4TU.Federation

Annual report 2018

May 2019

Contents

Activity reports:

Introduction

For the third year in a row, increasing numbers of students and funding lagging behind are the two main themes for the 4TU.Federation. This is the first time that we can see light at the end of the tunnel. As from 2019, the sector plans will provide the financial scope to appoint extra staff, and the Van Rijn committee will in 2019 present its recommendations on how to fund higher education.

High Tech for a Sustainable Future

In 2018, it was decided which programmes on the theme of High Tech for a Sustainable Future (HTSF) would create new research cores by implementing new tenure track positions and through the appointment of post-docs. HTSF gives a new dimension to working together, where recruitment often takes place in a 4TU context and for multiple positions at the same time. By combining our strengths, we can achieve greater critical mass so that programmes can create more impact, especially for society.

Initiatives

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. 4TU is often able to enable these connections – and make them visible – with few resources. We shall continue to promote these initiatives in the future.

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, Nicoly Vermeulen (Delft University of Technology - TUD) Frank Baaijens, Jan Mengelers, Jo van Ham (Eindhoven University of Technology – TU/e) Thom Palstra, Victor van der Chijs, Mirjam Bult (University of Twente - UT) Arthur Mol, Louise Fresco, Thijs Breukink/Rens Buchwaldt (Wageningen University & Research - WUR)
Executive Committee	Victor van der Chijs (UT, chair), Tim van der Hagen (TUD), Jan Mengelers (TU/e), Louise Fresco (WUR)
Support	Lotte Melenhorst (TUD), Renee Westenbrink (TU/e), Maurice Bouwens (UT), Karin Horsman (WUR)
4TU	IJsbrand Haagsma

The General Management Board met three times and the Executive Committee five times, including a meeting with a delegation of staff. In addition, the Executive Committee had a meeting with the Van Rijn committee. During a number of these meetings, decisions were taken by board members from the financial administration foundation who were in attendance.

Funding

The main theme of the meetings of the Executive Committee and the General Management Board was the political discussion about funding the universities of technology. Contributions were made to the CHEPS research report, the problem analysis of the Association of Universities in the Netherlands (VSNU) (which resulted in the Room for Investing in Talent report) and the start-up phase of the Van Rijn committee, which must ultimately advise the government about a new way of funding. Right before Christmas, the Executive Committee had an extremely constructive discussion with this committee. The specific problem areas in science and technology were consistently backed up with numbers, and the consequences of funding lagging behind created a sense of urgency.

Meeting of experts

On 11 April, the 4TU.Federation and FME organised a well-attended meeting of experts about engineers and the job market. During this meeting, economists, experts in the field of education, members of the House of Representatives and State Secretary for Economic Affairs and Climate Policy Mona Keijzer looked for scenarios to remedy the lack of engineers in the Netherlands. The meeting once again showed the urgency of the problem and that simple solutions do not grow on trees, especially if financial resources are lacking. The added value was that experts, decision-makers and stakeholders engaged in dialogue in this respect.

Strategy

Because of the publicity given to the problems that arise along with the enormous growth in the number of students, external stakeholders have been seeking out the 4TU.Federation more often. This is changing 4TU's positioning. Given that the current activity programme will come to an end in 2021, it was decided to conduct a survey

among stakeholders before reviewing the strategy of the 4TU.Federation. Three groups were approached: those who are directly involved in the 4TU organisation, internal stakeholders who take part in 4TU's programme of activities and external stakeholders. The result of this stakeholders' survey will point the way for 4TU's strategy, which will be decided on in the course of 2019.

External partners

It was decided to continue to take part in the new technology pact. It was also resolved to take over the financing of the History of Technology Foundation from Eindhoven University of Technology and to fund this organisation collectively.

Bottom-up initiatives

Staff and students regularly undertake joint initiatives under the auspices of 4TU. Worth mentioning in this respect are the initiatives of the editorial boards of the four university magazines to publish a 4TU career special and the representatives of the health domains, who will be joining forces. The latter initiative is aimed at better embedding technology in health research and education, for example by showing that technology can make healthcare more affordable. The bottom-up initiatives show that the added value of cooperation is felt in many layers of the organisation.

