

4TU.Federation
Annual Report 2019

April 2020

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Introduction

In 2019, the [High Tech for a Sustainable Future \(HTSF\) programme](#) produced its first set of tangible results. Scientists involved with the Plantenna programme developed a sensor module that can be used by a prototype cyberplant to wirelessly monitor parameters such as temperature and humidity. In the near future, this module will be put to the test in a greenhouse network. Pride & Prejudice developed a measuring instrument, the Sensory Interactive Table, which can measure various aspects of social eating habits. Precision Medicine primarily focused on cross-fertilisation, resulting in a new line of research, *flow MRI of nano- and microbubbles used for contrast ultrasound imaging and phasor analysis of medical MRI data*, for which Siemens' open architecture MRI machine is used.

During a well-attended afternoon on 22 October, the impact of the five HTSF programmes was presented to colleagues and external stakeholders. The [animations](#) created for each of the programmes provided a lasting reminder of this event and were widely used to publicise the programmes on social media. During the event Victor van der Chijs passed on the [chairperson's gavel](#) to Louise Fresco. The 4TU.Federation would like to express its deep gratitude for the tireless efforts he has put into strengthening relations with our external partners. In the four years of Van der Chijs' chairmanship, 4TU has built a solid and visible profile within the academic landscape.

Another well-attended event was the finals of the [4TU.Impact Challenge](#) on 7 November, organised by 4TU.Impact. The 15 finalists illustrated that entrepreneurship is well and truly alive among students. This event further stimulates that entrepreneurial spirit and offers students the opportunity to show their products and innovations to a wider audience. A group of [enterprising students](#) paid a visit to Prime Minister Mark Rutte and Prince Constantijn from TechLeap also made a contribution during the event; two very special highlights of the year.

[Sharing and providing access to knowledge acquired and facilities developed](#) are important objectives of the 4TU.Federation. The [4TU.Centre for Engineering Education](#) updated its popular Innovation Map with educational innovations, which now contains 215 products. [4TU.High-Tech Materials](#) designed two web applications – one to provide an overview of the [materials science infrastructure](#) at the four universities of technology and one to provide an overview of the [expertise of materials scientists](#) within HTM.

Funding

After many years of discussion, in the summer the cabinet took the decision to [redistribute university funding](#) towards science and technology subjects. By choosing to redistribute rather than increase funding, the cabinet caused a deep rift between general universities and universities of technology. 4TU was instructed by the minister to draw up a sector plan for science and technology education in collaboration with general universities, universities of applied sciences and the business community, focusing in particular on mutual cooperation. Student organisations will also be involved in this process. 4TU is keen to use the sector plan to strengthen ties with the science faculties of the [general universities and the technical universities of applied sciences](#). We are also aware that technology only has added value in the context of the other fields of science. This will form part of the 4TU.Federation's new strategy, which will be adopted in 2020.

Initiatives

Like last year, we have once again seen that staff and students increasingly attach added value to the 4TU.Federation in that it brings together activities within their own institution with those of the other universities of technology. This was reflected, among other things, in the publication of the [4TU.Career Special](#) for alumni, the first copy of which was presented to the chair in the presence of the employee representative bodies of the four universities of technology. Health@4TU, which brings together scientists in the field of medical technology, is also rapidly evolving into a reputable discussion partner for external parties.

International

In April, Wageningen University and TU Delft hosted delegations from **TU9** and **TU Austria**. In June, discussions were held with TU Dublin, a cluster of a number of technical institutions in Ireland. These international connections facilitate the exchange of knowledge and serve as a source of inspiration for our own strategy. They can also lead to the strengthening of existing partnerships and new initiatives.

Structure

This annual report consists of the activity reports of the General Management Board and the Executive Committee, the Education Management Committee, the Research Management Committee, the federation's various research centres, the HTSF programme and the joint Master's degree programmes. It also reports on the formal external relationships that the 4TU.Federation has built up. Each research centre reports to one of the management committees and has an individual multi-year budget from which to fund its activities.

1 General Management Board & Executive Committee

General Management Board	Tim van der Hagen, Rob Mudde, Nicolay Vermeulen (TU Delft) Frank Baaijens, Jan Mengelers/Robert-Jan Smits, Jo van Ham/Nicole Ummelen (TU/e) Thom Palstra, Victor van der Chijs, Mirjam Bult (UT) Arthur Mol, Louise Fresco, Rens Buchwaldt (WU)
Executive Committee	Victor van der Chijs (UT, Chairman), Tim van der Hagen (TU Delft), Jan Mengelers/Robert-Jan Smits (TU/e), Louise Fresco (WU)
Support	Lotte Melenhorst (TU Delft), Renee Westenbrink (TU/e), Maurice Bouwens (UT), Henrieke de Ruiter (WU)
4TU	IJsbrand Haagsma

The General Management Board met three times and the Executive Committee five times, including a meeting with a delegation of staff.

Funding

The meetings of the Executive Committee and the General Management Board were once again dominated by the political discussion about funding the universities of technology. The Van Rijn Committee's report, 'Wissels Om', and the cabinet's response to it led to intensive discussions with the minister and the Ministry of Education, Culture and Science. The task of drawing up a sector plan for science and technology education has begun; the Education Management Committee is responsible for coordinating the details of the plan with the external partners.

Strategy

Following an internal and external stakeholder survey, the decision was taken in June not to make any major changes to the 4TU.Federation's strategy. The strategy will, however, devote more attention to **publicising** the substantive results of our cooperation and, in coordination with the institutions, to publicising technological developments at the institutions that may have a wider impact. In 2020, the Board will decide on the specific strategy for the period up to 2025.

Business community

In 2019, discussions were initiated with the Confederation of Netherlands Industry and Employers (VNO-NCW) about more intensive (substantive) cooperation through two initiatives. Firstly, this concerns aligning efforts regarding (technological) innovations in the context of **Dutch societal challenges** and transitions, coupled with the earning capacity of the Dutch economy. This includes a joint increase in investments based on the cabinet's economic development forecast. The 4TU4Industry group, which emerged from 4TU.Impact, will tackle this issue. The second issue to be addressed is the contribution to the development of the **MalieAcademy**, founded by VNO-NCW, which focuses on translating technological trends into business strategies and the implementation thereof. The MalieAcademy targets in particular medium-sized companies. This provides an opportunity for universities to strengthen their ties with that sector.

Affiliated parties

In 2011, the Netherlands Organisation for Applied Scientific Research (TNO) and 4TU established the LNG TR@D Foundation. Since then, the foundation's activities have come to an end and it has been liquidated and deregistered from the Chamber of Commerce by a joint decision of TNO and 4TU.

Key indicators

The number of assistant, associate and full professors (in FTEs) in the 2008-2018 period is given in the tables below. This table highlights the fact that the number of female FTEs has grown faster than the number of male ones. This is due to the increasing efforts within universities of technology to attract more women.

Numbers of academic staff (assistant, associate and full professor in FTEs), male and female, 2008-2018

MAN	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	18/17	18/08
TUD	737	747	751	754	734	726	731	735	744	757	775	2,4%	5,2%
TUE	457	465	462	453	447	438	435	432	454	444	440	-0,9%	-3,7%
UT	391	423	486	467	452	434	421	417	418	423	435	2,8%	11,3%
WU	401	404	398	397	408	408	405	405	390	391	385	-1,5%	-4,0%
VROUW	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	18/17	18/08
TUD	111	124	128	139	146	161	167	178	185	196	215	9,7%	93,7%
TUE	55	59	62	65	58	73	81	98	108	114	120	5,3%	118,2%
UT	92	106	117	121	118	117	114	115	119	127	145	14,2%	57,6%
WU	101	104	106	115	121	123	132	144	152	162	170	4,9%	68,3%

Source: WOPI. Reference date: 31 December. Exclusive of student assistants

2 Research Management Committee

Board	Arthur Mol (WU, chairman), Tim van der Hagen (TU Delft), Frank Baaijens (TU/e), Thom Palstra (UT)
Support	Pieter Munster (WU, secretary), Lotte Melenhorst (TU Delft), Lisette Appelo (TU/e), Hanneke Bodewes (UT)
4TU	IJsbrand Haagsma, Linda Baljeu

In 2019, the Research Management Committee consisted of the Research portfolio holders of the Executive Boards of the four universities of technology. 4TU.Research is responsible for the realisation and supervision of the collaboration and planning by the universities with regard to research. In 2019, for example, the High Tech for a Sustainable Future programme was presented and the decision was taken to make a contribution to the Dutch CardioVascular Alliance. The committee also oversees the operation and management of the 4TU.Research Centres.

4TU Talent Stimulus: High Tech for a Sustainable Future

The 4TU Talent Stimulus 'High Tech for a Sustainable Future' is a research programme initiated by 4TU.Research. For the 2018-2021 period, a total of €22 million has been set aside for this from the organisation's own resources. During the programme presentation on 22 October 2019, the five programmes (DeSIRE, Plantenna, Precision Medicine, Pride & Prejudice and Soft Robotics) presented their plans and current research at a well-attended meeting. In 2019, the vacancies for permanent academic staff continued to be filled, bringing the **total number of newly appointed tenure track candidates** to 45. More information about these programmes can be found in Section 17.

Research centres

Funding for the 4TU.Humans & Technology (H&T) research centre came to an end in 2019. The management committee strongly believes that Humans & Technology will be a major topic in the future and also recognises the added value of working together in a 4TU context. It was therefore decided **to continue** funding the research centre until the end of 2021. The strategy of the 4TU.ResearchData was also discussed in 2019. The management committee endorses this strategy and therefore decided to maintain funding for 2020 and 2021.

Dutch CardioVascular Alliance

The 4TU.Federation has been a partner of the Dutch CardioVascular Alliance (DCVA) since 2018, because it believes that a more central (i.e. national) approach to cardiovascular research best serves the interests of the patient. 4TU believes that the **research into medical technology** conducted at the institutions can make a significant contribution to the achievement of DCVA's objectives. Therefore, in 2019 the decision was taken to donate €100,000 for 2020 and €100,000 for 2021 to the DCVA.

Visits from Austria and Germany

On 22 March 2019, a delegation from **TU Austria** visited 4TU and was welcomed in Delft. Wageningen welcomed a delegation from **TU9** (the nine universities of technology in Germany) on 19 April. Both visits addressed themes that are relevant to universities of technology in the Netherlands, Austria and Germany. For example, we learned about the role of the Academy of Engineering in Germany, and at both meetings we discussed the topics of Open Science and Open Data, as well as how to influence the European agenda. In addition to these political topics, each organisation also had the opportunity to present its own initiatives of which it is particularly proud: 4TU introduced the High Tech for a Sustainable Future programme and TU Austria presented its concept for Pilot Factories.

The Van Rijn Committee's report

Following the publication of the Van Rijn Committee's report, the minister decided to allocate more government funding to the universities of technology. These funds are sorely needed, but an **adverse side effect** is that these funds are taken away from general universities. In 2019, the management committee spent ample time discussing the consequences of the publication of the Van Rijn Committee's report.

Sector plans for science and technology

Following the terms agreed in the government's coalition agreement, the Ministry of Education, Culture and Science decided to draw up sector plans for science and technology. In 2019, the management committee spent ample time discussing the process and implementation of these plans

Key indicators

Number of 4TU doctorates, 2009-2019

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	19/18	19/09
4TU	842	915	917	973	1.064	1.145	1.130	1.182	1.063	1.161	1.230	5,9%	46,1%
TUD	264	333	319	303	353	371	357	395	359	368	400	8,7%	51,5%
TUE	192	189	199	245	218	243	234	224	212	264	290	9,8%	51,0%
UT	191	188	203	196	220	244	234	267	197	243	247	1,6%	29,3%
WU	195	205	196	229	273	287	305	296	295	286	293	2,4%	50,3%

Number of 4TU PhD candidates present, 2010-2019

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	19/18	19/10
M												
TUD	1708	1835	1854	1871	1881	1913	1959	1995	2021	1983	-1,9%	16,1%
TUE	849	893	851	886	925	969	1028	1072	1070	1063	-0,7%	25,2%
UT	850	839	831	784	784	783	756	751	699	648	-7,3%	-23,8%
WU	907	929	994	963	962	953	938	933	912	922	1,1%	1,7%
V												
TUD	613	681	713	730	744	739	751	771	795	828	4,2%	35,1%
TUE	308	312	308	324	355	398	415	462	494	509	3,0%	65,3%
UT	411	445	421	409	420	452	436	442	429	383	-10,7%	-6,8%
WU	785	872	965	992	941	943	929	938	955	1014	6,2%	29,2%
4TU	6.431	6.806	6.937	6.959	7.012	7.150	7.212	7.364	7.375	7.350	-0,3%	14,3%

(Reference date 31 dec)

Prizes

All of the following prizes were awarded in the 2019 reporting year. The titles of the grants should not serve as a guide. For example, the Vici 2018 grant was awarded in February 2019, and was therefore included in this annual report.

