

Strategy for 2020-2025

1 Introduction

The sector plan entitled 'Strength in Innovation (Slagkracht in Innovatie) 2004-2010' marked the start of the 3TU.Federation, but since then the playing field has changed considerably. Technical degree programmes are more popular than ever, and universities of technology are struggling to cope with the increased intake due to underfunding at a time when the labour market is crying out for engineers. At the same time, we are facing a multitude of societal challenges, from climate change, the energy transition and (urban) construction to mobility, digitisation and health. Universities of technology are tasked not only with training a sufficient number of engineers, but also with designing the degree programmes in such a way that our graduates are capable of working in multidisciplinary teams. Engineers are also expected to develop entrepreneurial skills and to carry out their work in an ethically and socially responsible manner.

Technological innovations are increasingly taking place against the backdrop of societal transitions, as outlined in the advisory report of the Advisory Council for Science, Technology and Innovation (AWTI) 'Strengthening the role of science, technology and innovation in societal transitions'. The importance of these developments is now widely acknowledged by the universities of technology. For instance, the expansion of the Federation to include Wageningen University has stimulated closer interdisciplinary co-operation by connecting technical disciplines with applications in the agrifood sector. The relationship between engineering sciences and medicine is another example where interdisciplinary co-operation has gained momentum. Society increasingly needs T-shaped professionals, who are able to combine sound knowledge of and skills specific to their field with the ability to collaborate with other disciplines in order to effect social transitions. The co-operation of universities of technology as part of the 4TU community primarily focuses on strengthening disciplinary foundations, while regional coalitions, such as the Leiden-Delft-Erasmus strategic alliance and the Eindhoven-Wageningen-Utrecht knowledge coalition, mainly focus on interdisciplinary co-operation. The 4TU programme 'High Tech for a Sustainable Future' represents yet another springboard for combining the strengthening of technical disciplines with the need for interdisciplinary co-operation to tackle societal challenges. In the years to come, this programme will facilitate the creation of additional opportunities for other parties to participate, in which we explicitly want to explore opportunities for co-operation with the social sciences and humanities.

Interest in technology has soared since the Federation was founded. To be able to accommodate the intake of students and the demand on the labour market for technical graduates, teaching capacity is being expanded year on year. In response to the report published by the Advisory Committee on Higher Education and Research, the government has earmarked funding for the expansion of teaching capacity in the science and technology sectors. Building upon the Sector Plan for Science and Technology Education, the universities of technology, in co-operation with the science faculties of the general universities, technical universities of applied sciences, student organisations and the business community, will introduce measures to achieve this. We are therefore also seeing greater co-operation emerging in the field of education. The Bachelor's degree programme

in Mechanical Engineering in Amsterdam and the associated collaboration between the VU University Amsterdam and the University of Twente is a noticeable example of this.

And so it is on this new playing field that 4TU is taking initiatives and joining forces in order to respond to these societal challenges. The universities of technology ensure that sufficient high-quality technological research can take place and that there are plenty of well-trained engineers in the Netherlands. Through its collaborations in the areas of education, research and knowledge valorisation, 4TU is a discussion partner at national and European level for governments, politicians and stakeholder organisations and represents the four universities of technology in discussions with these parties. Wherever possible, 4TU also collaborates with other Dutch and European universities.

In the short term, the structural impulse given to science and technology during this government's term provides opportunities to consolidate this sector; for the long term, it is vital that this momentum continues. The government's economic development forecast is a good starting point for this. The COVID-19 crisis, which has dominated 2020, has highlighted just how important it is for a country to have a healthy economic foundation. The further development of the Dutch high-tech manufacturing industry, which has access to sufficient technical personnel, is a key factor in this. For this reason, it is essential that the investments announced in the economic development forecast are not delayed.

4TU's strategy is consistent with the Strategic Agenda for Higher Education and Research and therefore contributes to achieving those ambitions by (i) strengthening co-operation between universities of technology, (ii) establishing relationships with other disciplines within science and technology, medicine and the social sciences and humanities (SSH) and with social partners and the business community, (iii) ensuring broad accessibility and giving students the opportunity to get the most out of themselves (Sector Plan for Science and Technology Education), (iv) training our students to become T-shaped professionals who are able to combine knowledge of and skills required in their field with the ability to apply that knowledge and those skills in a changing social context, and making our degree programmes available to a more diverse public by improving the range of digital education programmes on offer (Centre for Engineering Education and Sector Plan for Science and Technology Education), (v) ensuring that our education and research responds to the needs of society and the labour market (HTSF programme, 4TU Research Centres, 4TU.Impact, Sector Plan for Science and Technology Education) and (vi) strengthening co-operation in Europe in order to compete with the best in the world (HTSF programme, Centre for Engineering Education, 4TU.Impact and the coalition with TU9 (Germany), TU Austria and Nordic Five Tech (Scandinavia)).

A study was carried out in 2019 to gain insight into how the 4TU.Federation can contribute as effectively as possible to the above-mentioned developments. The outcomes partly underpin the approach for the 2020-2025 period:

- Further consolidate the technology domain in co-operation with external parties
- Contribute to accelerating transitions in Europe
- Visibly contribute to the availability and use of technological developments that have an impact on society
- Join forces to create an impact through mutual co-operation

These goals will be discussed in more detail in Chapter 3. Here we will also discuss how 4TU's new and existing activities can contribute to achieving these goals effectively.

2 Mission and vision

4TU has a **social impact** in the Netherlands **by visibly** strengthening, combining and making maximum use of knowledge and creativity in the technology sector. This requires sufficient high-quality technological research and plenty of well-trained engineers.