Key indicators

The number of assistant, associate and full professors (in FTEs) in the 2007-2017 period is given in the tables below. This table shows the growth in academic staff. One noteworthy point is 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, 2007-2017

MALE	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	17/16	17/07
TUD	710	737	747	751	754	734	726	731	735	744	757	1,6%	6,6%
TUE	456	457	465	462	453	447	438	435	432	454	444	-2,2%	-2,5%
UT	376	391	423	486	467	452	434	421	417	418	423	1,3%	12,7%
WU	401	401	404	398	397	408	408	405	405	390	391	0,2%	-2,6%
FEMALE	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	17/16	17/07
TUD	99	111	124	128	139	146	161	167	178	185	196	5,6%	97,2%
TUE	48	55	59	62	65	58	73	81	98	108	114	5,7%	138,2%
UT	71	92	106	117	121	118	117	114	115	119	127	6,1%	78,6%
WU	94	101	104	106	115	121	123	132	144	152	162	6,8%	71,9%

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

2 Research Management Committee

Board	Arthur Mol (WU, chair), Tim van der Hagen (TU Delft), Frank Baaijens (TU/e), Thom Palstra (UT)
Support	Meike Sauter (WU, secretary), Lotte Melenhorst (TU Delft), Lisette Appelo (TU/e), Maurice Bouwens (UT)
4TU	IJsbrand Haagsma, Linda Baljeu

In 2018, 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 2018, this was realised e.g. via the new High Tech for a Sustainable Future programme. The committee also oversees the operation and management of the 4TU.Research Centres.

4TU Talent Stimulus: High Tech for a Sustainable Future

4TU Talent Stimulus 'High Tech for a Sustainable Future' is a new research programme initiated by 4TU.Research. For the 2018-2021 period, a total of 22 million euros has been set aside for this from the organisation's own resources. By combining their complementary knowledge, the universities of technology are going for innovation in research to achieve the maximum result together.
In March 2018, the 17 proposals that had been received were evaluated by a committee of academics. On the advice of this committee, 4TU.Research has approved five programmes: DeSIRE, Plantenna, Precision Medicine, Pride & Prejudice, and Soft Robotics. These programmes are covered in Chapter 16 of this annual report.
Researchers from the four universities work together within each of these programmes, for which 18 new tenure track staff were recruited as early as in 2018. These new, permanent academic staff, which will be involved in both research and teaching, not only guarantee continuity of the lines of research but also tie together research and teaching at the same time.
A special focus has been placed on recruiting female staff. Within the universities, the HR portfolio holders for Diversity have been brought together, and they have shared a list of handy tools for recruiting more women (and for recruiting women in general).

Research centres

A consortium of 4TU researchers has formed around the subject of energy. This group, under the leadership of Paulien Herder (Delft), has been awarded €150,000 a year for the 2018-2021 period. This sum will be used to set up the 4TU.Energy network organisation. The aims of this centre are elaborated on in chapter 13.
In 2018, it was decided to continue funding 4TU.High-tech materials until the end of 2021. The centre will also involve materials research in physics and chemistry.

Technology deans' forum

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 2018, the management committee spent ample time discussing the process and implementation of these plans and decided to set up a consultative structure among those persons directly involved. This technology deans' forum accommodates representatives of the deans of the 4TU technology faculties, plus those from the University of Groningen.

Dutch CardioVascular Alliance

On behalf of the 4TU.Federation, Frank Baaijens (TU/e) has joined the Supervisory Board of the Dutch CardioVascular Alliance (DCVA). The aim of this new alliance of twelve partners, researchers and healthcare professionals in the area of cardiovascular diseases, is to realise a 25% reduction in the burden of disease by 2030. Research groups from all universities and hospitals work together in alliances and receive support from partners in accelerating valorisation and implementation. This ensures that patients benefit from solutions faster. See also Chapter 18 (External partners).

Key indicators

The number of doctorates was on the rise again in 2018, after declining in the previous year. From now on, the number of PhD candidates present will be included in this annual report.

Number of 4TU doctorates, 2008-2018

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	18/17	18/08
4TU	789	842	915	917	973	1.064	1.145	1.130	1.182	1.063	1.161	9,2%	47,1%
TUD	236	264	333	319	303	353	371	357	395	359	368	2,5%	55,9%
TUE	191	192	189	199	245	218	243	234	224	212	264	24,5%	38,2%
UT	160	191	188	203	196	220	244	234	267	197	243	23,4%	51,9%
WU	202	195	205	196	229	273	287	305	296	295	286	-3,1%	41,6%