'Vernieuwingsimpuls'

ERC

Veni 2019: awarded in July 2019

Starting 2019: awarded in September 2019

Vidi 2018: awarded in May 2019

Advanced 2018: awarded in March 2019

Vici 2018: awarded in February 2019

Consolidator 2019: awarded in December 2019

TUD	<p>Veni 2019 Casper Poulsen Paola De Magistris Giulia Giordano Michelle Laurenzi Zoë Robaey Masoud Babaie Miguel Bessa Thomas Burdyny Anne-Catherine Dieudonné Mark van de Ruit Feijja Yin Frederik Zietzschmann</p> <p>Vidi 2018 Martijn Caspers Jan van Gemert Louise Nuijens Neelke Doorn Hadi Hajibeygi Sicco Verwer Jan-Willem van Wingerden</p> <p>Vici 2018 Stan Brouns Sander Otte Andrea Ramírez Bernd Rieger Andy Zaidman</p>	<p>Starting 2019 Daan Brinks Arjen Jakobi Tim Taminiau Menno Veldhorst David Vermaas</p> <p>Advanced 2018 -</p> <p>Consolidator 2019 Rene Pecnik</p>	WU	<p>Veni 2019 Annette Janssen Carla Araya-Cloutier Nico Claassens Lysanne Sniijders Charles Underwood Lieke Melsen Gert Salentijn Mark Sterken</p> <p>Vidi 2018 Chiel v Heerwaarden Vera Ros Emilie Wientjes David Ludwig Annemiek ter Heijne</p> <p>Vici 2018 Leónie Bentsink Ton Hoitink</p>	<p>Starting 2019 David Ludwig</p> <p>Advanced 2018 John van der Oost Dolf Weijers Lourens Poorter</p> <p>Consolidator 2019 -</p>
TU/e	<p>Veni 2019 Anat Akiva Erik Bekkers Antoni Forner-Cuenca Lenneke Kuijer Weiming Yao</p> <p>Vidi 2018 Lorenzo Albertazzi Richard Lopata</p> <p>Vici 2018 Rembert Duine</p>	<p>Starting 2019 Nicholas Kurniawan Jesper Nederlof</p> <p>Advanced 2018 Jaap den Toonder Erik Bakkers</p> <p>Consolidator 2019 Peter Zijlstra</p>	UT	<p>Veni 2019 Monika Kuffer Derya Demirtas</p> <p>Vidi 2018 Johannes Schmidt-Hieber Jeroen Leijten</p> <p>Vici 2018 Devaraj van der Meer</p>	<p>Starting 2019 David Fernandez Rivas Monica Moralis Masis</p> <p>Advanced 2018 Andrew Skidmore Arjen Hoekstra Bram Nauta</p> <p>Consolidator 2019 Mariëlle Stoelinga Misra Sarthak</p>

NWO Gravitation grant

This summer, leading scientist and former director of research of 4TU.Ethics & Technology Philip Brey (UT) and his consortium were awarded a grant of €17.9 million from the Ministry of Education, Culture and Science's Gravitation Programme. Scientists in the field of ethics and philosophy of technology are going to review time-honoured philosophical core concepts, such as autonomy, justice and responsibility,

which are being challenged by technological developments. This should lead to innovative perspectives and greater control of the major changes brought about by new technologies in areas such as artificial intelligence, synthetic biology and climate technology.

The programme, which will run for ten years, is a collaboration of researchers from the University of Twente, TU Delft, Eindhoven University of Technology and Utrecht University, in which Wageningen University & Research, Leiden University and University Medical Center Utrecht also participate. The four universities of technology have already successfully joined forces in the field of ethics and technology within the Research Centre for Ethics and Technology (see also Section 8 of this Annual Report).

3 Education Management Committee

Board	Frank Baaijens (TU/e, Chairman), Tim van der Hagen (TU Delft), Thom Palstra (UT), Arthur Mol (WU)
Support	Lilian Halsema (TU/e, secretary), Barbara Marx/Irma Croese (TU Delft), Lisette Woud (UT), Eva Verschoor (WU)
4TU	IJsbrand Haagsma, Linda Baljeu

In 2019, the Education Management Committee consisted of the Education portfolio holders of the Executive Boards of the universities of technology. This committee is responsible for the realisation and supervision of the collaboration and planning by the universities with regard to education, under the auspices of 4TU.Education.

Language policy and accessibility

In 2019, 4TU.Education set up a working group to develop a joint vision and associated measures aimed at improving the intake and accessibility of 4TU Bachelor's degree programmes. This working group, entitled Language and Accessibility, addressed topics such as decentralised selection, teaching in English, and internationalisation in relation to accessibility.

In 2019, it was once again necessary to regulate the intake of a number of Bachelor's degree programmes using a decentralised selection process. Thanks to the increased funding for science and technology, fewer Bachelor's degree programmes have requested a *numerus fixus* (NF) for 2020 than was the case in 2019.

The four universities of technology are jointly taking a number of measures aimed at increasing intake capacity:

- Analysing and increasing the intake capacity of NF degree programmes at sector level
- In the event of an (explosive) increase in enrolment in degree programmes, students are actively referred to other programmes at their own university or at the other universities of technology or technical universities of applied sciences
- Investigating the possibility of a joint Programme Choice Check, also in cooperation with technical universities of applied sciences, with the aim of helping students choose the 'right' programme and improving pass rates
- Jointly developing online teaching for those components with the greatest intake bottlenecks
- Investigating the possibilities of making agreements with the business community about accommodating growing student numbers with their facilities and staff
- Advising students enrolling in an NF programme, where a comparable programme without NF is available, to apply to the comparable programme at another university of technology

The management committee also considered the *institutions' language policies*. Many of the degree programmes are taught in English, unless a specific area or discipline also has an application that is specifically aimed at the Netherlands, for example teacher training programmes and medical, psychological and culturally related programmes. Programmes will also continue to be taught in Dutch if the intake would increase exponentially if it were to be taught in English and that growth could not be accommodated. Dutch will also continue to be the language of instruction if a programme is not (yet) able to deliver sufficient quality because the lecturers do not have sufficient English-language skills or are unable to implement the *international classroom* didactic concept.

Following the national debate on the binary system, the committee also discussed the positioning of the PDEng.

Key indicators

International intake at universities of technology has risen in recent years to around 20% of the total intake. The significant increase in the number of students during the 2009-2019 period is illustrated in the following figures.

Number of enrolments, male/female students, Dutch/international students

4TU student population, 2009-2019, all students (primary enrolment as of 1 October)

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	19/18	19/09
TUD	16.570	17.329	17.721	17.874	19.148	20.034	21.469	22.199	23.325	24.507	24.961	2%	51%
TUE	7.267	7.307	7.519	7.762	8.377	9.209	10.116	10.764	11.372	11.969	12.237	2%	68%
UT	8.530	8.886	9.398	9.314	9.315	9.263	9.082	9.396	9.921	10.665	11.404	7%	34%
WU	5.695	6.457	7.071	7.491	8.302	9.032	9.720	10.697	11.446	11.946	12.280	3%	116%
4TU	38.062	39.979	41.709	42.441	45.142	47.538	50.387	53.056	56.064	59.087	60.882	3%	60%
M	27.535	28.178	29.022	29.280	30.967	32.363	34.025	35.290	36.983	38.681	39.529	2%	44%
V	10.527	11.801	12.687	13.161	14.175	15.175	16.362	17.766	19.081	20.406	21.353	5%	103%

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	19/18	19/09
INT	4.820	5.658	6.461	6.839	7.246	7.688	8.726	9.895	10.905	12.209	13.154	8%	174%
NL	33.242	34.321	35.248	35.602	37.896	39.850	41.661	43.161	45.159	46.878	47.728	2%	44%

Bachelor's intake, male/female students, Dutch/international students

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	19/18	19/09
TUD	2.782	2.730	2.790	2.756	3.057	3.125	3.274	3.353	3.641	4.094	3.783	-8%	36%
TUE	1.524	1.501	1.591	1.729	1.967	2.144	2.276	2.396	2.616	2.338	2.296	-2%	51%
UT	1.384	1.788	2.000	1.780	1.792	1.814	1.691	2.060	2.113	2.335	2.631	13%	90%
WU	1.016	1.113	1.102	1.181	1.457	1.484	1.521	1.655	1.713	1.711	1.620	-5%	59%
4TU	6.706	7.132	7.483	7.446	8.273	8.567	8.762	9.459	10.083	10.478	10.330	-1%	54%
M	4.770	4.746	5.116	5.092	5.657	5.793	5.956	6.149	6.725	6.869	6.664	-3%	40%
V	1.936	2.386	2.367	2.354	2.616	2.774	2.806	3.310	3.358	3.609	3.666	2%	89%

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	19/18	19/09
INT	486	671	844	725	741	768	805	1.158	1.307	1.875	2.070	10%	330%
NL	6.220	6.461	6.639	6.721	7.532	7.799	7.957	8.301	8.776	8.603	8.260	-4%	33%

Collaboration with the business community

In view of the high student numbers and high workload at universities of technology, the 4TU.Federation is looking for opportunities to collaborate with the business community, for example by exploring the possibility of involving employees in teaching activities. A pilot with these so-called **hybrid lecturers** has been launched in the Brainport region.

4TU is also striving for Open Access in teaching, whereby the guiding principle is that knowledge is shared with society. We are stimulating and creating awareness among students about this particular responsibility of the world of academia. To this end, it has been agreed within 4TU to strive for confidentiality clauses in graduation contracts with companies to be limited in scope and for these to be made publicly available. Decisions are yet to be taken at the individual institutions.

Centre for Engineering Education

The four universities of technology are collaborating to **improve engineering education** through the Centre for Engineering Education (CEE). The 4TU.CEE collects and develops evidence-based knowledge. CEE continuously monitors and analyses the effectiveness of innovations in education within the four institutions. The four partners exchange expertise and experience in order to benefit as a group. National and international events are organised to give scientists at universities of technology the opportunity to inspire and learn from each other. One of the main themes in 2019 was Teaching Excellence. The four institutions are participating in a longitudinal international study on university culture in relation to the **appreciation of scientists**. The 4TU.CEE informs and advises the board of 4TU.Education on educational innovations. See Section 13, 4TU.CEE, for detailed information on this centre.

Numbers

The following tables illustrate that the number of Master's students at the four universities of technology has more than doubled over the past ten years. Moreover, the relative number of female Master's students has risen.

In 2018, the dramatic increase in the number of Bachelor's degrees obtained by international students is striking: a staggering 45% more than in the previous year. Dutch universities of technology are attracting increasing numbers of international students. This indicates that the four universities enjoy a solid reputation both within the Netherlands and abroad, but this also leads to debate in society.

Intake by + transfer to Master's programmes, male/female students, Dutch/international students

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	19/18	19/09
TUD	1.368	1.156	1.240	2.089	2.327	2.519	2.207	2.882	3.393	3.500	3.459	-1%	153%
TUE	494	487	621	717	887	976	655	1.117	1.180	1.264	1.373	9%	178%
UT	667	314	567	847	688	667	471	1.072	1.122	1.117	1.195	7%	79%
WU	890	1.095	992	1.325	1.310	1.300	1.228	1.676	1.750	1.765	2.035	15%	129%
4TU	3.419	3.052	3.420	4.978	5.212	5.462	4.561	6.747	7.445	7.622	8.062	5%	136%
M	2.205	1.795	2.098	3.170	3.243	3.516	2.893	4.131	4.577	4.666	4.858	4%	120%
V	1.214	1.257	1.322	1.808	1.969	1.946	1.668	2.616	2.868	2.956	3.204	8%	164%
INT	1429	1.637	1.711	1.858	1.867	2.219	2.773	2.889	3.117	3.114	3.098	-1%	117%
NL	1.990	1.415	1.709	3.120	3.345	3.243	1.788	3.858	4.328	4.532	4.964	10%	149%

Number of BSc and MSc degree certificates issued, male/female students, Dutch/international students

4TU BSc degree certificates, 2008-2018

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	18/17	18/08
4TU	3.182	3.493	4.338	5.542	4.875	4.955	5.565	5.175	5.617	5.962	6.440	8%	102%
M	2.271	2.393	2.996	3.863	3.166	3.205	3.651	3.284	3.608	3.854	4.011	4%	77%
V	911	1.100	1.342	1.679	1.709	1.750	1.914	1.891	2.009	2.108	2.429	15%	167%
INT	175	201	312	335	399	480	483	541	470	450	649	45%	271%
NL	3.007	3.292	4.026	5.207	4.476	4.475	5.082	4.634	5.147	5.512	5.791	5%	93%

4TU MSc degree certificates, 2007-2017 (including "doctoraal", graduate degrees)