4TU takes initiatives and pools its resources in order to respond to these societal challenges based on its core values: *connection*, *representation* and *innovation* in education, research and valorisation.

Connection

4TU is the partnership of the four universities of technology in the Netherlands. At the 4TU.Centre for Engineering Education they work closely on (research into) educational innovation. The 20 post-Master's degree programmes are offered through the Stan Ackermans Institute. The research activities are organised around themes at 4TU.Research Centres and the HTSF programme seeks to establish connections with socially relevant issues. As part of the new Sector Plan for Science and Technology Education, 4TU is playing a leading role in strengthening ties with the science faculties of the general universities and the technical universities of applied sciences.

Representation

By connecting and working together to strengthen research and education, the 4TU.Federation is a discussion partner for (European) governments, research institutes and social and political organisations. In this role, 4TU coordinates with other actors in the technology domain, including NWO Applied and Engineering Sciences (NWO-TTW) and TO2.

Innovation

Co-operation between the four universities of technology stimulates innovation in research and education. Furthermore, the Centre for Research Data stimulates policy and develops methods for open access data. As a result, the universities are at the forefront of the development of new technology. As part of the High Tech for a Sustainable Future research programme, the four universities of technology connect and improve their teaching and research. Co-operation with other scientific disciplines will be intensified on the basis of the added value of technology in the context of these disciplines. This will enable scientific disciplines to complement each other in an interdisciplinary context.

4TU has formulated a number of ambitions for the years ahead, which will be used to develop the mission.

By 2025...

- ... 4TU will represent the **technology domain** in the Netherlands and be a visible discussion partner for politicians, government bodies and umbrella organisations in the business community regarding technology
- ... 4TU.Federation will cooperate intensively with **external parties**
- ...4TU will effectively influence **Dutch and European** innovation and education policy
- ...4TU will make an essential and **visible contribution** to tackling social challenges in the Netherlands

3.1 Strengthening the field of technology through external co-operation

The four universities of technology play a crucial role in developing technological solutions to societal problems in areas such as the climate, energy transition, (urban) construction, mobility, digitalisation and health. But, of course, we cannot do this on our own. By collaborating with other disciplines and other sectors, we can maximise the impact of our activities on society, and it is precisely for this reason that establishing connections and working together are key concepts in the new 4TU strategy. The Ministry of Education, Culture and Science's Strategic Agenda for Higher Education and Research, published in December 2019, also places a particular emphasis on co-operation, attributing a prominent role to the sector plans. Collaboration between universities of technology through the 4TU.Federation promotes the joining of forces within the field of technology as well as the strengthening of technical disciplines. The creation of social transitions necessitates both the strengthening of technical disciplines and interdisciplinary co-operation with scientific domains. The Leiden-Delft-Erasmus strategic alliance and the Eindhoven-Wageningen-Utrecht knowledge coalition focus specifically on interdisciplinary collaboration. As a representative of the universities of technology, 4TU is a key discussion partner when it comes to making choices for the future.

Consultation between 4TU and the various partners takes place at different levels of the organisation. 4TU's board members work alongside other partners, both within and outside the field of technology, to put important issues and developments on the agenda and to release resources for them. Board representatives are natural discussion partners of ministries and politicians. The deans of science and technology faculties hold their own consultations, the outcomes of which are then translated into education and research. Strategies are drawn up in collaboration with the board for concrete investment plans for education and research. In this regard, efforts are combined as much as possible through coalitions with organisations such as the Association of Universities in the Netherlands (VSNU), the Royal Netherlands Academy of Arts and Sciences (KNAW), the Dutch Research Council (NWO), the Confederation of Netherlands Industry and Employers (VNO-NCW) and TO2. When forming coalitions (broad with a large critical mass or narrower but with a specific focus), considerations are made as to which coalition will be most effective in achieving results, both in the short and long term. Examples of such a bundling of forces include the initiative launched by technology deans, the Sector Plan committee, NWO-TTW and 4TU to create an [Agenda for Engineering Sciences in the Netherlands](#) and the coalition of the willing (NWO-TTW, 4TU, TNO, EZK and TechLeap) in the field of valorisation.

The foundation of an Academy of Engineering by KNAW will reinforce the position of the engineering sciences. The Academy of Engineering will bridge the gap between fundamental sciences and the above-mentioned challenges and transitions experienced by Dutch society. In order to solve these societal challenges, the intake capacity for engineering programmes must be substantially increased and there must be greater investment in the scientific infrastructure for technological research. The signing of a technology agreement in the next government term will help to give these developments a structural embedding.

3.1.1 Academy of Engineering

Over the past few months, intensive discussions have taken place with the KNAW regarding the establishment of an Academy of Engineering, as a division of the KNAW. The duties of

this new Academy of Engineering constitute an amalgamation of the tasks currently carried out by the KNAW and ActI, with a particular focus on engineering sciences. Three sub-areas have been identified: (i) fundamental engineering sciences, (ii) engineering technology, (iii) engineering design. The foundation of an Academy of Engineering sends a very clear signal that engineering sciences occupy a significant position in the Netherlands and that they in turn establish connections between science, government and society. In the coming years, the 4TU.Federation and the Academy of Engineering will work together to develop a relationship; it is our intention to use this relationship not only to strengthen the field of technology in the Netherlands, but also to help develop the connections between technology and other scientific fields.