Number of 4TU PhD candidates present, 2010-2018

M	2010	2011	2012	2013	2014	2015	2016	2017	2018	18/17	18/10
TUD	1708	1835	1854	1871	1881	1913	1959	1995	2021	1,3%	18,3%
TUE	849	893	851	886	925	969	1028	1072	1070	-0,2%	26,0%
UT	850	839	831	784	784	783	756	751	699	-7,4%	-17,8%
WU	907	929	994	963	962	953	938	933	912	-2,3%	0,6%
F											
TUD	613	681	713	730	744	739	751	771	795	3,0%	29,7%
TUE	308	312	308	324	355	398	415	462	494	6,5%	60,4%
UT	411	445	421	409	420	452	436	442	429	-3,0%	4,4%
WU	785	872	965	992	941	943	929	938	955	1,8%	21,7%
4TU	6.431	6.806	6.937	6.959	7.012	7.150	7.212	7.364	7.375	0,1%	14,7%

Reference date: 31 December

Prizes

All of the following prizes were awarded in the 2018 reporting year. The titles of the grants should not serve as a guide. For example, the Vici 2017 grant was awarded in February 2018, and was therefore included in this annual report.

Innovative Research Incentives Scheme	ERC
Veni 2018: awarded in July 2018	Starting 2017: awarded in July 2018
Vidi 2017: awarded in June 2018	Advanced 2017: awarded in April 2018
Vici 2017: awarded in February 2018	Consolidator 2018: awarded in Nov 2018

TUD	**Veni 2018** Jeremy Brown Georgy Filonenko Robbert Krebbers Mengmeng Li Cynthia Liem MMus Mladena Luković Zoltán Perkó Carlas Smith **Vidi 2017** Anton Akhmerov Joris Bierkens Andrea Caviglia Frans van der Meer Amir Zadpoor **Vici 2017** Marnix Wagemaker	**Starting 2017** Oded Cats Sonia Conesa Boj Attila Geresdi Sergio Grammatico Jens Kober Marios Kotsonis **Advanced 2017** Nynke Dekker Ibo van de Poel **Consolidator 2018** Pouyan Boukany Chirlmin Joo	UT	**Veni 2018** Guillaume Lajoinie Jelmer Renema **Vidi 2017** Thomas Weinhart **Vici 2017** Jacco Snoeijer	**Starting 2017** Massimo Sartori Richard Stevens **Advanced 2017** Stefano Stramigioli **Consolidator 2018** Tibor Kudernac
TU/e	**Veni 2018** Alessandro Corbetta Rob Eggermont Tom Huiskamp Thijs Laarhoven Bart Macco Elizabeth O'Neill Soora Rasouli **Vidi 2017** Pieter Harpe Sandra Hofmann Oliver Tse **Vici 2017** Nikhil Bansal	**Starting 2017** Farbod Alijani Bart M.P. Jansen Sandra Loerakker Jurjen Tel Yoeri van de Burgt **Advanced 2017** Bert Meijer Nico Sommerdijk **Consolidator 2018** Willem Mulder	WUR	**Veni 2018** Georgy Filonenko Alexander Haverkamp Karen Kloth Dennis Oonincx Maryna Strokal Daan Swarts Yvonne Wientjes Ruud Wilbers Hannah van Zanten **Vidi 2017** Bernice Bovenkerk Maarten Smulders Eveline Verhulst **Vici 2017** Richard Immink	**Starting 2017** - **Advanced 2017** - **Consolidator 2018** -

NWO Spinoza Prize

In June 2018, the Netherlands Organisation for Scientific Research (NWO) announced that Marileen Dogterom and John van der Oost were the winners of the NWO Spinoza Prize. This is the highest honour in Dutch scientific research; each of the laureates receives 2.5 million euros to spend on scientific research and activities in relation to knowledge utilisation.
One of the most important 'faces' of biophysics in the Netherlands, Dogterom is among other things a professor of Bionanoscience at TU Delft and the driving force behind the national consortium BaSyC (Building a Synthetic Cell).
Van der Oost, professor of Microbiology at Wageningen University & Research, is one of the pioneers of the ground-breaking CRISPR-Cas technology. This enables scientists to remove, add and alter genes with the greatest precision. Experts call CRISPR-Cas one of the greatest revolutions in the life sciences.

Well represented in NWO Perspective programme

At the beginning of November 2018, NWO granted funding to six programmes within its Perspective programmes. These research programmes, with a budget of 28 million euros in total, enable researchers to work closely with businesses and civil society organisations in the development of technologies to meet the great needs of society. A university of technology will provide the programme manager for five programmes. Researchers from all four universities of technology will take part in the research focusing on new robotics for food production and on clean chemical processes for the storage of green electricity.