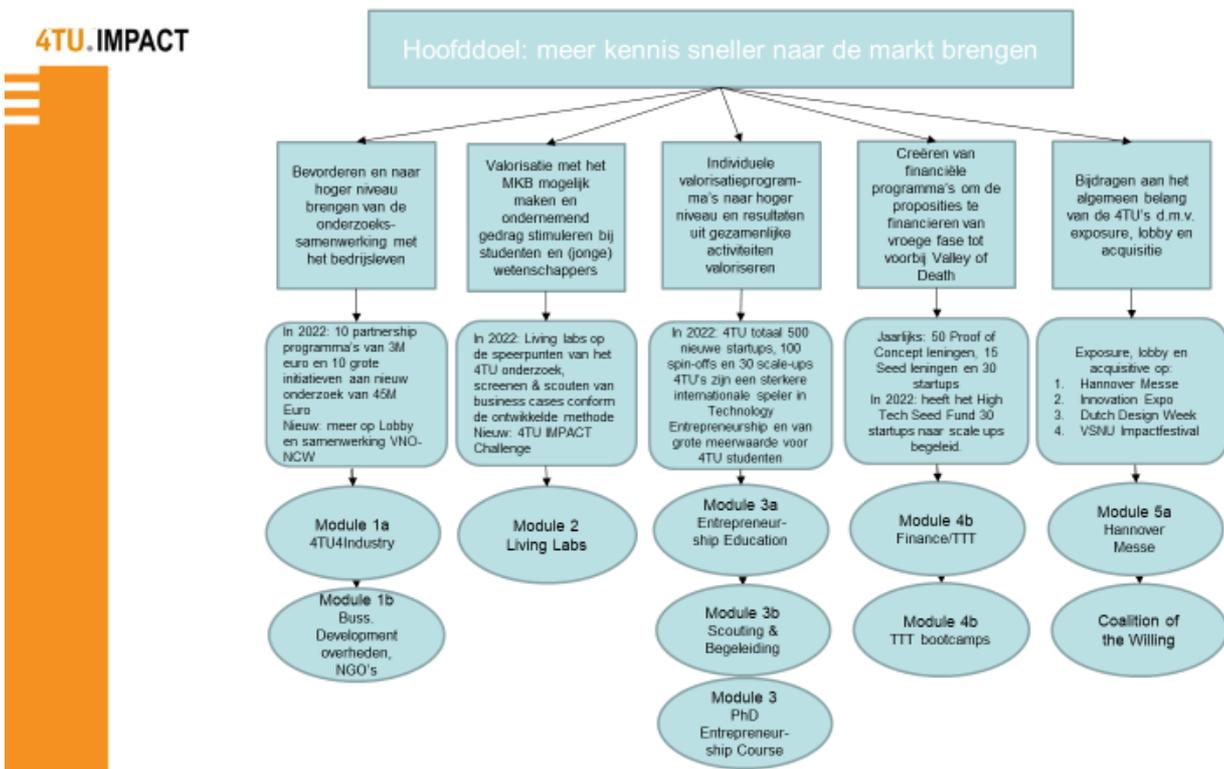
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	18/17	18/08
4TU	4.829	4.861	5.054	5.892	5.556	5.987	6.416	6.960	7.540	8.045	8.448	5%	84%
M	3.276	3.259	3.373	3.805	3.643	3.845	4.080	4.366	4.701	4.846	5.195	7%	71%
V	1.553	1.602	1.681	2.087	1.913	2.142	2.336	2.594	2.839	3.199	3.253	2%	109%
INT	1.129	1.247	1.398	1.649	1.674	1.845	1.967	2.164	2.643	2.926	3.058	5%	171%
NL	3.700	3.614	3.656	4.243	3.882	4.142	4.449	4.796	4.897	5.119	5.390	5%	55%

4 IMPACT

Director	Paul Althuis (TUD)
Programme manager	Roelyn van der Hoek (UT)
Management team	Paul Althuis (TUD), Jaap Beernink (UT), Steef Blok (TU/e), Sebastiaan Berendse (WU)

The joint valorisation efforts are based within the 4TU.IMPACT centre. It reports to the Valorisation Management Committee, consisting of the Valorisation portfolio holders of the four universities of technology. In 2019 these were Nicolij Vermeulen (TU Delft), Victor van der Chijs (UT), Jan Mengelers (TU/e), who was succeeded in May by Robert-Jan Smits (TU/e), and Rens Buchwaldt (WU).

For the Dutch knowledge economy, it is essential for a sufficient level of innovation to emerge in order to keep the economy operating and keep the people in the Netherlands prosperous and happy. In this regard, it is important to generate enough ideas and successful results that can ultimately be sold on the market. The four universities of technology play an active role in improving the Dutch knowledge system, endeavouring to **bolster the wave of innovation** washing into our economy. To this end, 4TU has drawn up the 4TU IMPACT plan for a period of four years (2018-2021). A number of working groups have since been added and some of the targets have been adjusted. Below you will find an overview of the targets and sub-targets, followed by a report on the activities carried out in the second year and a look ahead to 2020.



In 2019 the 4TU4Industry working group participated in the Hannover Messe, carried out a study into the feasibility of the '1000 doctoral candidates plan', developed a new strategy and prepared the Knowledge and Innovation Agendas (KIAs).

In 2020, the working group will continue to strengthen relationships with allies such as the Confederation of Netherlands Industry and Employers (VNO-NCW), Top Sectors and the Dutch Research Council (NWO). Topics that are of interest to several universities of technology are explored together and these are being incorporated into the current KIA structure. The working group will also establish new frameworks for

the next coalition agreement and the 2024 Dutch innovation policy and develop at least one joint programme.

Module 2 - Living labs

On 7 November 2019 young, highly talented students in the Netherlands competed against each other during the finals of a unique innovation competition organised by the four universities of technology. On the same day, the 15 finalists discussed their ideas with Prime Minister Mark Rutte, and the winner of the challenge will accompany the Dutch trade delegation to the World Expo in Dubai at the start of 2021. More than 1,000 students, around 80 teams per university, participated in the local preliminaries of the 4TU Impact Challenge that took place earlier this year at each of the four universities of technology. The candidates worked on their idea or prototype with the help of coaches from companies that are pioneers in their field. Chat sessions, training sessions and workshops helped the 15 finalists prepare for the pitch of their lives in The Hague.



Photo: The finalists of the 4TU Impact Challenge

Module 3A - Entrepreneurship education

The working group has conducted research into activities based on two games, the €5 game and the snowflake game, which are used to analyse different ways of learning to think as an entrepreneur. In 2020, the working group will publish an article on the research into the games and in June a conference will be held on the Snowflake game, among other things. The working group has also used and further expanded the 4TU MOOC Entrepreneurship for engineers.

Module 3B - Screening & scouting

Recently, research has been carried out into how the chains can be better connected to each other. ScienceFinder, the search system for companies and investors, was also further developed and launched in 2020. A sub-working group has started preparing a pilot for a 4TU Entrepreneurship Course for PhD candidates on the two Technology Tech Transfer themes (see below).

Module 4 - Finance

The two Technology Tech Transfer applications (TTT), submitted jointly by 4TU and TNO, have been approved. The two themes are Smart Systems and Circular Technologies. The kick-off with business developers took place in the autumn. The cooperation also resulted in the creation of Innovation Industries in 2017 and the development of the IIF-2 fund this year. This year a fund amounting to €200 million was launched.

In 2020, 4TU will submit a joint application with a number of UMCs, focusing on the MedTech theme. In addition, a budget has been made available to set up a pilot project for two boot camps on the TTT themes.

Module 5 - Events

The four universities of technology made a concerted effort to be well represented and to maximise opportunities for lobbying and acquisitions during the Hannover Messe and Dutch Design Week.

At the 2019 Hannover Messe, 4TU successfully focused on presenting the broad ecosystem: from fundamental research, to application, to start-up, to business. 4TU also experimented with a new concept: the innovation hackathon. In 2020, the Hannover Messe was cancelled due to the coronavirus. In 2021, the innovation hackathon will be continued, where companies, researchers and students will come together to find a solution to a company's problem.



ScienceWorks was commissioned by 4TU to produce an overview of the impact performance of the universities of technology in the Netherlands. ScienceWorks formulated six categories for examining the average performance of each university (excluding UMCs), with a particular emphasis on the average score of 4TU. The results indicate that the four universities of technology score by far the highest when it comes to innovation.

Total value of projects acquired

This annual report covers the acquisition figures and business activities, both of which are indicators of valorisation. The figure below is the total amount of indirect and contract funding received by the university in question in 2019 (by the date on which the project was signed). The full value of the contract for each project acquired in 2019 is provided. This includes only actual research projects, not proposals. This final figure provides a clear picture of the universities' order portfolio.

Wageningen did not provide its figures, so they are therefore not included in the totals in the table below.

Acquisition 2019 (in millions of euros)

		4TU
Indirect funding		129,6
Contract funding		237,8
<i>Business community</i>	47,6	
<i>Dutch government</i>	48,7	
<i>EU government</i>	119,8	
<i>Other</i>	21,8	
Total indirect + contract		367,4

Commercial activity

The indicator for business activities is measured as the number of spin-offs and start-ups. The international definitions of these terms, which are also used by the Association of Universities in the Netherlands (VSNU), have been adopted for the purpose of this report.

	Spin-offs	Startups
TUD	8	10
TU/e	8	21
UT	3	onbekend
WU	3	2

*At present, TU Delft registers only start-ups that are related to the university, but that have no license or shares (i.e. 'High-tech start-ups')

* Wageningen reports only spin-offs from Wageningen University (not from Wageningen Research)

5 Applied Mathematics Institute

Scientific director	Kees Vuik (TUD)
Secretary	Laurie Baggen (TU/e)
Management team	Arnold Heemink (TUD), Luc Florack (TU/e), Anton Stoorvogel (UT), Jaap Molenaar (WU)
Board	John Schmitz (TUD), Johan Lukkien (TU/e), Joost Kok (UT), Jaap Molenaar (vervanger WU)
Project Blended Learning	Hans Cuypers (TU/e, project manager), Bart van den Dries (TUD), Jan Willem Polderman (UT), Joost van Opheusden (WU)
Steering committee Blended Learning	Stephan van Gils (UT, chairman), Kees Vuik (TUD), Marko Boon (TU/e), Maarten de Gee (WU), Jan van der Veen (CEE)
SRO coordinators	Energy: Johann Hurink (UT) Water: Henk Schuttelaars (TUD) Health: Stephan van Gils (UT) Big Data: Nelly Litvak (UT) Resilience: George van Voorn (WU)

More and more technology sectors are in great need of advanced and application-oriented mathematics knowledge and expertise. Within the 4TU.AMI programme, the focus is on the Strategic Research Orientations (SROs) of Energy, Water, Big Data, Health and the relatively new area of Resilience. These SROs serve as a platform where the knowledge and expertise of the four universities of technology will be of benefit to technological businesses and knowledge institutions. In addition, AMI develops maths teaching in a blended form. There is great demand for this in service teaching and for the transition from higher professional education (HBO) to university-level education (WO).

Teaching

At the annual InterTU study day, (held on 23 October 2019) service-teaching lecturers exchanged experiences with each other on digital educational tools, among other things. Together with the German mathematical institute Matheon, 4TU.AMI organised the Mathekalender, an annual mathematics contest for secondary-school students.

The 4TU.AMI Blended Learning project group has started and developed several initiatives since its inception in 2016. Various maths courses now have access to [digital educational resources and online testing](#), both in the universities' own teaching and in bridging and service teaching. In 2018, a [repository](#) was created where digital educational resources are available to professors. This project has caught the attention of the Minister of Education, Culture and Science, and it is seen as a model project as part of SURF. As a result of the project, more digital and blended material has been developed at the four universities of technology; for example, Project Innovation Mathematics Education (PRIME) has been set up in Delft and the Education Innovation (EdIn) faculty group in Eindhoven. In April 2019, the project group organised the successful conference 'Mathematics Education: the next decade and beyond'.

Research

In 2019, the theme of the annual AMI conference was [the Mathematics of Deep Learning](#). Deep learning is very popular in machine learning and artificial intelligence applications, for example in self-driving cars, speech recognition and medical imaging. At this conference, international experts talked about their mathematical research in the field of deep learning.

SRO Energy organised several conferences and submitted a number of applications, including a Perspective programme proposal and a Gravitation programme proposal (currently being assessed). Several applications were approved (OP Oost, TKI, NWO, RVO, NOW TOP, NOW-ORC and NWO OTP).

An article published by SRO Big Data (Alessandro Di Bucchianico, Laura Iapichino, Nelly Litvak, Frank van der Meulen and Ron Wehrens), entitled 'Mathematics for Big Data', has been selected for The Best Writing on Mathematics 2019. The article explains how different methods from mathematics and statistics can be used to control the ever-growing flow of data.

SRO Health is closely involved in the [4TU Precision Medicine programme](#), where diagnostics are improved by integration with deep learning and medical imaging techniques. In 2019, SRO Health was involved in events such as AI in Health (UT), Enabling Data-Driven Methods for Inverse Problems in 3D Imaging (Lorentz workshop) and the Mathematics of Deep Learning conference mentioned above.

SRO Water is busy preparing a Perspective programme proposal. In 2020, this SRO will also publish the book 'Mathematics of Marine Modeling' in Springer's Mathematics of Planet Earth series.

SRO Resilience, which is affiliated with the interdisciplinary [4TU DeSIRE programme](#), has developed rapidly: since it was established in June 2018 thirteen partners have already joined the project, four conferences/workshops have been organised and the DeSIRE tenure track candidates have produced 26 publications. Five themes have also been identified: the resilience of cities, transport, water, energy, and food systems. These themes work together on issues related to resilience, methodology for modelling, quantifying and measuring resilience and uncertainty (in which mathematics and statistics are of course strongly represented), and the coordination and management of systems to improve resilience. At the end of 2019, DeSIRE members (tenure track candidates and staff) were involved in seven H2020 proposals, two NWA proposals and seven NWO proposals.