3.1.2 Greater capacity, more engineers

In the field of science and technology, there is a substantial imbalance between demand on the labour market and intake capacity. The four universities of technology are working together to make engineering degree programmes more attractive to students, to increase the national **intake capacity for these programmes** and, by extension, to reduce the number of programmes subjected to a numerus fixus. Following the recommendations of the Van Rijn Committee, the Ministry of Education, Culture and Science asked 4TU to draft a Sector Plan for Science and Technology Education in collaboration with the science faculties of the general universities, universities of applied sciences, student organisations and the business community. This plan focuses on seven specific projects:

- Joint promotional/awareness campaign to raise **international awareness** of the opportunities for talented scientists in the Netherlands in the coming years.
- Joining forces to give scientists the opportunity to devote more time to teaching duties as well as offer them more **development opportunities and career prospects** in teaching, based on the position paper *Room for everyone's talent*.
- Working together to ensure that available teaching capacity is **distributed evenly throughout the country** and to come to agreements on increasing this capacity in the coming years.
- Working together to develop a **programme choice check** for degree programmes within the three disciplines. This programme choice check will also actively suggest relevant science and technology study programmes offered at universities of applied sciences.
- Jointly investigate, for example in mathematics, where teaching materials can be developed that can be used in all Bachelor's degree programmes and bridging education. Besides being efficient, **joint teaching materials** also facilitate mobility between higher education institutions. This project encompasses both classroom-based and digital educational resources.
- Jointly develop **life-long development** programmes geared towards continued education and preventing the departure (drain) of professionals in the business community and public institutions. Here it goes without saying that a regional approach for each discipline, in co-operation with the higher professional education sector, should be adopted.
- Joint campaign to raise the profile of **electrical engineering**, with a particular focus on female students.

4TU will work closely with general universities, universities of applied sciences, student organisations and the business community to develop and implement these plans. This will provide a boost to the science and technology sector and will allow the four universities of technology to continue to produce more high-quality engineers for the labour market. More intensive co-operation in the science and technology sector will also facilitate agreements

on how we want to prepare students for their future career, in which working in multidisciplinary teams, demonstrating entrepreneurial flair and taking account of ethical and social responsibilities will be the norm.

3.1.3 Investing in scientific infrastructure

Large-scale facilities play a crucial role when answering social questions relating to health, the environment, climate and safety. They also attract young talented scientists and are instrumental in bringing together scientists, research funders, politicians and industry. The Paul Scherrer Institute in Switzerland is a good example of how a state-of-the-art research facility can be created by pooling resources. Proposals for large-scale national facilities for technological research will be developed in conjunction with the technology deans' forum, drawing inspiration from the Paul Scherrer Institute.

In 2019, the Ministry of Finance announced its plan for an investment fund of several tens of billions of euros, to be used for ‘...investments in knowledge development, R&D and infrastructure’. Once the details had been finalised, the government then announced the creation of a National Growth Fund¹ on 7 September. For the 2021-2026 period, €20 billion will be earmarked for projects in the fields of knowledge development, education, research and innovation and infrastructure. The purpose of the Growth Fund is to safeguard long-term prosperity, for which the economy will have to grow faster and in a different way. A national committee will assess project applications

Germany

A ‘Roadmap for Research Infrastructures’ was also recently published in Germany. This roadmap outlines three new research infrastructures: for high-resolution electron microscopy at the Jülich Research Centre, for the ACTRIS ESFRI project and for photonic methods for research into, and treatment of, infectious diseases. The costs amount to more than €50 million per project and will be prioritised in national public funding during the design and implementation phases.

worth at least €30 million, after which the government will make a decision. The four universities of technology will collaborate with technology deans, NWO-TTW and VNO-NCW to develop concrete proposals for **investments in technical and scientific facilities**. Proposals are currently being considered within the framework of the economic development forecast on the following topics:

- Quantum technology
- Smart industry (future of work)
- Energy transition (electric, hydrogen, wind, CO₂ mitigation, energy saving)
- Artificial intelligence
- Nanotechnology
- Optics and photonics
- Advanced materials
- Medical technology
- Food transition
- Sustainable development of the Netherlands

In 2016 the KNAW drew up an agenda setting out 13 ‘dream projects’, ideas for (science) facilities that researchers would like to see up and running by 2025 or thereafter². Following the KNAW’s example, 4TU will draw up a shortlist of large-scale engineering dream projects in cooperation with external partners. Throughout the strategic period, selected projects will be submitted as proposals for funding from the Growth Fund.

¹ <https://www.rijksoverheid.nl/onderwerpen/nationaal-groefonds>

² <https://www.knaw.nl/nl/adviezen/knaw-agenda-grootschalige-onderzoeksfaciliteiten-13-geselecteerde-faciliteiten>

As a result of the COVID-19 crisis, it is to be expected that the government will prioritise relief funds to help those sectors that are currently most affected by the crisis. This is a sensible measure for the short term. However, it is still prudent to continue investing for the long term. The big question will be how the government will manage the transition from the COVID-19 crisis to the 'new normal'. Technological innovations are indispensable in this transition to a resilient, sustainable and safe future. In 2020, a Techrede speech will be organised for the first time, conveying this key message. Our intention is to organise this event on an annual basis, with our partners in the field of technology participating as much as possible.

