also collaborates with small and mid-sized businesses in the Brainport region to help start up new activities in the field of remote diagnostics and remote care using so-called living labs.

On a national level, TU/e has joined forces with Utrecht University and the University Medical Center Utrecht to help set up the joint research facility Institute for Diagnostic and Interventional Imaging (IDII).

Furthermore, TU/e actively participates in the nine Dutch top sectors, three of which are related to the field of health: Life Sciences & Health, High-Tech Systems and Materials and Creative Industries. TU/e actively participates in molding these sectors.

On an international level, TU/e is active in research programs and projects organized by the European Framework Program for Research. TU/e participates in the European EIT KIC ICT Health & Wellbeing program and is currently helping to prepare a new EIT KIC Health Technology program.