The research programmes will be funded from NWO's Perspective funding instrument for the top sectors. Every year, NWO grants Perspective funding to five or six new research programmes that fit in the top sectors. These are areas where Dutch businesses and research centres excel worldwide and seek to maintain their leading position. The multidisciplinary approach ensures that they do not work on scientific and societal problems alone. The participants also make substantial contributions to the Dutch economy and strengthen the international competitive position of the Netherlands with their research results.

3 Education Management Committee

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

In 2018, 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.

Continuing growth in the number of students

In 2018, the number of students at Dutch universities of technology was on a sharp rise again. The management committee collects data about the student population and analyses the growth of the number of students over the past years. Strategies are being sought to manage the explosive growth without a reduction in the quality of degree programmes. To guarantee the quality of the programme, it is unfortunately necessary to use decentralised selection for some of the Bachelor's degree programmes. The four universities of technology share their experiences and best practices in relation to the selection criteria and procedures. They are aiming to coordinate with each other at an early stage with regard to the programmes to which a numerus fixus will be applied, thereby allowing transfers to peer universities to proceed in the most orderly manner possible.

Internationalisation

The management committee also considers the degree to which degree programmes are offered in English. In 2018, it was decided to set up a working group to address decentralised selection, teaching in English, and internationalisation. The combination of these three aspects in relation to the accessibility of education will also be examined.

The significant increase in the number of students during the 2008-2018 period is illustrated in the following figure. It is also interesting to note that there has been an increase in the number of female students at the universities of technology. This number has grown in the past ten years by 112%.

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

4TU student population, 2008-2018, all students (primary enrolment as of 1 October)

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	18/17	18/08
TUD	15.490	16.570	17.329	17.721	17.874	19.148	20.034	21.469	22.199	23.325	24.508	5%	58%
TUE	7.066	7.267	7.307	7.519	7.762	8.377	9.209	10.116	10.764	11.372	11.966	5%	69%
UT	8.134	8.530	8.886	9.398	9.314	9.315	9.263	9.082	9.396	9.921	10.666	8%	31%
WU	5.157	5.695	6.457	7.071	7.491	8.302	9.032	9.720	10.697	11.446	11.944	4%	132%
4TU	35.847	38.062	39.979	41.709	42.441	45.142	47.538	50.387	53.056	56.064	59.084	5%	65%
M	26.243	27.535	28.178	29.022	29.280	30.967	32.363	34.025	35.290	36.983	38.688	5%	47%
F	9.604	10.527	11.801	12.687	13.161	14.175	15.175	16.362	17.766	19.081	20.396	7%	112%

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	18/17	18/08
INT	4.257	4.820	5.658	6.461	6.839	7.246	7.688	8.726	9.895	10.905	12.253	13%	188%
NL	31.590	33.242	34.321	35.248	35.602	37.896	39.850	41.661	43.161	45.159	46.831	4%	48%

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

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	18/17	18/08
TUD	2.637	2.782	2.730	2.790	2.756	3.057	3.125	3.274	3.352	3.640	4.094	9%	55%
TUE	1.394	1.524	1.501	1.591	1.729	1.967	2.144	2.276	2.395	2.616	2.336	9%	68%
UT	1.337	1.384	1.788	2.000	1.780	1.792	1.814	1.691	2.059	2.113	2.336	3%	75%
WU	887	1.016	1.113	1.102	1.181	1.457	1.484	1.521	1.654	1.712	1.711	4%	93%
4TU	6.255	6.706	7.132	7.483	7.446	8.273	8.567	8.762	9.460	10081	10.477	7%	67%
M	4.503	4.770	4.746	5.115	5.093	5.656	5.793	5.956	6.149	6.722	6.869	9%	53%
V	1.752	1.936	2.386	2.368	2.353	2.617	2.774	2.806	3.311	3.359	3.608	1%	106%

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	18/17	18/08
INT	445	481	670	842	725	738	761	803	1.149	1.298	1.886	13%	324%
NL	5.810	6.225	6.462	6.641	6.721	7.535	7.806	7.959	8.311	8.783	8.591	6%	48%

Centre for Engineering Education

The four universities of technology are collaborating to improve engineering education through the Centre for Engineering Education (CEE). The CEE collects and develops evidence-based knowledge with regard to engineering education. The four partners exchange expertise and experiences and enable researchers to improve their teaching skills by developing, exploring and demonstrating new teaching methods. One main theme in 2018 was to assess the teaching achievements of the academic staff. The four universities of technology are participating in a longitudinal international study on university culture in this area. The database on its website, listing innovative projects by colleagues within the four institutions, has reached 175 and provides great inspiration for professors who seek to renew their teaching practice.
This reporting year as well, the CEE regularly joined the Education Management Committee to update those present on trends, innovations in education and the results of studies. See also Chapter 14 (4TU.CEE).