3.1.4 Technology Agreement

In the previous period, 4TU argued that the Netherlands should enshrine its ambition to be among the **global leaders in technology** in a Technology Agreement. There was precedent for this with the Energy Agreement, in which the commitment to sustainability was recorded. To be a leading authority in Europe, it is imperative that the public sector invest much more in technological education and research. In the agreement, the government, employers, employees and knowledge institutions should formalise an **investment agenda** that spans several government terms. Even in times of economic slowdown, a substantial increase in spending on technology and innovation will be required. These efforts will also have a knock-on effect in terms of business investment. As part of the Broad Social Review, the Ministry of Finance presented policy choices for the future on 16 social themes and the cross-cutting theme of digitisation. The Innovative Society report³ contains a datasheet that advocates a strengthening of targeted policy for societal challenges. This datasheet (fiche 2) presents specific ingredients for the technology agreement previously advocated by 4TU. In addition to increasing the budget for departmental knowledge and innovation programmes, this datasheet also links the strengthening to other proposals in the report and outlines prospects for intensifying the themes of the mission-driven top sectors and innovation policy:

- Climate and energy
- Circular economy
- Agriculture, water and food
- Safety
- Health and care

The 4TU.Federation will actively engage with the umbrella organisations VNO-NCW/SME and FME to promote the strengthening of targeted policy for societal challenges through such an agreement in The Hague. The desire to conclude this agreement will be discussed with the various political parties and civil society organisations during the next strategic period. Within 4TU, 4TU.IMPACT will be responsible for implementing this process, steered by the four TU rectors.

³ <https://www.rijksoverheid.nl/binaries/rijksoverheid/documenten/rapporten/2020/04/20/bmh-9-innovatieve-samenleving/bmh-9-innovatieve-samenleving.pdf>

3.2 Accelerating transitions in Europe

The European Union is a leading financier of research and innovation through major funding programmes. The universities of technology do well at acquiring funding from European programmes, because the European themes are closely linked to the social issues and economic impact that are high on the agenda at the universities of technology.

Horizon Europe will be launched after 2020 with a budget of €100 billion, linked to the UN's Sustainability Development Goals. The largest budget is reserved for the Challenges and Industrial Competitiveness pillar, covering the themes of Health, Inclusive and Secure Society, Digital and Industry, Climate, Energy and Mobility and Food and Natural Resources. The mission-driven commitment to co-operation between partners, with a focus on joint ambitions for the challenges, is in keeping with the working method of the universities of technology. In the coming period, we want to expand our influence in Europe by assuming a co-ordinating role on more European projects.

4TU wants to leverage its increased visibility in the Netherlands to **effectively influence European innovation and education policy** with a strong presence in Brussels. This will be easier to achieve as an alliance. Specifically, it means that the 4TU.Centre for Engineering Education and its strategic partners in Brussels are raising awareness of the importance of innovations in engineering education so that they are used more effectively in European degree programmes.

We also want to secure a good position for the 4TU.Research Centres and the HTSF programme, with the support of 4TU.Impact, to take on leading roles in European co-operation projects.

Finally, in conjunction with our international partners in Germany, Austria and Scandinavia, we intend to use our influence to translate Europe's Green Deal ambitions into mission-driven research and innovation programmes.

3.2.1 CEE leading the way

The 4TU.Centre for Engineering Education (CEE) is leading the way in the field of engineering education through research and the application of *evidence-based innovations*. The CEE's contributions are also appreciated within the broader partnership of universities, the VSNU. A good example of this is the framework for the recognition of excellent lecturers⁴ which has been adopted by the VSNU and is currently being translated into a toolkit, which will be soon be available for all members to use. On an international level, the CEE is a leading member of international networks of engineering education such as SEFI (Europe) and CDIO (worldwide). In the next strategic period, the CEE will capitalise on its international influence by leading a **European project**, for example.

3.2.2 Exploring European opportunities

In the previously mentioned Technology Agreement, which 4TU and the business community will promote in The Hague, the Netherlands will enshrine its ambition to be among the global leaders in technology (3.1.3). Accordingly, joint efforts will also be made to push for a **more prominent role for innovation and research** in EU policies. The Knowledge Coalition recently drew attention to this in an open letter to the Dutch government.⁵ Not only will these investments create economic growth and jobs, they will also help us to keep up with developments in the US and China. To safeguard the EU's

⁴ <https://www.4tu.nl/cee/en/publications/roadmap-for-change-web-version.pdf>

⁵ <https://www.vno-ncw.nl/nieuws/eu-budget-moet-komende-jaren-vol-inzetten-op-innovatie>

strategic autonomy in the world, therefore, the EU needs to be more independent and innovative in terms of technology.

The scope of European programmes such as Horizon 2020, EIT and individual research grants is growing relative to that of national research programmes, and they are helping to shape national research policies. Applying for European grants is time-consuming and the likelihood of success is very limited. If, as universities of technology, we want to have a leading role within Europe, we will need to take on the role of coordinator more often.

During the rectors' visits to the respective research centres and during the mid-term review of the HTSF programme, both of which will take place in 2020, opportunities for increasing our own impact in Europe will be explored. Discussions on this issue will shape the further implementation of the strategy, with 4TU.IMPACT playing a facilitating role. The design discipline is currently laying the foundations for an EIT Innovation Community and the possibility of joint participation through the 4TU.Federation (also as a legal entity) is also being explored.

3.2.3 Green Deal

The ambitions of the European Green Deal⁶ were presented by European Commissioner Frans Timmermans, the most important of which being the commitment to make the EU climate neutral by 2050. To achieve this, Europe is moving towards legislation that decarbonises the energy sector, reduces the energy consumption of buildings, makes industry greener and reduces transport emissions. European legislation will go hand in hand with major investment in technological innovations and fundamental research. If these investments are to have an impact on Europe's citizens, co-operation with the other scientific disciplines is essential. The 4TU.Federation has good relationships with other European associations of technical universities, such as TU9 (Germany), TU Austria (Austria) and alliances in Scandinavia, which have the potential – through representatives of Member States, amongst others – to exert influence that leads to the adoption of effective transition programmes that are grounded in research and innovation, thus contributing to Europe's ambition to become a world leader in clean products and technologies.