Other valorisation

4TU.AMI has approved several funding applications. In 2019, the Mathematics with Industry study group (SWI) took place in Wageningen. During this event, mathematicians spent a week tackling mathematical questions from the business community. For example, Synopsis wanted to investigate the best location for connections on chips and KWR Water wanted to be able to predict when water filters reach saturation point. In all cases, mathematics was able to make a material contribution to the solution.

To strengthen ties with the business community, 4TU.AMI organised another Company Event in 2019, this time dedicated to the theme of digital twins. Companies appreciate being able to connect with 4TU mathematicians directly via AMI. 4TU.AMI also regularly attends conferences and events to improve the visibility of mathematics for other disciplines and companies; for example, AMI had a stand at the annual NWO innovation festival TEKNOLOGY, which focuses on the connection between scientific disciplines, social organisations and the business community.

Furthermore, the director of 4TU.AMI is vice chair of the PWN Innovation Committee, which is committed to promoting innovation in the business world and at knowledge institutes through cooperation.

Agenda for 2020

4TU.AMI will continue to serve as a unifying factor between the mathematics groups of the four universities of technology. 4TU.AMI will further reinforce the [cooperation with businesses](#) and knowledge institutions through the SROs. There is a clear need for a network that brings businesses and universities together. To this end, 4TU.AMI will continue to organise the Company Events on a regular basis. In addition, the current annual events (e.g. the InterTU study day and the Spring Congress) will be continued. As the Blended Learning project will come to an end in 2020, 4TU.AMI is currently considering new initiatives and projects in the field of education. Finally, 4TU.AMI will also draw up a proposal for the NWO Gravitation programme in 2020.

In 2020 there will also be a change of director: Kees Vuik (TU Delft) will be succeeded by Johann Hurink (UT) in July.

6 Built Environment

Scientific director	André Doree (UT)
Secretary	Tom Coenen (UT)
Management team	Frank van der Hoeven (TUD), Erik Schlangen (TUD), Bauke de Vries (TU/e), Henk Visscher (TUD & BTIC)

When formulating the plans for the 2018-2021 period, a number of strategic choices were made. The centre will focus on:

- Alignment with the National Construction Agenda (with a view to involvement/centrality)
- Thematic choices related to the government's ambitions (for funding)
- The search for alternatives in addition to regular research programmes (such as NWO)

In 2019, a great deal of time and attention was devoted to the pathways arising from the National Construction Agenda. For example, the [Building and Technology Innovation Centre](#) (BTIC) was established in May 2019. The BTIC's objective is to set the innovation agenda for construction and to provide a platform and act as a driving force for creating **research agendas**, as well as respond to calls. The director of research at 4TU.BE is one of the founders of the BTIC and sits on the board.

4TU.BE is closely involved in the human capital agenda for the **National Climate Agreement** and the SER covenant 'People make the transition' that was signed on 17 April. 4TU.BE is represented in administrative consultations and in the core team for implementation. The centre also collaborates with the MBO Council and the HBO Council on new ways of working for Research & Design, such as regional Field Labs for the neighbourhood-oriented approach to the energy transition.

The BTIC programme themes

The BTIC has launched five programme themes. For each programme theme a writing team has been formed with representatives from the faculties involved in 4TU.BE and from TNO. These writing teams work on a multi-year agenda and constitute a platform that can respond to calls from NWO, NWA and the TKIs. To this end, the BTIC engages with ministries, TKIs, sector organisations and research institutions. The five programme themes are:

- *Energy transition in the construction industry*

In 2019, a successful programme proposal was submitted to the Urban Energy TKI (MMIP3/4). The Integral Energy Transition Programme for Existing Buildings has a budget of €21.4 million and has been awarded a subsidy worth €13.8 million. The BTIC and writing teams are currently working on a proposal for the MIMIP5 tendering process.

- *Circularity*

The writing team has drawn up a vision document and project proposals were prepared and submitted as part of the 'Concrete Agreement'. A limited subsidy (€22.5 K/faculty) was granted for this purpose on the basis of the Concrete Agreement. We will find out in the spring of 2020 whether the proposals will be accepted.

- *Digitisation*

Proposals are in the pipeline for the Ministry of Foreign Affairs and the national DigiDeal for the Built Environment.

- *Infrastructure*

There are still several unknowns regarding this theme. The expectation is that the theme will not be taken up by the Task Force, but that there will be a concerted effort with Directorate-General for Public Works and Water Management (Rijkswaterstaat, RWS) to develop a comprehensive proposal, linked to Ministry of Infrastructure and Water Management (I&W)/RWS policies and programmes.

- *Area development and climate adaptation*

There were already many players and stakeholders in this domain. Discussions are ongoing with Delta Technology to see in which areas the cooperation with 4TU.BE can lead to synergy.

Impact

The centre has an impact on the following topics:

- Strengthening the representation of 4TU.BE and its profile in discussions with the ministries, employers' organisations, SER, the MBO Council and the Netherlands Association of Universities of Applied Sciences, at both an administrative and executive level.
- Improving the position of 4TU.BE in relation to the TKIs, in particular the Urban Energy TKI. This will allow the centre to have a greater influence on the focus of research and the research agenda in the field of energy transition for the built environment.
- 4TU.BE is involved in discussions relating to the 'Implementation of the built environment' component of the National Climate Agreement.
- Acquisition of research funding for the Integral Energy Transition Programme for Existing Buildings (awarded by the Urban Energy TKI), the Concrete Agreement, the formation of the BTIC, and most likely also the DigiDeal for the Built Environment.
- Establishing the BTIC as a platform/structure to improve the synergy between TNO and Construction/Building faculties.
- Through the programmes and proposals, the 4TU/TNO writing teams have direct access to sector organisations, ministries and institutions.

Agenda for 2020

In 2020 the pathways and themes will be further developed and consolidated. The writing teams will play a key role in this. The **energy transition will be an important topic**, with the launch of the Integral Energy Transition Programme for Existing Buildings, the submission of a proposal for the MMIP5 call to tender, and the roll-out of the SER core team's programme focused on Field Labs for combined research and education linked to the Ministry of the Interior and Kingdom Relations' (BZK) programme for natural-gas-free neighbourhoods.

The centre expects to receive grants for the Circularity theme from the Concrete Agreement. Discussions with BZK and the DigiDeal for the Built Environment also indicate that grants will be awarded for research and projects. Explorations are still underway for the Infrastructure and Area Development and Climate Adaptation themes. Progress made on these themes will be evaluated in the autumn. In addition, in 2020 more attention will be paid to the website, documentation and widening involvement within the faculties by organising meetings.

Scientific director	Daan van Eijk (TUD)
Scientific co-directors	Berry Eggen (TU/e), Mascha van der Voort (UT)
Management team	Ena Voûte (TUD), Lin-Lin Chen (TU/e), Geert Dewulf (UT)

Design United (DU) contributes to the specialisation of design professionals by developing new knowledge and increasing access to existing knowledge. This improves the innovation strength of the industry, promotes economic growth and contributes to solving problems of society. Design United forms a community for Dutch research in design and targets both designers and researchers, as well as relevant organisations.

The activities of the research centre have the following objectives:

- Knowledge & Projects: the development of an approved research agenda and the resulting research collaboration initiatives
- Scientific Excellence: promoting a shared understanding of the research area and exchange of knowledge and experiences with a view to enhancing the quality of research
- Connected Knowledge: increasing accessibility to research results via symposia, an annual design research exhibition and publications
- Network: creating a network comprising the above parties and an authoritative organisation, which can influence policy development and serve as a point of contact for partners

Results for 2019

Design United played an active role in implementing the Knowledge and Innovation Agenda (KIA) of CLICKNL, the Top Consortium for Knowledge and Innovation and the Creative Industry top sector. The KIA serves as a guide for calls for research proposals aimed at the creative industry and researchers. NWO is increasingly interested in calls for proposals in the design domain and once again involved researchers from the design faculties in formulating the call-for-proposal texts and sitting on the programme committees, including Create Health, a programme of the Netherlands Organisation for Health Research and Development (ZonMW). This agenda is also leading in implementing the schemes developed and run by the Netherlands Enterprise Agency (RVO).

Design United is a co-founder and organising partner of the **Design Research & Innovation Festival (DRIVE)** during Dutch Design Week in Eindhoven. The event is carried out in cooperation with and is co-funded by CLICKNL. On Thursday 24 October 2019 this festival was held for the sixth time in the Natlab in Eindhoven, as part of Dutch Design Week (DDW). For Design United, this week is a major national event, bringing together many stakeholders of the creative sector.

This year, DRIVE focused on the themes of the mission-driven innovation policy: health & healthcare, energy transition & sustainability, agriculture, water & food and security. Around 75 researchers and creative professionals shared their latest knowledge, insights and working methods in workshops and discussion sessions. Half of the 250 visitors were scientists and the other half were businesses, professionals and government agencies associated with the creative sector.



DRIVE Festival in 2019



Design United exhibition in 2019

Dutch Design Week

For the sixth consecutive year, Design United enjoyed a high-profile appearance at Dutch Design Week thanks to its exhibition. This exhibition displayed 4TU research projects on design, research and technology by means of 32 stands, a speaker's corner with dozens of lectures, a brochure and a website. The exhibition was visited by approximately 75,000 people, including various representatives from companies, fellow researchers from universities of applied sciences and a special programme with leading experts from the national Top Sectors.

Agenda for 2020

In 2020, DU will continue to pursue a substantive agenda focusing on the following topics: a design approach to complex product service systems (1), design in experimental environments such as field labs and living labs (2), and a healthy society, circular economy and smart industry through design-driven innovation (3). These three agenda items are consistent with CLICKNL's KIA through the development of key enabling technologies in the Design for Change, The Human Touch and Value Creation road maps. Design United is closely involved in implementing the new mission-driven innovation agendas of the Creative Industry top sector.

DU will continue to take part in the development of the 4TU Pride & Prejudice programme, especially in relation to acquiring extra research funding and strengthening the network. In addition, DU is also committed to developing new and bigger 4TU projects.

DU will also join forces with CLICKNL again this year to organise the 2020 edition of the DRIVE festival. This year, it will be aligned with the World Design Embassies of Dutch Design Week, which also focus on mission-driven domains. In connection with DRIVE, DU will present its own 4TU exhibition at Dutch Design Week 2020.

As part of a new initiative DU will also organise so-called 'Design Perspectives', meetings for 4TU scientists to explore a particular subject in depth. The topics to be addressed in 2020 are artificial intelligence and healthcare.

8 Ethics and Technology

Scientific director	Anthonie Meijers (TU/e)
Managing director	Tijn Borghuis (TU/e)
Assistant director	Karen Buchanan (TU/e)
Management Team	Scientific en managing director, de decanen en een aanvullende vertegenwoordiger van TU/e en TUD

The 4TU.Centre for Ethics and Technology (4TU.Ethics) was established in 2007 to study the ethical aspects of the development, use and regulation of technology. The national and international innovation agendas assign high priority to the development and application of methods and strategies for ethical and socially responsible technical innovations. The industrial sector is also aware of this challenge. 4TU.Ethics looks for ways to promote socially responsible innovation, with special emphasis on technological issues within the top sectors and other relevant domains.

4TU.Ethics works according to its own research agenda, which is based on – and is constantly geared to – the research agendas of the four core departments, each of which influences the others. At the start of 2019, 4TU.Ethics had a total of 13 professors, 26 senior researchers, 17 post-docs and junior researchers, 33 doctoral candidates, and 71 affiliated members. The number of members increased by 14 in 2019.

Activities and impact

In 2019, the research centre continued to work on the implementation of the 2018-2021 strategy in the areas of research, education (including the course programme for PhD candidates) and valorisation.

A particularly outstanding result was the [awarding of an NWO Gravitation grant](#) for the 'Ethics of Socially Disruptive Technologies' proposal, submitted by 4TU.Ethics in collaboration with the Ethics Institute of Utrecht University (lead applicant Philip Brey). This project, which has more than [€26 million](#) at its disposal, will considerably expand research in the field of philosophy and ethics of technology in the Netherlands. The project is expected to involve 79 FTEs for academic staff in the period up to 2024, and 117 FTEs in the period between 2025 and 2029.

Furthermore, a number of national and international events were organised, as well as workshops with other 4TU centres,

including the 'From the Ethics of Risk to the Ethics of Resilience Integrating Participatory Approaches' workshop (Twente) organised in cooperation with the [4TU.Resilience Engineering](#) centre. The aim was to embark on a process of reconsideration with regard to the traditional concept of risk in ethics, which no longer fits in with the changing conception of risk in resilience engineering.

Two Cybersecurity Ethics workshops were organised in collaboration with [4TU.NIRICT](#) (17-18 April and 11-12 September in Utrecht) with the aim of building a community of researchers from the fields of philosophy and computer science. This is particularly relevant today given that ethical values such as privacy and rights are at stake when it comes to securing ubiquitous systems (Internet of Things). A proposal to hold a workshop on Cyber Security Justice in 2020 has been submitted to the Lorentz Centre. The second edition of the [4TU.Ethics Bi-annual Conference](#) was held in Eindhoven on 7 and 8 November. The theme was 'Ethics of Socially Disruptive Technologies'. Keynote speakers were Catriona McKinnon, University of Exeter (Geoengineering: fantasies of control), Ingrid Robeyns, Utrecht University (The promises and limits of the capability approach for the ethics of technology) and Tamar Sharon, Radboud University Nijmegen (The Googlization of health: an empirical-philosophical enquiry). The conference was attended by 130 participants, half of whom came from outside the Centre, and attracted a strong international audience with participants from various European countries, Israel and the United States. This conference led to a number of participating researchers becoming affiliated with the Centre.