Digitisation

The directors of the 4TU Master's degree programme Sustainable Energy Technology submitted a proposal for further digital collaboration as part of the Virtual Student Mobility project. For this purpose, two MOOCs will be developed per university, and students in Delft, Eindhoven and Twente can follow each other's MOOCs as their in electives. The project was launched in mid-2018 and will be completed in the 2020 academic year.

The 4TU.Applied Mathematics Institute (4TU.AMI) is a leader in the development of blended learning and open and online education. Educational and technical aspects of blended learning are being investigated and developed, with the objective of using them within the four universities for a variety of modules, including calculus, linear algebra and statistics.

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. This trend can also be seen in the number of Bachelor's and Master's degrees awarded.
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

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	18/17	18/00
TUD	1.049	1.368	1.156	1.240	2.089	2.327	2.519	2.207	2.878	3.392	3.498	18%	233%
TUE	338	494	487	621	717	887	976	655	1.117	1.182	1.243	6%	268%
UT	464	667	314	567	847	688	667	471	1.072	1.122	1.118	5%	141%
WU	736	890	1.095	992	1.325	1.310	1.300	1.228	1.676	1.748	1.763	4%	140%
4TU	2.587	3.419	3.052	3.420	4.978	5.212	5.462	4.561	6.743	7.444	7.622	10%	195%
M	1.623	2.205	1.795	2.098	3.170	3.243	3.516	2.893	4.127	4.578	4.666	11%	187%
F	964	1.214	1.257	1.322	1.808	1.969	1.946	1.668	2.616	2.866	2.956	10%	207%

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	18/17	18/08
INT	1.223	1.429	1.636	1.711	1.858	1.865	2.216	2.771	2.883	3.109	3.117	8%	155%
NL	1.364	1.990	1.416	1.709	3.120	3.347	3.246	1.790	3.860	4.335	4.505	12%	230%

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

4TU BSc degree certificates, 2007-2017

	2007	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*17/16*	*17/07*
4TU	3.350	3.182	3.493	4.338	5.542	4.875	4.955	5.565	5.175	5.626	5.962	6%	78%
M	2.320	2.271	2.393	2.996	3.863	3.166	3.205	3.651	3.284	3.616	3.854	10%	66%
V	1.030	911	1.100	1.342	1.679	1.709	1.750	1.914	1.891	2.010	2.108	5%	105%
INT	155	175	201	312	335	397	476	482	541	470	450	-13%	190%
NL	3.195	3.007	3.292	4.026	5.207	4.478	4.479	5.083	4.634	5.156	5.512	11%	73%

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

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	17/16	17/07
4TU	4.037	4.596	4.791	5.007	5.890	5.555	5.987	6.415	6.960	7.542	8.045	8%	99%
M	2.617	3.043	3.189	3.326	3.803	3.642	3.845	4.079	4.366	4.703	4.846	8%	85%
V	1.420	1.553	1.602	1.681	2.087	1.913	2.142	2.336	2.594	2.839	3.199	9%	125%
INT	870	1.129	1.247	1.398	1.649	1.674	1.845	1.967	2.164	2.637	2.933	22%	237%
NL	3.167	3.467	3.544	3.609	4.241	3.881	4.142	4.448	4.796	4.905	5.112	2%	61%

4 IMPACT

Director	Kees Eijkel (UT) until 1 Sept., succeeded by Paul Althuis (TUD)
Programme manager	Roelyn van der Hoek (UT)
Management team	Paul Althuis (TUD), Kees Eijkel (UT) until 1 Sept., 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 2018, these were Nicoly Vermeulen (TUD), Victor van der Chijs (UT), Jan Mengelers (TU/e) and Rens Buchwaldt (WU).

In 2017, the valorisation departments of the four universities of technology drew up a plan of activities to which they will jointly contribute. Previously, activities were largely regional, but by taking a joint 4TU approach, even more can be achieved in a relatively short period of time. Implementation of the plan commenced in 2018. The figure gives an overview of the aims and division by module.