⁶ [https://ec.europa.eu/commission/presscorner/api/files/attachment/859164/What is the European Green Deal nl.pdf](https://ec.europa.eu/commission/presscorner/api/files/attachment/859164/What%20is%20the%20European%20Green%20Deal%20nl.pdf)

3.3 Making technological developments available

4TU highlights the value of technology and technological research, both within and outside our own institutions. In doing so, not only do we create an impact, but we also generate public support for technological transitions. To raise awareness of 4TU's activities, we will actively **communicate** our message to both internal and external stakeholders. This message conveys a sense of wonder as to the significance of these transitions and emphasises the importance of working together to achieve them. Interdisciplinary co-operation helps to identify and address concerns about the changes associated with transitions.

The communication strategy will also utilise bottom-up initiatives, including the idea of launching a joint platform with the four university magazines giving short, informative videos on recent research projects carried out at each of the four universities, under the banner **4TU TV**. The concept is already being used by TU Delft and we will be exploring opportunities for close co-operation.

The communication material will also be used to promote the Netherlands as an attractive place for **talented international scientists**. To this end, it is important to establish a clear profile, which may vary from one institution to another. These profiles should also complement and reinforce each other. By adopting a clear position, scientists will be invited to provide an objective and independent voice in the public debate.

A strong position will help us to benefit from the innovation fund, as announced by the government, as part of **transformative coalitions**. Our efforts here will focus on education, research *and* entrepreneurship.

3.3.1 Attractive to talented scientists

In order to develop new technologies and to train engineers to bring these technologies to the market, universities of technology in the Netherlands will need to attract several hundred senior academic staff members over the next few years. This is far too many to recruit in the Netherlands alone. In 2020, 4TU will launch an **international awareness** campaign among talented scientists to promote the fact that top jobs in science and technology are here for the taking. The aim is to increase the quality of the candidate pool. In addition to Europe and the Anglo-Saxon countries, we will also explicitly explore the possibilities of attracting talent from Asia to the Netherlands on a long-term basis.

In terms of diversity, the technology sector still has a lot of work to do. In recent years, partly due to the opportunities afforded by the research sector plans, a great deal of attention has been paid to **gender diversity**. We have plenty of catching up to do, and we want to accelerate this process. To this end, 4TU is committed to achieving gender diversity within its programmes. A good example of this is the HTSF programme, which was launched in 2018; here, the board paid specific attention to the ratio of men and women when appointing academic staff. Joint measures will also be taken to address those degree programmes which have a markedly different gender balance compared to similar programmes in other countries. We will also start work on drafting a joint policy to increase accessibility for students and staff from different cultural backgrounds in order to better reflect our society.

Getting to Gender Parity in a Top-Tier Mechanical Engineering Department: A Case Study (MIT)⁷

Thematic analysis of interviews reveals that the gender equality so far achieved by the department has been a result of very deliberate, enduring structural changes, (e.g., hiring processes), and a strong representation of proactive department members with high levels of self-efficacy. These members are aware of gender equity issues, believe in their ability to enact change, and are willing to devote the time and energy to do so. Different but complementary actions, from changing the way the admissions office recruits applicants to broadening the faculty hiring searches, have compounded over

time to help produce the current state of near parity in the undergraduate population.

Thirteen point two percent of mechanical engineering bachelor's degrees were awarded to women in the 2014-2015 year, making it one of the most gender-imbalanced engineering disciplines in the U.S. This is not the case, however, at MIT. In the fall of 2016, women composed 49.5% of mechanical engineering majors, an unheard-of percentage among peer schools and large engineering programs. This figure, moreover, surpasses even MIT's current overall undergraduate ratio of 46.1% female.

Textbox: MIT's efforts paid off.

3.3.2 Independent voice

In order to strengthen our profile in the next strategic period as the **independent voice** in the political debate on social issues, our scientific figureheads, rectors and centres active in these fields will regularly respond to these issues by drawing on their expertise. In 2020, the rectors will visit the centres, and opportunities will be explored during these discussions. The centres will be called upon to make their voices heard in society and will receive a communication budget for this purpose. The new 4TU communications advisor will work alongside the centres and the sub-programmes within HTSF to draw up a **communication agenda** so that their activities can generate more impact, both individually and as a whole.

3.3.3 Profiling

The importance accorded to technology in society is encouraging more and more players to offer technical degree programmes. If an increasing number of organisations do this without consulting each other, the resources available for this purpose will become fragmented and critical mass per university will decrease. As a result, the quality of both research and the degree programmes will decrease across the board.

In its report 'Shaking up the System'⁸, the Advisory Council states that the Dutch higher education system is insufficiently prepared for the future. Universities and universities of applied sciences need to strengthen their profiles and cooperate more closely, and the government needs to assume greater control.

The four universities of technology work together to coordinate the strategic division of tasks, specialisations and the concentration of supply. It is encouraging to see that the science and technology deans have agreed to develop a national capacity plan for STEM degree programmes. This agreement has been laid down in the Sector Plan for Science and Technology Education. A national capacity plan will help to secure broad support when appealing to the government for targeted investments in STEM degree programmes.

⁷ <https://peer.asee.org/getting-to-gender-parity-in-a-top-tier-mechanical-engineering-department-a-case-study>

⁸ <https://english.awti.nl/publications/documents/publications/2019/06/12/advice-shaking-up-the-system---towards-a-future-proof-higher-education-and-research-system>

Het stelsel op scherp gezet. Naar toekomstbestendig hoger onderwijs en onderzoek

Het stelsel voor hoger onderwijs en onderzoek presteert weliswaar goed in vergelijking met andere landen, maar het is onvoldoende voorbereid op de toekomst. Universiteiten en hogescholen moeten zich meer laten leiden door de maatschappelijke vraag.