In August the two-year project 'Ethics Education for Engineers' led by Lavinia Marin (TU Delft) was launched, where case-based exercises for teaching ethics to Bachelor's and Master's students are being collected, edited and combined for publication as an open educational resource via a 4TU.Ethics open repository. This project is part of the SURF programme Open and Online Education: Open Educational Resources, subsidised by the Ministry of Education, Culture and Science.

To improve external communication, the design and layout of the 4TU.Ethics website was completely revised in 2019.

Funding

In 2019, members of 4TU.Ethics acquired funds for eight new projects:

NWO	€27,890,000
EU/ERC	€ 0
EU/H2020	€ 0
Other	€ 293,376
Total	€ 28,183,376

Agenda for 2020

Following the start of the Gravitation project, a large number of new researchers, particularly PhD candidates, will become involved in the centre's activities, such as in the 4TU.Ethics Graduate Course programme.

As the Ethics Education for Engineers project progresses, the first educational resources will be made available online in the course of the year. From February to June, the project will take part in the SURF Sharekit pilot, which will test a new search portal for [accessing educational resources](#).

Workshops and other meetings will also be organised, including the following annual events: the PhD Day, organised in cooperation with the PhD council, and the Annual Research Day in Wageningen.

Finally, new valorisation initiatives will be developed to target secondary school students and stakeholders in socially responsible innovation.

9 High-Tech Materials

Scientific director	Jilt Sietsma
Coordinator	Reina Boerrigter
Management team	Bernard Dam (TUD), Rint Sijbesma, Marc Geers (TU/e), Remko Akkerman, Gertjan Koster (UT), Karin Schroën, Joris Sprakel (WU)
Board	Theun Baller (TUD), Philip de Goey (TU/e), Jeroen Cornelissen (UT), Raoul Bino (WU)

The primary objective of the 4TU.High-Tech Materials Research Centre (4TU.HTM) is to stimulate and take a fresh approach to materials science research and education within the four universities of technology through collaboration and new initiatives. The researchers involved represent many aspects of materials science, ranging from fundamental to applied research and from nanotechnology to constructions. Following the conclusion of the 'New Horizons in Designer Materials' research programme in 2019, in the coming period 4TU.HTM will focus specifically on education, on the materials infrastructure and on the relationship with industry, e.g. via a strategic partnership with the Materials Innovation Institute (M2i).

New Horizons in Designer Materials

The aim of the three-year 4TU.HTM research programme (2016-2019) was to provide a stimulus to materials science research in the Netherlands, with a view to initiating new research lines at the four universities of technology, which will continue to contribute to the high level of materials-science research and education in the Netherlands for the decades to come.

The six 4TU.HTM research projects are characterised by close cooperation with international experts and **various research groups within 4TU** and elsewhere in the Netherlands. For example, Danqing Liu ('Communicating Surfaces', TU/e) published a paper in Nature Communications with Nicholas B. Tito ('Reversible Crosslinking', TU/e) as early as 2017. She also collaborated with Julius Vancso (UT), project leader of Maciej Kopeć's 4TU.HTM project ('From Flatland to Spaceland'), which resulted in publications in Advanced Materials Interfaces (2019) and in ACS Applied Materials & Interfaces (2020) and with Joris Sprakel (WUR), professor of Physical Chemistry & Soft Matter, which resulted in a publication in Nature Communications (2019).

Other projects have also resulted in various **academic publications** in leading international journals. A publication specifically for the public was published in March 2020, in which the research and results obtained are explained in an accessible manner by the post-docs involved. Of the six high-potential post-docs who carried out the research, two have received personal grants that have allowed them to continue their research topics in collaboration with new post-docs. Two post-docs now have a tenure track position. 4TU.HTM will continue to devote attention to the activities ensuing from this research programme in the future.

Joint Materials Science Activities

4TU.HTM has a programme for Joint Materials Science Activities, in which the participating research groups from the four universities of technology can receive funding and support for activities aimed at promoting excellence, collaboration and the accessibility of materials science research. In 2019, 4TU.HTM supported the Low-Energy Ion Scattering workshop (Twente), the International Liquid Crystal Elastomer Conference (Eindhoven) and the Granular Materials Workshop at the Lorentz Centre, organised by colleagues from Wageningen and Twente. Finally, at the end of 2019, 4TU.HTM provided financial support for research projects based on the shared use of equipment.

Two projects will be carried out in 2020:

- Expertise in the synthesis and characterisation of smart materials and coatings (UT) will be combined with expertise in the field of electrically driven protein separation (WU)

- A cross-lab research project into mechanical metamaterials, a collaboration between TU Delft and TU/e in which a designer is also involved in the development of demonstration materials

Materials knowledge and infrastructure

The visibility of materials science and materials experts is invaluable for the field. The availability, accessibility and quality of research equipment is essential for materials science research. 4TU.HTM has therefore adopted a joint approach, for example by developing a [web application](#) that provides an overview of the [materials science infrastructure](#) at the four universities of technology and one that provides an overview of the [expertise of materials scientists](#) within 4TU.HTM. In 2020, the four universities' materials infrastructure will become even more accessible.

Industry

In 2019, 4TU.HTM further developed the strategic partnership with M2i to stimulate interaction with industry. Two thematic [events with industrial partners](#) and scientists were organised: a scientific workshop on Nucleation in April and a scientific workshop on Nano-Characterisation in October. 4TU.HTM also organised its annual symposium in cooperation with M2i. During Meeting Materials, the M2i conference held in December 2019, HTM organised Education in Materials Science sessions to exchange knowledge on teaching the principles of materials, not only to students of materials science, but also to students from other disciplines and to people from industrial practice. At least [two joint meetings, to be organised in collaboration with M2i](#), are also scheduled for 2020. The first is a workshop on Surfaces, Interfaces & Coatings in October, which will bring together researchers from 4TU's materials science community and industrial contacts from M2i's network of industrial partners. The annual HTM symposium will be organised in December 2020 in cooperation with M2i, during Meeting Materials (14-15 December), which will further stimulate interaction with industry.

Teaching

Graduate Courses contribute towards a broader and more structural training programme for PhD candidates. They help around 500 PhD candidates from research groups affiliated with 4TU.HTM to develop into fully-fledged materials science researchers with a broad-based, well-founded overview of the field. However, the concept of Graduate Courses is relatively new for universities and it is difficult for materials scientists to find the right information. In 2020, 4TU.HTM will provide an overview of the [post-graduate courses on offer](#) in Materials Science. Where necessary, 4TU.HTM will take the initiative to ensure that gaps in its range of courses are filled by encouraging lecturers and providing organisational support to open up new courses to PhD candidates at the four universities of technology, e.g. a Materials Characterisation course or a specific Materials Equipment Course.

In collaboration with M2i, in October 2020 a Business Awareness Course on the importance of materials science for industry will be taught. In addition, in 2020 4TU.HTM will develop a Presenting Materials Science Course geared to the needs of PhD candidates and post-docs. The possibility of developing Open Online Materials Science Courses will also be explored.

Cooperation

In addition to encouraging cooperation between materials research groups within 4TU, 4TU.HTM will also establish relationships with other materials research institutes and research groups. To this end, from 2020 onwards 4TU.HTM has committed itself to activities organised by [MaterialenNL](#), an initiative of the [three top sectors Chemicals, HTSM and Energy](#) which aims to promote the exchange of knowledge, cooperation and coordination in the field of materials research. MaterialenNL is organising a national materials day which is scheduled to take place in the fall of 2020.

Scientific director	Dirk Heylen (UT)
Management team	Mark Neerincx (TU Delft), Wijnand IJsselsteijn (TU/e)

The 4TU.Humans & Technology (4TU.HT) centre brings together the social and technology sciences around research into innovative forms of human-technology interaction. The primary aim of the centre is to work with researchers from the four universities of technology and external partners to create road maps for research and funded programmes. In addition, the centre seeks to create a living ecosystem of consultation among academic partners, the business community and other organisations. Furthermore, the centre aims to promote research within the four universities of technology in the field of human-technology relations in specific areas, both nationally and internationally. Special emphasis is placed on the linkage of technology and human sciences.

A special focus has been placed on training young researchers in the multidisciplinary field from the beginning. Besides training, forming a new community of young researchers is an important goal.

4TU.HT houses the [Smart Social Systems and Spaces for Living Well](#) research programme, where six PhD candidates and a number of post-docs work together on research in the field of multi-modal interaction (tactile interaction, in particular), virtual humans (with an emphasis on virtual reality and artificial intelligence), and affective & social computing.

Main activities

In 2019 a lot of attention was paid to the subject of [artificial intelligence](#). In the research into the automatic measurement of human behaviour and emotions (affective and social computing) on the one hand and intelligent virtual agents on the other, the theme was represented in the research programme and at various events throughout the last period.

In 2019, the centre organised a large number of national events related to the theme on topics such as Explainable AI, Moral Agents and the future of social robots. On an international level, the second workshop on the evaluation of AI systems was organised by the 4TU community during the Intelligent Virtual Agent Conference in Paris.

In light of the growing interest in artificial intelligence, it is essential that we also pay sufficient attention to the human dimension, for example, subjects such as trust in AI, privacy and cooperation between people and autonomous systems. Various researchers from the 4TU centre have collaborated on the NWO's national research agenda (AIREA-NL) in order to highlight these questions.

4TU is also affiliated with the [Hybrid Intelligence programme, which was awarded a Gravitation grant](#). In this programme six universities, led by VU Amsterdam, will spend ten years researching artificial intelligence as a means of supporting employees.

As part of 4TU's [Pride and Prejudice](#) programme, the centre plays an active role in the field of AI for behavioural change and the automatic measurement of human behaviour and emotions. One of the measuring instruments that the centre has developed for this purpose is the interactive dining table that can measure various aspects of social eating habits. The first version of the table was presented during Dutch Design Week and attracted a lot of interest.

Agenda for 2020

The line of activities such as seminars and workshops will be continued in 2020. The main themes will be ethics, artificial intelligence and mental well-being. Various meet-ups and symposia on conversational interfaces, among other things, are scheduled to take place. The year will be concluded with a larger symposium, during which the results of the research programme and other projects acquired thanks to the centre's networking activities will be presented.

Scientific director	Mark van den Brand (TU/e)
Programme manager	Margje Mommers (TU/e)
Board	Sander Stuijk (TU/e), Alan Hanjalic (TU Delft), Kofi Makinwa (TU Delft), Birna van Riemsdijk (UT), André Kokkeler (UT), Bedir Tekinerdogan (WU)

Information and communications technology (ICT) research at the universities of technology concentrates on refreshing and prioritising individual sub-disciplines. The 4TU.Netherlands Institute for Research on ICT (4TU.NIRICT) research centre focuses on integrating, positioning and prioritising all aspects of ICT research, in both multidisciplinary and chain approaches in a rapidly digitising world. Since more than 50% of research conducted at universities of technology in the Netherlands concerns ICT, the research centre can effectively devote itself to strengthening the national ICT research network. In collaboration with the Dutch ICT research platform (IPN), which primarily focuses on computer science, NIRICT aims to intensify **ICT research at the national level** by stimulating and facilitating collaboration with other disciplines.

In 2019, Inald Lagendijk and Maarten van Steen stepped down as MT members and Alan Hanjalic, André Kokkeler and Kofi Makinwa were appointed. Birna van Riemsdijk made the transition from TU Delft to the University of Twente and now represents UT in the NIRICT management team. As a result of these changes and new members, NIRICT has succeeded in creating a stronger and balanced board, in which both electrical engineering and computer science are represented.

Community day

One of NIRICT's main objectives is to bring the Dutch ICT community closer together, which is why NIRICT organises an annual Community day, which this year took place in Utrecht in January. The event was attended by around 40 participants, who had the opportunity to do some networking. Presentations were also given, followed by plenary discussions on themes such as Fostering healthy ICT science and engineering ecosystems, Less ICT more FAIR Data, Developing an ICT Strategy for the Life Sciences domain and Quo vadis? A perspective on future targets of Dutch academic ICT research.

Community funding

Since 2018, the focus of NIRICT has been on the call for proposals for community funding. The aim of this is to strengthen and facilitate collaboration between researchers and the work of the NIRICT community. This call led to the organisation of many **workshops, tutorials, presentations, training courses** and a Master's thesis **competition**. These activities were organised by the community itself, and covered topics such as Expressive Robots, GPGPU Applications, Wirelessly Powered Smart Dust and Cyber Security. These activities led to a number of publications (including a book entitled 'Model Management and Analytics for Large Scale Systems') and a strengthening of ties between researchers from different universities of technology, disciplines and countries. The joint efforts have also contributed to a better understanding of the various topics.

ICT.OPEN

In 2019, NIRICT was a partner of ICT.OPEN, the biggest conference for the ICT research community in the Netherlands. The aim of the collaboration between NIRICT and ICT.OPEN is to **connect the ICT communities** already established. NIRICT focuses on researchers who are at the start of their careers, which is why ICT Next Generation (ICTng) was also represented this year, with financial support from NIRICT. During the break before dinner, a fun networking drinks reception was organised around the theme 'the Good, the Bad and the Ugly'. The community was asked to discuss the 'good', 'bad' and 'ugly'

aspects of the ICT world in three rounds. In addition to the ICTng drinks, NIRICT also provided speakers for the skills session, and it had a table during the speed-dating session.