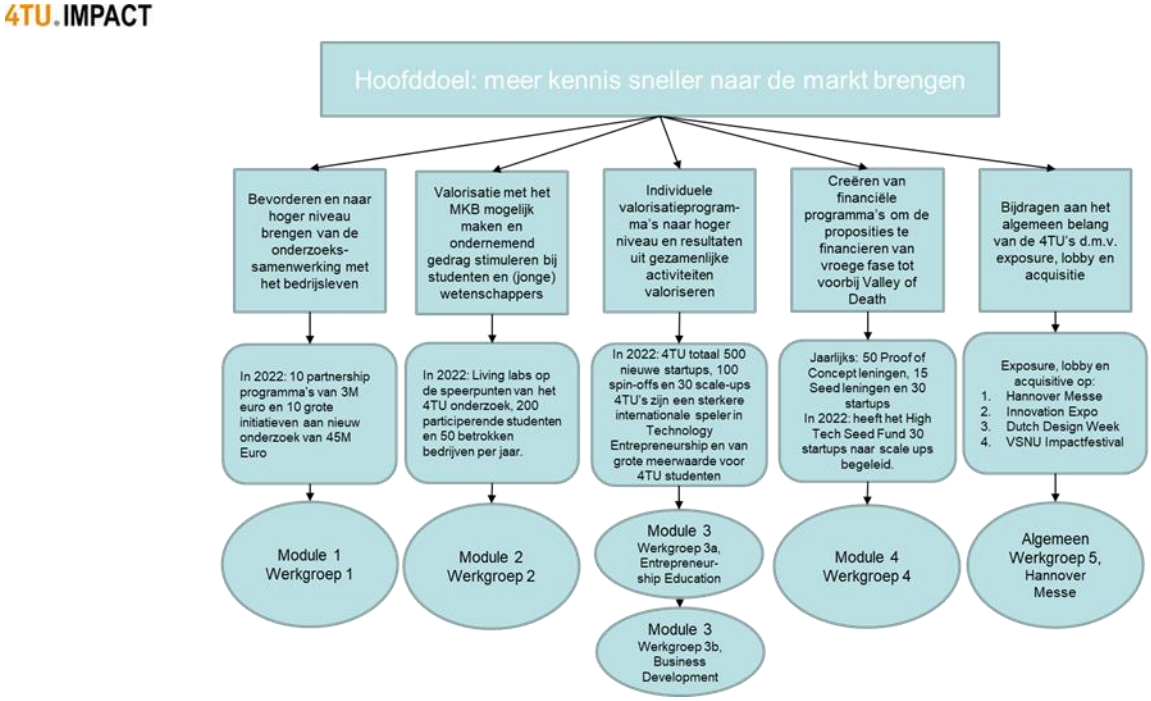


Diagram of 4TU.IMPACT activities plan

Module 1 - 4TU4Industry

This module builds on the collaboration with businesses by organising public/private alliances or strengthening them on the basis of resources, mainly from indirect funding. In 2018, three alliances, created in the run-up to the 4TU programme High Tech for a Sustainable Future, received support for their valorisation.

Module 2 - Living labs

In 2018, a review of the living labs and field labs was set in motion. This will be completed in the first three months of 2019 as the starting point for working towards greater collaboration in the existing living labs, logical connections and the establishment of new labs.
Following the successful student challenges at the universities of Eindhoven and Twente, it has been decided to start them in Delft and Wageningen as well. A joint national finale will follow: the Dutch 4TU Impact Challenge. The winner will receive a stand in the Holland Pavilion at Expo 2020 in Dubai and funds to realise the winning project.

Module 3A - Entrepreneurship education

This module combines forces in the area of research into entrepreneurship training. The previously developed Entrepreneurship for Engineers MOOC will continue running, and a second one, aimed at the theme of the circular economy/climate, is in the making. In addition, one of the partners directs an annual study into tools to encourage students to be more enterprising, which knowledge is then shared with others.

Module 3B - Screening & scouting

This revolves around creating awareness among researchers, in addition to scouting, screening and building together on business propositions that can grow to become licences or a start-up.
In 2018, NWO Applied and Engineering Sciences (NWO-TTW), together with 4TU and the Netherlands Organisation for Applied Scientific Research (TNO), developed a profile for 'measuring' a start-up/spin-off. With budget from 4TU, TNO and StartUp Delta, a start was also made with developing Science Finder: a search system for businesses and investors. This will quickly provide them with clarity on potential investment areas.

Module 4 - Finance

This module is used to create financial programmes for funding the growing number of propositions, from the initial stage to past the 'valley of death'. In 2018, two applications were under preparation for the new Thematic Technology Transfer scheme of the Ministry of Economic Affairs and Climate Policy and the Ministry of Education, Culture and Science. It will become clear in the first half of 2019 whether the applications have been approved for funding.