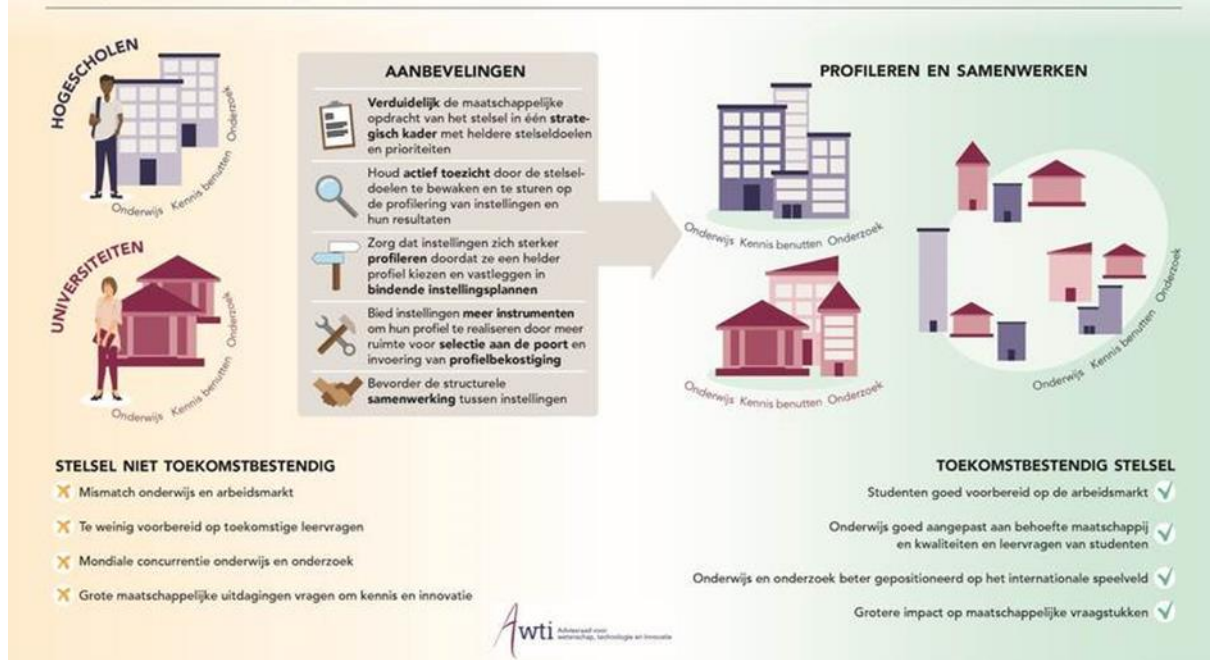


Figure: Summary of the AWTI's recommendations (only available in Dutch)

3.3.4 Transformative coalitions

In February, the AWTI published an advisory report on the role of science, technology and innovation (STI) in societal transitions⁹. The council believes that more could be done to make better use of STI. To stimulate this, the government will need to present an overall vision of the Netherlands of the future as well as a corresponding radical approach to the transitions. To this end, the council recommends, among other things, the development of a network of interconnected transformative coalitions. In this network, various new and unexpected parties will work together and learn from each other. The report recommends looking for parties who are capable of coming up with original solutions, such as artists, academics and innovative entrepreneurs.

4TU scientists involved in the HTSF programme, for example, would be particularly suited to this role. For this reason, 4TU wants to participate in one or more of these coalitions once they have been set up by the government.

⁹ <https://english.awti.nl/documents/publications/2020/03/11/advice-strengthen-the-role-of-science-technology-and-innovation-in-societal-transitions>

3.4 Creating an impact through mutual co-operation

Scientists are quick to act when money is being distributed. As soon as proposals can be submitted for the distribution of funds in a 4TU context, the Federation suddenly becomes very visible. However, most of those people are left disappointed and return to their day-to-day work at their own institution. Therefore, in order to create more continuity, we want to reach the academic community at the four universities of technology in a different way. Current education, research and valorisation programmes will be continued and, where possible, strengthened. To complement this, we will also capitalise on the added value that joining forces can generate, both in terms of science and support.

It has come to our attention that it is not always a matter of course for some of the staff at the technical universities to seek out and contact colleagues at the other institutions. For this reason, we intend to highlight examples of (bottom-up) initiatives for co-operation. The Federation can take action to increase the visibility of existing partnerships for staff members and, by extension, stimulate new initiatives. Appointing staff at several universities of technology, for example within the HTSF programme, can bolster mutual co-operation. Our chosen approach is outlined below.

4TU will use storytelling in its **communication** to help visualise the substantive co-operation within the Federation. We will profile two scientists at each of the universities who, based on their experience, are able to articulate what the co-operation within 4TU means to them and what impact it has on their work. What have they achieved that would not have been impossible without 4TU? The profiles can then be adapted into content for the four institutions' various communication channels and can be used in a variety of ways, from quotations to short texts or in-depth interviews.

3.4.1 4TU.Graduate School

In recent years, a great deal of attention has been paid to the third cycle in higher education. At universities, this third cycle typically comprises doctoral programmes. At universities of technology, the **programme to become a technical designer (PDEng)** also constitutes part of this third cycle.