IEEE International Workshop on Information Forensics and Security

NIRICT was also a partner of the IEEE International Workshop on Information Forensics and Security (WIFS). WIFS is an annual event, and in 2019 it was held in Delft. Thanks to the support of NIRICT, ten Master's students from TU Delft, UT and TU/e, who themselves lacked the financial means to do so, were able to take part in the workshop and social events.

Agenda for 2020

In the past year few ICTng activities have taken place and NIRICT would like to breathe new life into ICTng. A new board will be appointed within ICTng and NIRICT's Community day will also be devoted to the younger generation and how to support them.

At the end of 2019 NIRICT teamed up with the European Innovation Academy and, as a result, four students from the four universities of technology will be able to participate in this programme in Portugal in 2020.

As in previous years, in 2020 NIRICT will once again be a partner of ICT.OPEN and the centre will continue to be involved in the call for community funding. This call will become much broader by focusing more on the national level, so that it helps to stimulate ICT in the whole of the Netherlands. NIRICT will also focus on project acquisition and on connecting electrical engineering and computer science. The management team is currently fine-tuning its vision, mission and strategy, which will be completed in 2020.

TU Delft	Alastair Dunning (Coordinator) Jasmin K. Böhmer (Data Officer), Madeleine de Smaele (Data Steward), Egbert Grambergen (Data Engineer), Arie Braat (Data Engineer) Ardi Nonhebel (ICT Specialist), Jan van der Heul (Data Librarian), Eric Rumondor (Data Librarian), Ellen Verbakel (Data Librarian)
TU/e	Leon Osinki (Data Librarian), Sjef Öllers (Specialist Scientific Information)
UT	Maarten van Bentum (Data Librarian)

Originally a data collection of hydrological measurements, 4TU.ResearchData has evolved into the largest data archive of its kind in the Netherlands. Within 4TU, the 4TU.Centre for Research Data (in short: 4TU.ResearchData) was established in 2010 as an initiative of three universities of technology (Eindhoven, Delft and Twente). The mission is to guarantee **accessibility of science and technology research data** during and after completion of research, thus spurring on the quality of today's and tomorrow's research.

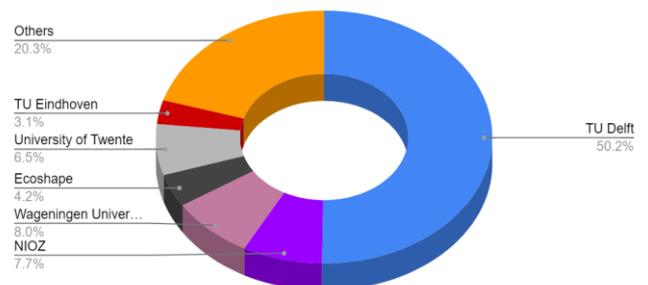
Although the name 4TU.ResearchData suggests otherwise, the data archive and services are accessible to all researchers who use data from science, technology, engineering, mathematics (STEM) and design sciences projects. Non-academic research institutes also make use of the services such as the Royal Netherlands Institute for Sea Research (NIOZ), Deltares, EcoShape and the European Severe Storms Laboratory (ESSL).

Looking back on 2019

In December 2019, the milestone of **9,000 datasets** was reached – thanks to the addition of 816 new datasets compiled and stored in the course of the year.

This continued growth of the repository, in which it is now also possible to search by category, collection and institution, is a valuable asset for researchers. The personal service and support for researchers to document, store and publish their research data ensures that researchers retain control over their data, and that the data will continue to be accessible to other researchers in the long-term.

Bron van datasets geüpload in 2019



The **range of programmes offered** by 4TU.ResearchData has also expanded. In addition to the Essentials 4 Data Support course, which has been successfully completed by 320 students to date, the Massive Online Open Course (MOOC) Delivering Research Data Management Services was launched in December. Of the more than 1800 participants from 126 countries, more than 3.8% have obtained the final certificate.

Following the launch of the Software Carpentries workshops in 2018, in 2019 four workshops were held at TU Delft and one at TU Eindhoven, **attended by more than 150 researchers** trained in software management and the principles of programming. In addition, the first Genomic Data Carpentry workshop, held at TU Delft in June 2019, was attended by 23 researchers.

In 2019, a series of interviews was conducted with researchers who use the services. These showcase interviews provide an insight into the many, bespoke, ways in which ResearchData supports researchers in the management of datasets for their projects and their research groups according to FAIR principles.



Profiled [Researchers](#) who use 4TU.ResearchData's data management & publishing services.
Photo: J. van der Heul, A. van der Kuil

In 2019 a start was also made on modernising the archive infrastructure. 4TU.ResearchData completed a tendering process to develop a new technical infrastructure. The new version of the archive will be released in the autumn of 2020, with new features for sharing, managing and publishing research data. This will increase the user-friendliness of 4TU.ResearchData.

Looking ahead to 2020

4TU.ResearchData's Strategy for 2020-2023 describes in detail the envisaged developments and broadening of services and products for the coming period. Among other things, the new data archive infrastructure will enable researchers to manage their research data. Discipline-specific networks will also be created.

The current range of training courses for researchers and research support staff will also be expanded in 2020 to include workshops on Software Carpentry and Code Refinery. Furthermore, 4TU.ResearchData will further expand its ties and relationships with researchers from within and outside the universities of technology so as to promote the services and use of the archive.

Director	Perry den Brok (WU)
TU Delft	Aldert Kamp (leader), Renate Klaassen (coordinator)
TU/e	Birgit Pepin (leader), Caroline Vonk (coordinator)
UT	Jan van der Veen (leader), Ineke ten Dam (temporary coordinator)
WU	Emiel van Puffelen (leader), Nicolette Tauocchio (coordinator)
Advisory Board	Kristina Edström (KTH Stockholm), Marc de Vries (TUD), Lex Lemmens (TU/e), Rikus Eising (UT), Erik Heijmans (WU), Christiaan Meijer (Student TUD)

The 4TU.Centre for Engineering Education (4TU.CEE) encourages innovations and research in engineering education. It does this by linking **education innovation** to previous or new research, strategy development and international cooperation.

For each activity, the CEE brings together lecturers and researchers from each participating university. The spectrum of projects and activities runs from a range of short innovation projects to doctoral programmes of longer duration. Connection to international experts and relevant literature is an element of the 4TU.CEE approach. The centre regularly presents its results at conferences, during workshops and its own events, and in academic and other journals.

The substance of the [4TU.CEE Strategic Plan](#) for the 2019-2021 period is aimed at four main topics: (1) training the engineers of the future, (2) interdisciplinary engineering education, (3) the creation of education ecosystems for modern engineering education and (4) excellent professors in engineering education.

Results in 2019

In 2019 the CEE was more visible than ever. The [4TU.CEE Innovation Map](#) has been completely overhauled and now contains information on more than **215 innovations/projects**. With over 25,000 hits, the 4TU.CEE's websites received almost 20% more visitors than in 2018. The 4TU.CEE also published five [newsletters](#) for more than 3,000 subscribers and reported on activities via a [blog](#) and on [LinkedIn](#).

Aldert Kamp (TU Delft) wrote a [position paper](#) for CESAER (EU) entitled 'Science and Technology Education for 21st century Europe'. The CEE was also **recognised as a role model** for a well-functioning educational ecosystem for innovation in education and teaching by the Dutch education councils (the Senior Secondary Vocational Education Council (MBO Council), the Primary and Secondary Education Councils (PO and VO Councils), the Association of Universities in the Netherlands (VSNU), the Netherlands Association of Universities of Applied Sciences (VH)), the Ministry of Education, Culture and Science and the Netherlands Initiative for Education Research (NRO) and, among others, by the Swedish Royal Academy of Engineering Sciences (IVA).

With the help of Ruth Graham, the CEE commissioned a roadmap for the implementation of the **Education Career Framework**, which is supported by all universities affiliated with the VSNU.

The 4TU.CEE also participates in an NRO consortium that wants to conduct research into the teaching and professional development of lecturers in higher education, within the context of educational renewal.

Conferences

In 2019, various presentations were given at, among others, the SEFI conference and the CDIO in Hong Kong and Shenzhen. CEE also played an active role on the organisation committee of the international conference of the Association for Interdisciplinary Studies. A number of publications also appeared, including a [special issue](#) on interdisciplinary education in the field of Architecture in the International Journal of Technology and Design Education (TU Delft) and a [contribution](#) on the use of online resources by mathematics students (TU/e). Brochures were also published on topics such as engineers for the future

(TU Delft), research as part of the Senior Teaching Qualification (UT) and an [evaluation of three years of educational innovation calls for proposals](#)(WUR).In Delft, CEE played an important role in setting up and implementing the [Joint Interdisciplinary Project \(JIP\)](#).

Workshops and training courses were organised on topics such as intercultural education (for which a [toolbox](#) for lecturers was also developed), encouraging active learning among students, and excellent teaching. The theme of student challenges and student projects was addressed during the Learning Spaces Tour, which in 2019 took place in Wageningen and Eindhoven.

Twente received a Comenius Leadership grant for research and the renewal of its interdisciplinary design modules. A number of PhD candidates and post-docs also started new research projects, on topics such as interdisciplinary and student-oriented education (2 PhDs at UT), university lecturers' learning during professional development programmes (PhD at WUR), lecturers' learning through re-designing their curriculum (postdoc at WUR), challenge-based learning (3 postdocs at TU/e), learning outcomes in non-traditional engineering education (2 postdocs at TU/e), interdisciplinary living labs (PhD at TU Delft), new student profiles in engineering education (postdoc at TU Delft) and self-regulation in mathematics education (PhD at TU Delft).

Looking ahead to the future 2020

In 2020, progress will be made with various current and new projects on the four themes mentioned above: future engineering education, interdisciplinary engineering education, development of education ecosystems, and excellent professors in engineering education.

In 2020 the international [SEFI conference](#) will take place, organised by UT, Saxion and 4TU.CEE. The theme of the conference will be 'Engaging engineering education'.

This year, Ruth Graham's international Advancing Teaching network will meet in the Netherlands (VSNU, Comenius network and 4TU.CEE). In 2020, an NRO application relating to the professional development of university lecturers will also be submitted, with CEE as a participating consortium partner. Special attention is also expected to be paid to the reorganisation of teaching, such as through the use of assistants.

With the launch of several projects at the various universities of technology concerning, for example, challenge-based education and extracurricular learning, we expect the first findings of the various projects in educational innovation to be published in 2020.

14 Centre for Resilience Engineering

Scientific director	David Smeulders (TU/e)
Managing director	Marjolein Dohmen-Jansen (UT)
MT	Jan Dirk Jansen (TUD), Ingrid Heynderickx (TU/e), Tom Veldkamp (UT), Bram de Vos (WU)

The 4TU.Centre for Resilience Engineering (4TU.RE) is the knowledge centre for resilience engineering. This knowledge centre seeks to develop, apply and disseminate knowledge, methods and tools to make societies more resilient. 4TU.RE focuses on technical solutions and system designs in interaction with social-ecological systems.

DeSIRE

The main programme that the centre is working on is called **Designing Systems for Informed Resilience Engineering** (DeSIRE), from the 4TU call for proposals for High Tech for a Sustainable Future. DeSIRE is an extensive, interdisciplinary research and capacity programme for which 16 new tenure track positions were created in 13 faculties at the four universities of technology. In 2018 and 2019 **15 of these vacancies had been filled**. The tenure track candidates are talented young scientists. Furthermore, an additional ten young 4TU scientists have already indicated their interest in participating in the consortium.

The talent of the scientists involved is evidenced by the fact that most of them are preparing or have already applied for prestigious individual grants such as a VENI grant (five scientists). More senior scientists are in the race for ERC and VIDI grants and/or are principal applicants for at least six H2020 proposals, two NWA proposals, seven NWO proposals and 13 other applications.

Teaching: RE Academy

In 2019, the centre's ambitious project, Open Educational Resources for Urban Resilience, received funding from SURF. This marks a first major boost to the RE Academy. All the tenure track candidates are taking part in this project, and the aim is to include various courses from the four universities of technology. This will be achieved by sharing and developing **open educational resources** aimed at urban resilience in Delta Programme regions and by integrating these resources in a variety of 4TU programmes. The focus will be on the development of teaching materials, case studies and games. The resources will be suitable for blended learning and will be combined with didactic manuals, quiz questions and exercises, etc. They will also be of value to and useful for people in the professional field.

First conference on Resilience Engineering

In June, the centre organised its first conference on resilience engineering: 'Building connections for resilience engineering solutions'. The aim was to create a forum for scientists and people from the field to meet each other, exchange experiences and address challenges on all aspects related to the resilience engineering of socio-technological and ecological systems. It was a first step towards the ambitious goal of building an RE community **and initiating and strengthening partnerships**.