Module 5 – Exposure

The four universities of technology are working together to ensure that they are well represented for lobbying and acquisition during major events. In 2018, 4TU.IMPACT was present at the Hannover Messe, the Innovation Expo in Rotterdam and the Dutch Design Week.

Photos: Discussions were held at the Hannover Messe with the likes of State Secretary for Economic Affairs and Climate Policy Mona Keijzer, Secretary-General Maarten Camps and representatives of the top sectors.

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 contract and commercial funding received by the university in question in 2018 (by the date on which the project was signed). The full value of the contract for each project acquired in 2018 is provided. This includes only actual research projects, not proposals. This final figure provides a clear picture of the universities' order portfolio. This has increased by 12 million euros in comparison with the previous reporting year.

Acquisition 2018 (in millions of euros)

		4TU
Indirect funding		166.6
Contract funding		256.5
Business community	52.7	
Dutch government	57.7	
EU government	77.6	
Other	46.5	
Total indirect + contract		**450.9**

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, have been adopted for the purpose of this report:

	Spin-offs	Start-ups
TUD	3	18
TU/e	8	20
UT	3	(unknown)
WU	0	6

**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 (TU Delft)
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 (replacement WU)
Project Blended Learning	Hans Cuypers (TU/e, project manager), Bart van den Dries (TUD), Jan Willem Polderman (UT), Joost van Opheusden (WU)
Steering group Blended Learning	Stephan van Gils (UT, chair), Kees Vuik (TUD), Marko Boon (TU/e), Maarten de Gee (WU), Jan van der Veen (CEE)
SRO coordinators	Energy: Johann Hurink (University of Twente) Water: Henk Schuttelaars (TU Delft) Health: Stephan van Gils (University of Twente) Big Data: Nelly Litvak (University of Twente) 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 new Resilience area. 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

Since its establishment in 2016, the Blended Learning project group has provided digital educational resources and online testing for various courses, both in the universities' own teaching and in bridging and service teaching. In 2018, a repository[1] was created where digital educational resources are available to professors. This project has caught the attention of the Minister of Education, and it is seen as a model project as part of SURF. This works as a driving force; as a case in point, Project Innovation Mathematics Education has since been set up in Delft and the Education Innovation faculty group in Eindhoven.

In 2018, AMI again organised its annual InterTU study day and – together with the Matheon institute (Germany) – the Mathekalender, a mathematics contest for secondary-school pupils with a growing number of participants every year.

Research

The SROs where knowledge is shared and joint research is carried out promote collaboration among the mathematics groups of the four universities of technology. In addition, the platforms contribute effectively to cooperation with businesses and knowledge institutions in the Netherlands and abroad and organise various meetings.

[1] https://oncourse.tue.nl/equella/4TU.AMI/

The annual AMI conference was combined with the international Energy Open workshop of the Energy SRO and brought researchers together to explore new solutions for the energy transition.

Another successful event was the 4TU.AMI Big Data Symposium. The aim was to combine model order reduction with big data and to discuss the industrial applications of this combination. In addition, the Big Data SRO explained in *Nieuw Archief voor Wiskunde,* in its article 'Mathematics for Big Data' how different methods from mathematics and statistics can be used to control the ever-growing flow of data.

The Health SRO is closely involved in the 4TU programme Precision Medicine, where diagnostics are improved by integration with deep learning and medical imaging techniques.

At the end of 2018, a new SRO was established on the theme of resilience. Resilience and mathematics are closely connected, e.g. in statistics, risk analysis, simulations of near-disasters, etc. AMI therefore expects to be able to play a unifying role in the interdisciplinary 4TU programme DeSIRE.

The Water SRO submitted a proposal for the NWO programme Living Labs in the Dutch Delta and is busy preparing a Perspective programme proposal. In 2019, this SRO will also publish the book *Mathematics of Marine Modeling*.

Agenda for 2019

AMI will continue to serve as a unifying factor between the mathematics groups of the four universities of technology. AMI will further reinforce the cooperation with businesses and knowledge institutions through the SROs and the Blended Learning project. In 2019, AMI will also organise several networking events for companies. In addition, the current annual events, such as the InterTU study day, spring congress and new 4TU.AMI company events will be continued.

The Blended Learning project group is entering its completion phase. The results of the project will be presented in 2019, and a possible way to follow up the project will be explored. The project has already delivered much content and expertise. Application of this expertise can be extended to other specialisations.