The Graduate Schools of the universities of technology have been engaged in informal discussions for a number of years, which focus on coordinating the educational part of the doctoral programmes and the PDEng programme. The 4TU.Federation wants to formalise these discussions in the next strategic period, and the 4TU.Graduate School will be charged with ensuring critical mass by bundling programme activities in the third cycle wherever necessary. This is particularly relevant for disciplines in which there are no (or no longer any) active research schools.

The PDEng constitutes a unique link between the academic and professional worlds. Wageningen University is also currently in the process of developing plans to launch PDEng programmes. At the moment, the Stan Ackermans Institute coordinates the activities of PDEng programmes. In the next period, the 4TU.Graduate School will be responsible for these tasks. Since universities of applied sciences are also going to start offering programmes in the third cycle, it is imperative that future students and the business community are properly informed about the positioning of the PDEng programme in relation to the third cycle at universities of applied science.

3.4.2 High Tech for a Sustainable Future

Through the High Tech for a Sustainable Future talent programme, which has resulted in the appointment of around 45 Tenure Track candidates, 4TU is investing in research for the long term. There was a deliberate choice to focus on themes related to the UN's Sustainable Development Goals, the National Science Agenda and the social transitions that will take place in the coming period.

The activities and results of the HTSF programme contribute to the external profile of the universities of technology, partly through the efforts of 4TU.Impact. These five programmes are also intended to act as an internal magnet, bringing together scientists from different disciplines so that they can contribute to the programme in question. Opportunities for this primarily lie in the appointment of the new academic staff that the four universities of technology will be recruiting in the coming years as part of the sector plans for education and research.

Following the mid-term review which was conducted in 2020, it was concluded that most of the programmes promote intensive interdisciplinary co-operation. The appointment of 'groups' of Tenure Track candidates therefore seems to be an effective way to stimulate mutual co-operation. The current HTSF will come to an end in 2022. 4TU.Research will develop plans for a successor to the programme no later than the summer of 2021, drawing on those elements that have contributed to its success. The expectation is that new themes will be selected for this.

3.4.3 Research Centres

In the period 2018-2021, the 4TU.Research Centres were set the task of intensifying mutual co-operation and improving cohesion, and subsequently of exploring possibilities for generating an external impact. Funding for the current 4TU.Research Centres will continue until 2021. Decisions on the continuation, modification or phasing out of the Research Centres will be taken on the basis of an impact assessment. One of the most important criteria for continuation in the coming period will be the way in which the Research Centres look to the outside world and **actually have an impact**.

Impact through collaboration

We expect that those activities that are already having a visible impact and have the potential to continue to do so will be continued or replicated. We also anticipate that the collaboration at the Building and Technology Innovation Centre with the Netherlands Organisation for Applied Scientific Research (TNO), the Netherlands Association of Universities of Applied Sciences (VH), three ministries and three building federations, which is dedicated to agenda-setting programmes for **construction research**, will also be continued. Joint initiatives for the **Gravitation Programme are examples** of how opportunities are being created to take on the role of initiator in particular scientific fields. 4TU partnerships also have the potential to play a significant role in raising awareness of the **HTSF programme** among the academic community, government, the business community and civil society organisations. Collaboration with these partners ensures that research is successfully translated into practice.

Key technologies

The advisory report 'A more forceful choice for key technologies'¹⁰ calls for the development of coalitions of national key technology programmes. 4TU initiatives which focus on key technologies are capable of generating ground-breaking innovations with a

¹⁰ <https://english.awti.nl/publications/documents/publications/2020/01/30/advice-a-more-forceful-choice-for-key-technologies>

high societal impact. In co-operation with partners outside 4TU, there is potential for these initiatives to play a prominent role in coalitions dedicated to **materials technology, ICT and AI**. We are currently exploring whether 4TU could also fulfil such a role for **Robotics**.

Innovation

4TU.IMPACT has rapidly established itself as a collaborative platform for innovation. Within 4TU the lines have been shortened and co-operation with external partners such as NWO-TTW, TNO, TechLeap and the Ministry of Economic Affairs and Climate Policy (coalition of the willing) has intensified. This has resulted in two successful proposals (in collaboration with TNO) as part of the Thematic Technology Transfer (TTT) scheme. 4TU was also involved in the third successful proposal submitted by the Dutch CardioVascular Alliance. The current TTT scheme makes a valuable contribution to strengthening the valorisation ecosystem. 4TU.IMPACT will engage with the coalition of the willing to ensure the continuation of this programme so as to provide a sustainable response to bottlenecks in the valorisation ecosystem.

During the interim evaluation of the HTSF programme, the programme leaders expressed the wish to intensify co-operation with 4TU.IMPACT in order to further increase the innovative capacity of these programmes. In addition, well-attended activities are organised on a regular basis, such as the 4TU.Impact Challenge and the 4TU.Entrepreneurial PhD Course. In the next period, this exciting portfolio of activities will be expanded and the connection with 4TU's educational and research activities will be reinforced in order to accelerate the innovative capacity of these activities.

Education

The **Applied Mathematics Institute** (4TU.AMI) is extremely visible within its own 4TU community, especially in the field of education, but it also focuses on the application of mathematics research to address societal challenges. In addition, AMI develops maths teaching in a blended form. These topics are covered extensively on the website. The amount of information available can sometimes be overwhelming. In 2020, 4TU.AMI will be asked to refocus its internal communication on educational developments in mathematics from 2021 onwards. In addition to blended learning, the AMI is also working on the further development of standard teaching materials which colleagues in the field can use extensively as part of their curricula and in their teaching.