The conference featured three international keynote speeches, six scientific sessions, two practitioner workshops (one session by NGInfra and one by IBM) and pitches by the participating DeSIRE tenure track candidates. 4TU's 100 Resilience Fellows programme was also launched at the event (see below). This first national conference attracted around 90 participants. The follow-up survey showed that the attendees appreciated the interactive character of the event and that they were able to establish new connections.

100 Resilience Fellows

The centre used the occasion of the conference to launch 4TU's 100 Resilience Fellows programme (100 RF). This programme encourages young, mid-career and senior professionals from science and practice to visit groups within the four universities of technology to **exchange knowledge**. The 100 RF programme consists of a Young Resilience Fellows programme, Resilience Research Fellows and Ambassadors of

Resilience Engineering. The first RE Ambassadors were the two main keynote speakers at the DeSIRE conference: Jim Hall (University of Oxford) and Juliet Mian (Director of Resilience Shift, a programme of the Lloyd's Register Foundation). To date, nine national and international Resilience Fellows have been appointed, both from practice and academia.

International network for Resilience Engineering

The RE centre's international network has been expanded through relations with the following institutes:

- Stockholm Resilience Centre (SRC), Sweden, the headquarters of the global Resilience Alliance for socio-ecological systems. Following the productive visit of the 4TU.RE Steering Group to SRC in April, two joint conference sessions were organised.
- Future Resilience Systems (FRS), Singapore-ETH-Centre (ETH Zurich and four universities in Singapore). Several former FRS PhD candidates joined DeSIRE as tenure track candidates or post-docs. In 2020, the centre will organise the RE conference in collaboration with FRS.
- Stevens Institute of Technology, USA, will co-organise the annual RE conference in 2022.
- Texas A&M, USA
- TU Darmstadt-EmergenCITY, Germany (interdisciplinary research centre focused on the resilience of future digital cities). 4TU.RE was invited to write a Declaration of Intent for collaboration with this newly established centre.
- University of Oxford, United Kingdom
- Resilience Shift

Agenda for 2020

In 2020, the results of the many grant applications submitted by tenure track candidates will be announced. A decision will also need to be taken regarding the follow-up of the STARS – Resilient Smart Urban Mobility Systems research proposal.

In June, the RE centre will organise a summer school in Wageningen: Agent Based Modelling for Resilience – Making it Happen! (in collaboration with 4TU.AMI and the European Social Simulation Organisation).

Various matchmaking events will be organised with a view to setting up partnerships and, in collaboration with the Global Adaptation Center, opportunities to contribute to the Climate Week, organised around the Climate Summit in October 2020, will be explored.

The centre will devote plenty of attention to communication via a revamped website and newsletters.

15 Energy

Scientific director	Paulien Herder (TUD)
Managing director	Yvonne Schavemaker (TUD)
Management team	David Smeulders (TU/e), Gerrit Brem (UT), Harry Bitter (WU)

To facilitate and accelerate the energy transition, the four universities of technology are combining their efforts within 4TU.Energy. The mission is to bring researchers and students from the four universities closer together and thus strengthen ties in the field of education and research. This way, the people required for the transition can be trained together and crucial scientific knowledge and new technologies can be developed in order to facilitate progress towards a sustainable, CO₂-neutral – or, preferably, a CO₂-negative – energy system in the coming decades. This ambition ties in directly with the Sustainable Development Goals of the United Nations regarding CO₂ reduction, such as affordable and clean energy, climate action and sustainable cities and communities. In addition, 4TU.Energy contributes to the goals of the Dutch Energy Agreement and Climate Agreement.

In 2019, 4TU.Energy prioritised the development of a joint research project, the preparation of Graduate Schools and the support of joint events.

NWO Cross-Over

The NWO Cross-Over project [Reversible large-Scale Energy Storage](#) (RELEASE) was co-founded and co-funded by 4TU.Energy. The proposal was accepted in December 2019! The project (with a budget of over €10 million) focuses on key technologies, such as hydrogen production, the production of hydrocarbons from CO₂ and flow batteries. These technologies will play a major role in the future in the storing of energy for the short (2030) and longer term (2050). This proposal is coordinated by TU Delft, in cooperation with Twente and Eindhoven, and with 37 other partners (universities, universities of applied sciences, research institutes, industry, SMEs and government parties).

Graduate Schools

Work has begun to set up two [Graduate Schools](#), both to be launched in the autumn of 2020. The first concerns system integration, with contributions from Laurens de Vries (TU Delft), Johann Hurink (UT), Matthijs Smit (WUR) and Geert Verbong/Floor Alkemade (TU/e). This course will be taught in two blocks and will include lectures given by inspiring speakers as well as an energy game.

The second Graduate School is headed by Harry Bitter in collaboration with the 4TU.Energy team and is intended to provide PhD candidates with a broader understanding of the global energy system, including the different forms of energy, the use of energy in different sectors and links within the energy system. PhD candidates will also reflect upon and examine the development of the energy system to date as well as expectations for the future. It is hoped that these Graduate Schools will bring together many researchers from different disciplines and provide a basis for [future collaborations](#) in new areas of research.

Networks

4TU.Energy is [well connected](#) to leading Dutch networks, such as the [Netherlands Energy Research Alliance](#) (NERA), [Top Sector Energy](#) and the platform [Electro Chemical Conversion and Materials](#) (ECCM). Participants share knowledge and information and look for opportunities to collaborate on large-scale infrastructure projects or on the government's long-term mission-driven innovation programme, for example.

Upon request, support was provided for various events involving the four universities of technology, including the SENSE conference on Our Future Energy Landscape and the ECCM Graduate School. In addition to increasing the visibility of 4TU.Energy, the joint facilitation of these events results in collaborations and discussions between the various universities.

Agenda for 2020

2020 will see the implementation of several plans which were developed during 2019, such as the Graduate Schools on system integration and the global energy system.

4TU.Energy is also keen to contribute to the visibility of academic work on the topic of the energy transition in society. To that end, 4TU.Energy will produce short accessible videos on a monthly basis. These videos will demonstrate in a clear and instructive way the joint contribution of the universities of technology to the energy transition. They can also be used to highlight particular projects and infrastructure. These videos can be used to target the general public, as well as politicians, national and international media and new students, for example.

In 2020, 4TU.Energy will continue to bring in new research. At present, the centre is exploring the issues of heat conversion and the storage of heat and molecules in the subsurface and the built environment. 4TU.Energy will also continue to participate in events in which all four universities of technology are involved and which could lead to new collaborations and ideas for research and innovation. Examples include the Smart Buildings symposium in February (TU Delft) and the Caloric Heating and Cooling Seminar in July (UT).

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Stan Ackermans Institute

Director	Paul Koenraad (TU/e)
Coordinator	Ben Donders (TU/e)
Board	Paul Koenraad, Ben Donders, Geert Dewulf (UT), André de Haan (TUD)
Coordinator Delft	Pieter Swinkels
Coordinator Twente	Timo Meinders

The Stan Ackermans Institute (SAI) is the banner under which the designer programmes at the universities of technology in the Netherlands are presented to potential trainees and businesses. Graduates receive the degree of Professional Doctorate in Engineering (PDEng).

The SAI presents itself via a website, brochures and social media posts. To recruit potential trainees, the SAI also attends business days at the four universities of technology and elsewhere in the country and in Germany (Hannover Messe). In 2020, a brochure will be published containing a selection of design assignments that trainees have completed.

TU Delft has four active degree programmes, in Twente a fifth programme was launched in 2019 – Business & IT – and TU/e has 11 active degree programmes. The intake in the programmes has declined slightly from 170 to 168, and the number of graduates has declined from 181 to 158. An overview of intake and graduation figures by programme and institution is provided by the table in this section.

The Education Management Committee asked the SAI board to issue advice on the future of the degree programmes following a discussion between 4TU.Education and CCTO about the new programme at UT and the plans of the universities of applied sciences for a third cycle (working title 'professional doctorates'). The board formulated its advice after consulting CCTO and the Deans of the Graduate Schools of the four universities of technology.

Overview of intake and degree certificates issued for designer programmes 2014-2019

	2014		2015		2016		2017		2018		2019	
	D	I	D	I	D	I	D	I	D	I	D	I
TU Eindhoven												
Process and Product Design (PPD)	23	22	22	24	19	28	23	28	30	21	26	22
Information and Communication Technology (ICT) ¹	8	14	11	6	14	10	3	12	10	5	8	5
Logistics Management Systems (LMS) ²	6	11	12	4	7	10	4	0	8	0	1	0
Mathematics for Industry (MI)	10	15	15	6	14	0	5	0	0	0	0	0
Software Technology (ST)	16	19	20	17	15	20	16	17	20	18	15	19
Design and Technology of Instrumentation (DTI)	8	10	7	7	10	9	6	9	9	0	6	0
Architectural Design Management Systems (ADMS)	0	0	1	0	1	0	0	0	0	0	0	0
User-System Interaction (USI)	17	15	15	17	14	13	18	0	10	1	2	1
Automotive Systems Design (ASD)	6	13	12	14	11	15	14	14	14	14	13	15
Smart Energy Buildings & Cities (SEBC) ³	8	9	10	8	8	6	8	13	1	12	15	9
Clinical Informatics (CI)	7	10	9	13	11	13	10	13	12	13	10	14
Qualified Medical Engineer	2	7	3	1	6	7	0	5	6	7	5	4
Data Science (DS)		0		0		11		20	9	20	16	25
Total	111	145	137	117	130	142	107	131	129	111	117	114
TU Delft												
Process and Equipment Design (PED)	7	10	10	9	9	9	8	13	10	10	12	13
Bioprocess Engineering (BPE)	5	9	12	7	10	8	7	7	8	7	7	7
Comprehensive Design in Civil Engineering (CDCE)	5	0	0	0	1	0	0	0	0	0	0	0
Chemical Product Design (CPD)		9	1	7	6	7	7	6	9	8	6	8
Civil & Environmental Engineering									0	5	0	6
Total	17	28	23	23	26	24	22	26	27	30	25	34
Twente												
Energy and Process Technology (EPT)	1	3	2	4	3	11	4	6	9	12	6	10
Robotics		4	1	2	4	5	2	4	4	3	2	1
Civil Engineering (CE)		5	6	6	3	7	4	2	4	7	6	7
Healthcare Logistics		0	0	0	0	0	0	0	0	0	0	0
Maintenance			0	2	0	9	1	4	8	7	2	2
Business & IT (<i>nieuw</i>)												0
Total	1	12	9	14	10	32	11	16	25	29	16	20
Total 4TU	129	185	169	154	166	198	140	173	181	170	158	168

¹ New name: Design of Electrical Engineering Systems

² New name: Industrial Engineering

³ New name: Smart Buildings & Cities

17 High Tech for a sustainable Future

With the allocation of €22 million to five research programmes on the theme of High Tech for a Sustainable Future, the 4TU.Federation gave a huge boost to research on sustainable technology. This will enable the four universities of technology to take the lead in creating significant impact on challenges facing society in the long term. The four universities of technology freed up this sum within the framework of the profiling budget intended for research that contributes to the Dutch National Research Agenda (NWA). The research proposals fit the focus areas of the government's Top Sector policy, the NWA and the UN's Sustainable Development Goals.

17.1 DeSIRE

Programme coordinator: Tatiana Filatova, UT

The [Designing Systems for Informed Resilience Engineering](#) (DeSIRE) programme connects new insights into resilience engineering with knowledge about economic and societal resilience. It focuses on three strategic challenges: Thinking and designing resilience, making resilience measurable and quantifiable, and related governance issues. The DeSIRE Resilience Academy provides support to a new generation of engineers and experts, 100 Resilience Fellows, who are trained to overcome challenges in the design, building and integration of vital infrastructure.

2019

For more information regarding activities carried out in 2019, please see Section 13 on the [4TU.Centre for Resilience Engineering](#).

17.2 Plantenna

Programme coordinator: Peter Steeneken, TU Delft

The Plantenna programme focuses on the heavily intertwined problems of climate change, air pollution and food shortages. In view of the growing world population and increasing urbanisation, these are issues that are set to intensify. A key component of the programme is the development of sensor technology that will collect information within plants about the condition of the crop and its immediate environment. By linking together plants equipped with this technology in networks – an 'internet of plants' – the information collected can be used to monitor the climate and weather and increase crop yields through more efficient fertilisation and irrigation.

2019

The main priority of the consortium, which consists of ten groups from the four universities of technology, was the recruitment of tenure track and postdoctoral researchers to carry out the research project. By the end of 2019, seven tenure track candidates (assistant professors), one associate professor and seven postdoctoral researchers had been appointed and, as a result, all positions have been filled.

The first set of tangible results has been achieved, including the development of a sensor module which can be used by a prototype cyberplant to wirelessly monitor parameters such as temperature and humidity. This will be tested in a network in a greenhouse.

As many as 43 organisations have expressed an interest in the Plantenna project; various grant applications have now been submitted in collaboration with these partners, or other joint efforts are currently in the pipeline.

One NWO grant amounting to €1.1 million has already been awarded (three PhD candidates) and seven proposals are either currently in preparation or have already been submitted.

17.3 Precision Medicine

Programme coordinator: Michel Versluis, UT

The aim of 4TU's new Precision Medicine programme is to use deep learning, a special kind of artificial intelligence, and medical imaging techniques to raise the level of diagnostics. In this way, the researchers involved in the programme aim to unlock more relevant medical information. This will enable a shift from a one-size-fits-all approach to a tailored, personalised approach. The researchers see this as *the* way to keep healthcare accessible and affordable in the long term.