Sector plans

In 2019, the sector overviews for SSH, science and technology were finalised by the Minister of Education, Culture and Science. These sector overviews present clear-cut choices for the disciplines for which sector plans have been formulated. The sector plan for technology, for example, focuses on engineering technology. The technology deans' forum took it upon itself to also prepare a sector plan for **design engineering**. An investigation will be carried out to determine the most effective way in which the design disciplines within the universities of technology can organise themselves together, with the aim of forming a bridgehead that can support a sector plan for design engineering.

Health

More than a third of education and research at universities of technology is health-related, and the theme plays an important role in the regional partnerships with the UMCs and the leading clinical teaching hospitals. Health and Care is one of the four themes of the mission-driven top sectors policy and the Ministry of Health, Welfare and Sport has announced its intention to develop additional measures relating to medical technology in the form of a National MedTech Agenda. The policies initiated by politicians present many opportunities for the universities of technology and their regional partners to work together on this theme.

The UMCs are united in the Netherlands Federation of University Medical Centres (NFU) and the leading clinical teaching hospitals in the Alliance of Leading Clinical Teaching Hospitals (STZ). 4TU and NFU are both members of the Dutch CardioVascular Alliance and the STZ explicitly states in its strategy that it wants to intensify its co-operation with the universities of technology. 4TU has bundled its health-related activities under the banner of **Health@4TU**. Not only has this provided a point of contact for health at the technical universities, but it is also helping 4TU to secure a place at the table with politicians, the NWO and health funds. Health@4TU has the potential to ensure that 4TU has an equivalent position to the NFU and the STZ. By working together, we can more effectively influence the implementation of the National MedTech Agenda and the Stay Healthy for Longer Mission, including by contributing to the formulation of programmes and the creation of adequate funding instruments for such programmes

Value of healthcare technology

Until recently, there was no clear picture of the standing of healthcare technology in our hospitals. For this reason, FME Zorg commissioned Ecorys to assess the value of healthcare technology in the Netherlands. The study revealed that of the €83 billion spent on medical and long-term care in the Netherlands, €3.2 billion was spent on healthcare technology in hospitals in 2016 (€2.9 billion on consumables and €0.3 billion on medical equipment). This accounts for 13% of all expenditure in hospitals in the Netherlands.

Agenda for better care, FME, 2019

3.4.4 Educational innovation

The **4TU.Centre for Engineering Education (CEE)** is leading the way in the field of engineering education through research and the application of evidence-based innovations. The CEE acquires its knowledge by undertaking joint projects and facilitates the sharing of knowledge between the four universities of technology. The database of over 200 innovation projects will be further expanded and publicised among the staff of the universities. The CEE is at the forefront of efforts to define the profiles of the engineers of the future and to design the corresponding educational ecosystem. The centre also conducts research and shares knowledge on the theme of interdisciplinary education. One of the key areas in which the universities are working together is on the development of a framework for teaching careers for excellent lecturers, and the CEE is regarded as an opinion former in this process.

The CEE also plays a crucial role in developing tools that help degree programmes to adjust their curricula to reflect the need for future engineers with a wider spectrum of skills and competencies, including the ability to collaborate as part of a multidisciplinary team, entrepreneurial skills and being aware and taking account of ethical and social responsibilities. To this end, the CEE will join forces with 4TU.Ethics and 4TU.IMPACT. In addition to assuming a leading role in the Netherlands, the CEE will also collaborate with European partners in this area.

4 Organisation and management

The 4TU.Federation is managed by the **Governing Board** (GB), consisting of all members of the four Executive Boards of the universities of technology. The GB adopts the foundation's multi-year plan, the annual plan and the annual report based on proposals put forward by the Executive Committee. The GB meets at least three times per calendar year during a dinner meeting.

The **Executive Committee** (EC) is responsible for the operational management of the Federation. It is advised in these activities by the Management Committees for Education, Research and Valorisation. 4TU's policy is translated into activities of the 4TU.Research Centres and the 4TU.Centre for Research Data and is outlined in sector plans. The Chair represents the EC, which has a rotating chairmanship. The EC meets at least four times per calendar year.

The Education and Research Management Committees

The Education and Research Management Committees consist of the Education and Research portfolio holders respectively of the Executive Boards of the universities of technology. These committees are responsible for the realisation and supervision of the collaboration and planning by the universities of technology in the fields of education and research respectively. The committees are also charged with the specific task of overseeing the functioning of the joint 4TU.Centres (with the exception of 4TU.Impact), the 4TU.Graduate School and the High Tech for a Sustainable Future programme. The Education and Research Management Committees are separate bodies within the 4TU.Federation. In the next period, an attempt will be made to achieve greater efficiency through a merging of the staff resources of the management committees. The management committees meet at least six times a year.

Valorisation Management Committee

The Valorisation Management Committee consists of the Valorisation portfolio holders of the Executive Boards of the four universities of technology. This committee is responsible for the realisation and supervision of the collaboration and planning by the universities with regard to knowledge valorisation at 4TU.IMPACT.

Office

The 4TU Office consists of two staff members, the 4TU secretary and a project officer. The Office liaises intensively with the policy officers who support the management committees, utilising the resources available within the institutions. The 4TU Office is supported by a communications advisor who identifies the areas – outside the representation of interests – in which the deployment of communication tools will generate the greatest impact for 4TU. The advisor then also implements these activities. In 2021 an evaluation will take place to determine 4TU's support needs for the long term and to explore how those needs will be met beyond 2021.

Products

The 4TU.Federation publishes an annual financial and general annual report containing activity reports of the Governing Board and the Executive Committee as well as the Management Committees for Research, Education and Valorisation and the 4TU centres. The strategy is adopted for a period of four years.