2019

All seven vacant tenure track positions were filled in 2019. Most tenure track candidates have acquired (internal or external) funding for PhDs and all are now involved in teaching activities.

A number of scientists involved also have a dual position at medical centres and vice versa. As such, key clinical partners include IDII (TU/e, Maastricht UMC+, UMCU), CMINEN (UT, Radboudumc, UMCG) and Medical Delta (TU Delft, Leiden UMC, ErasmusMC). Furthermore, a number of joint proposals received a high ranking in the NWA call for proposals. The first results of cross-fertilisation between the universities of technology will be revealed with, for example, a new line of research between Delft and Wageningen and the possible joint use of the MRI machine in Twente.

17.4 Pride and Prejudice

Programme coordinator: Aarnout Brombacher, TU/e

Exercise and nutrition are two important factors for a healthy lifestyle. Not only are both of these hard for people to change in the long term, they are also difficult to measure. What makes this project innovative is that it combines real-life monitoring via sensors (food consumption, physical activity and health parameters) with the development of design interventions at different levels of the system (person, group, society) and an evaluation of the effectiveness of these combined interventions, especially in the long term.

2019

In 2019, all eight tenure track positions were filled; an equal number of men and women were appointed. The scientists have since started their projects. A particularly exciting product, the sensory interactive table, was even presented during Dutch Design Week. The programme is involved in drawing up national agendas on prevention (the National Prevention Agreement) and Top Sector policy.

Various P&P scientists are helping to establish NWO consortia to develop project proposals for the NWA and/or to join larger public-private partnerships on the subject of Healthy Generations.

17.5 Soft Robotics

Programme coordinator: Herman van der Kooij, UT/TU Delft

Robots that operate among people need to have a soft touch. The robots that we are familiar with in industrial production are extremely precise and fast, but they are also rigid. They are less suitable for safe physical contact with people or, for example, picking up foodstuffs that can be damaged easily. 4TU Soft Robotics seeks inspiration from nature, like the grip of a tree frog or the flexible tentacles of a squid. Biological knowledge, new control technology and innovative robot design go hand and hand here: the partners in 4TU strengthen each other, so that the Netherlands can command a leading position in this new field.

2019

Good candidates have been found for five of the six tenure track positions; the sixth and final candidate for the position in Eindhoven is still being sought. Within the consortium, strong ties have been forged with academic hospitals and industrial partners. Efforts are currently being made to develop educational resources that will soon be able to help students find their way in this relatively young field of research. In Delft and Twente grants have been awarded for PhD positions and five research proposals are either currently in preparation or have already been submitted. The first annual open symposium on Soft Robotics will be held in June 2020.

18 Master's Programmes

Construction Management & Engineering

The Master's programme in Construction Management and Engineering (CME) is a two-year Master's degree programme taught in English. It addresses the growing need for change within the building and construction industry and teaches students how to deal with current and future transitions. At present, this industry is under huge pressure because of the growing need for more transparency, customer focus and innovation. In addition, today's society wants the industry to look for more sustainable solutions.

Directors of Studies:

Jules Verlaan (Delft), Bert Snijder (Eindhoven), Andreas Hartmann (Twente)

Construction Management & Engineering

Year	Intake (TUD+TUE+UT)	Degree Certificates (TUD+TUE+UT)	Number of students (TUD+TUE+UT)
2014/2015	80 + 57 + 29 = 166	42 + 35 + 18 = 95	n.v.t.
2015/2016	65 + 46 + 15 = 126	52 + 35 + 22 = 109	210 + 111 + 62 = 383
2016/2017	70 + 32 + 38 = 140	65 + 35 + 22 = 122	216 + 97 + 65 = 378
2017/2018	86 + 31 + 25 = 142	65 + 38 + 21 = 124	233 + 98 + 72 = 403
2018/2019	82 + 30 + 17 = 129	83 + 29 + 22 = 134	238 + 90 + 74 = 402
2019/2020	70 + 18 + 15 = 103	n.v.t.	236 + 93 + 70 = 399

Embedded Systems

The Master's programme in Embedded Systems deals with hardware/software systems that are embedded in a larger product. The programme is aimed at the development of good, i.e. efficient and reliable, embedded systems.

Directors of Studies:

Hans Tonino (Delft), Bas Luttkik (Eindhoven), André Kokkeler (Twente)

Embedded Systems

Year	Intake (TUD+TUE+UT)	Degree Certificates (TUD+TUE+UT)	Number of students (TUD+TUE+UT)
2014/2015	51 + 70 + 29 = 150	26 + 23 + 10 = 59	n.v.t.
2015/2016	58 + 74 + 16 = 148	28 + 54 + 17 = 99	146 + 147 + 61 = 354
2016/2017	55 + 63 + 36 = 154	36 + 47 + 15 = 98	164 + 153 + 60 = 377
2017/2018	69 + 86 + 33 = 188	53 + 55 + 20 = 128	191 + 171 + 76 = 438
2018/2019	79 + 66 + 29 = 174	66 + 72 + 19 = 157	205 + 176 + 81 = 462
2019/2020	48 + 57 + 30 = 135	n.v.t.	186 + 164 + 102 = 452

Science Education & Communication

An important aspect of the Science Communication curriculum in the Master's programme in Science Education & Communication is to make science communication as effective, accessible and professional as possible.

Directors of Studies:

Marc de Vries (Delft), Ruurd Taconis (Eindhoven), Jan van der Meij (Twente)

Science Education & Communication

Year	Intake (TUD+TUE+UT)	Degree Certificates (TUD+TUE+UT)	Number of students (TUD+TUE+UT)
2014/2015	$52 + 31 + 23 = 106$	$27 + 5 + 16 = 48$	n.v.t.
2015/2016	$40 + 32 + 16 = 88$	$31 + 27 + 13 = 71$	$88 + 75 + 58 = 221$
2016/2017	$41 + 27 + 10 = 78$	$37 + 25 + 14 = 76$	$92 + 67 + 48 = 207$
2017/2018	$37 + 23 + 24 = 84$	$47 + 31 + 14 = 92$	$87 + 63 + 49 = 199$
2018/2019	$32 + 37 + 0 = 69$	$32 + 16 + 0 = 48$	$65 + 64 + 0 = 129$
2019/2020	$20 + 15 + 0 = 35$	n.v.t.	$65 + 70 + 0 = 135$

Sustainable Energy Technology

This programme offers engineers broad competences in the field of energy technology. Graduates can apply the knowledge and skills that they acquire in projects with a system-oriented and interdisciplinary approach. After completing the programme, the engineer can apply the basic principles of SET to provide technological solutions to challenges in sustainable energy, taking into account economic, social, ecological and ethical factors.

Directors of Studies:

René van Swaaij (Delft), Camilo Rindt (Eindhoven), Jim Kok (Twente)

Sustainable Energy Technology

Year	Intake (TUD+TUE+UT)	Degree Certificates (TUD+TUE+UT)	Number of students (TUD+TUE+UT)
2014/2015	$84 + 67 + 24 = 175$	$85 + 47 + 19 = 151$	n.v.t.
2015/2016	$99 + 43 + 22 = 164$	$89 + 46 + 20 = 155$	$252 + 125 + 53 = 430$
2016/2017	$104 + 49 + 19 = 172$	$74 + 49 + 19 = 142$	$273 + 117 + 47 = 437$
2017/2018	$113 + 43 + 49 = 205$	$98 + 49 + 12 = 159$	$297 + 112 + 66 = 475$
2018/2019	$122 + 46 + 47 = 215$	$88 + 58 + 20 = 166$	$309 + 102 + 94 = 505$
2019/2020	$118 + 47 + 21 = 186$	n.v.t.	$330 + 105 + 105 = 540$

Systems and Control

The Systems & Control Master's degree programme is intended for students with a technical Bachelor's degree who are interested in analysis and the control of dynamic systems in the broadest sense. The programme is aimed at both fundamental and application-specific functions, with an emphasis on the multidisciplinary character of the field. It deals with applications in mechanical engineering, electrical engineering, applied physics, chemical engineering and aerospace engineering.

Directors of Studies:

Hans Hellendoorn (Delft), Camilo Rindt (Eindhoven), Jan Willem Polderman (Twente)

Systems and Control

Year	Intake (TUD+TUE+UT)	Degree Certificates (TUD+TUE+UT)	Number of students (TUD+TUE+UT)
2014/2015	$90 + 43 + 16 = 149$	$38 + 15 + 10 = 63$	n.v.t.
2015/2016	$82 + 20 + 7 = 109$	$39 + 17 + 12 = 68$	$196 + 84 + 36 = 316$
2016/2017	$97 + 51 + 24 = 172$	$65 + 33 + 7 = 105$	$239 + 112 + 37 = 388$
2017/2018	$123 + 39 + 21 = 183$	$68 + 32 + 9 = 109$	$282 + 119 + 49 = 450$
2018/2019	$107 + 41 + 38 = 186$	$92 + 40 + 19 = 151$	$306 + 125 + 72 = 503$
2019/2020	$95 + 54 + 28 = 177$	n.v.t.	$317 + 141 + 80 = 538$

Specialisation: Cyber Security

The Master's specialisation programme in Cyber Security offers Computer Science students deep technical knowledge and a good understanding of all relevant socio-technical problems. Cyber security is a multidisciplinary field with a core of computer science (such as cryptography, formal methods, secure software engineering, and machine learning) and a broad range of supporting disciplines (such as law, economics, criminology, management, and psychology).

Specialisation coordinators: Willem Paul Brinkman (Delft), Pieter Hartel (Twente)

Note: The table below contains figures for Twente only.

Specialisatie: Cyber Security

Year	Intake	Degree Certificates	Number of students
2015/2016	11	10	11
2016/2017	11	5	37
2017/2018	21	28	39
2018/2019	19	42	52
2019/2020	21	n.v.t.	74

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Externe relaties

The 4TU.Federation has entered into agreements with several external parties. This section reports on the results of these agreements in 2019.

NEMO Kennislink

For more than 15 years, NEMO has been using NEMO Kennislink to make [scientific information accessible](#) to a broad audience, specifically to secondary-school students and teachers. This is done using news items, background articles, files and multimedia across the breadth of science. The federation's support is also reflected in Kennislink's production figures in the area of Technology.

NEMO is committed to becoming more and more relevant for (young) adults, not only by creating content online but also by organising live events. In 2019 steps were taken towards achieving this ambition: in the Studio, the new exhibition space on the Marineterrein next to the NEMO Science Museum, the 'Future Food' exhibition was organised in collaboration with researchers from WUR, Eindhoven University of Technology and TU Delft.

There was a significant increase in the number of pages visited on the NEMO Kennislink website. In 2019, a total of 118 articles were published on the subject of 'Technology', for example the article on [the future of flying](#) and on [how glass disguises itself as a liquid](#). In the 'Faces of Science' series, blogs are written and published by young PhD candidates – ten of whom worked at one of the four universities of technology in 2019. For example, Clara Stegehuis (Mathematics, TU/e) explains [in this blog](#) who, mathematically speaking, is the most sociable musician.

DCVA

In a little over ten years, the chance of having an unforeseen heart attack or stroke will be a thing of the past. That is the aim of the Dutch CardioVascular Alliance (DCVA), a new alliance that the 4TU.Federation joined in 2018. Twelve organisations, researchers and healthcare professionals in cardiovascular research are uniting their forces at the national level. The idea is to be able to detect cardiovascular diseases earlier on, and speed up the development of solutions and their availability (including evaluation) to patients. The joint objective is to realise a 25% reduction in the disease burden by 2030. To reach this goal, DCVA expects that it will need at least €1 billion in the coming ten years for research, valorisation and implementation. The twelve partners collaborate intensively to bring together the necessary human and financial resources, both with each other and with new partners.

Science and Technology Registration Authority

The 4TU.Federation is one of the co-founders of the Science and Technology Registration Authority (*Registerautoriteit Bèatechniek*). The registration authority verifies the quality, transparency and comparability of the various professional registers in the fields of science and technology. The federation provides financial support to the foundation that carries out these activities.

Foundation for the Promotion of Science and Technology

With a financial contribution from the universities of technology, the Foundation for the Promotion of Science and Technology (STP) has implemented its programme in the context of the science and technology tournament OO Techniek, the Eureka Cup, the First Lego League Jr and the First Lego League. In 2018, preparations began for making STP part of the Talent for Technology Platform. Discussions regarding its realisation are still ongoing.

RAI Amsterdam

In 2019, Secretary IJsbrand Haagsma participated in the jury for the HISWA 'Product of the Year' contest. The award this year went to GALAXY-INFL8, the world's first inflatable emergency VHF antenna. It is the only inflatable VHF antenna in the world, and is patented by Shakespeare Marine. If needed, the antenna and the marine telephone can be deployed very quickly.

History of Technology Foundation

The History of Technology Foundation (SHT) was established in 1988 on the initiative of the Royal Institute of Engineers in the Netherlands (KIVI) and the universities of technology. The SHT carries out groundbreaking work in the field of technological history. With financial support from the 4TU.Federation, SHT stimulates the history of technology and uses historical research and publications to illustrate the extent to which social and technical development processes are interwoven.