AMI will support this connection with 4TU.NIRICT and the computer science and other groups involved with big data. Finally, AMI aims to submit a NWO Gravitation proposal, or something similar.

6 Design United

Scientific director	Daan van Eijk (TUD)
Managing director	Bart Ahsmann (TUD)
Board	Ena Voûte (TUD), Lin-Lin Chen (TU/e), Geert Dewulf (UT)
Liaison officers	Geert van den Boogaard (TUD), Stephan Wensveen (TU/e), Mascha van der Voort (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:
- development of an approved research agenda and resulting research collaboration initiatives;
- promoting a shared understanding of the research area and exchange of knowledge and experiences with a view to enhancing the quality of research;
- increasing accessibility to research results via symposia, an annual design research exhibition and publications;
- creating a network comprising the above parties and a powerful organisation, which can influence policy development and serve as a point of contact for partners.

Results for 2018

Design United played an active role in implementing the Knowledge and Innovation Agenda (KIA) of CLICKNL, the Top Consortium for Knowledge and the Creative Industry top sector. The KIA serves as a guide for the use of research funds for 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).

DU was one of the initiators in the development of Pride and Prejudice, a project approved in 2018 in the framework of the 4TU call for proposals for High Tech for a Sustainable Future. The project is aimed at the prevention of chronic disease by means of real-life monitoring and contextual intervention design. This means excellent prospects for bringing together researchers from all 4TU faculties in the 2018-2021 period in a subject at the heart of DU's agenda.

DU is a co-founder and organising partner of the Design Research & Innovation Festival (DRIVE) during Dutch Design Week in Eindhoven. In October 2018, this festival was held for the fifth time, on the theme of 'Into an Innovative & Inclusive Society'. The festival consisted of sessions about a broad range of topics related to the Knowledge and Innovation Agenda of CLICKNL. More than 150 researchers and creative professionals shared their latest knowledge with a total of 442 unique visitors.

DRIVE Festival 2018

Mind the Step 2018

In 2018, DU also had a prominent presence at the annual Mind the Step exhibition during Dutch Design Week. This exhibition displayed research projects by three universities of technology on design, research and technology by means of 52 stands, 25 lectures, a brochure and a website. The exhibition attracted 75,000 visitors, including Minister van Engelshoven (OCW), relevant civil servants and delegations from companies.

Agenda for 2019

In 2019, Design United will continue to pursue a substantive agenda focusing on the following topics:
- a design approach to complex product service systems;
- designing in field labs and living labs;
- a healthy society, a circular economy and smart industry through design-driven innovation.

This agenda is consistent with the CLICKNL's KIA through the development of key technologies in the road maps. DU is closely involved in formulating the new mission-driven innovation agendas of the Creative Industry top sector.

DU will continue to take part in the development of the 4TU programme Pride & Prejudice, especially in relation to extra research funding and strengthening the network.

DRIVE will be organised again in 2019, and this year the mission-driven domains will occupy centre stage. In addition, there is still room to present public/private partnerships in other domains. In connection with DRIVE, Design United will present its own 4TU exhibition at Dutch Design Week 2019. The aim is to give Industrial Design a clearer profile in this way.

7 Ethics and Technology

Scientific director	Anthonie Meijers (TU/e)
Managing director	Tijn Borghuis (TU/e)
Assistant director	Karen Buchanan (TU/e)
Management Team	Scientific and managing director, the head of departments and one additional representative from TU/e and TUD

The 4TU.Centre for Ethics and Technology (4TU.Ethics) was established 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.

At the end of 2018, 4TU.Ethics had a total of 14 professors, 22 senior researchers, 17 post-docs and junior researchers, 22 doctoral candidates, and 76 affiliated members. The total number of members grew this year by 27.

Research

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. During 2018, a new framework for the research in the coming period was developed that concentrates on socially disruptive technologies.

Main activities

In January, the Executive Committee switched from Twente to Eindhoven, and Wageningen University's Philosophy group officially joined 4TU.Ethics. In response to this addition and the more limited financial possibilities, the centre developed a new strategy for the 2018-2021 period in the area of research, teaching (including the course programme for PhD candidates), and valorisation. At the Annual Research Day in Eindhoven, the interdepartmental task forces of the centre examined their fields and methods. Part of the day was open to the public, with a lecture by Mariachiara Tallacchini (UCSC-Piacenza) entitled Algorithms and Rights: From Privacy to Fairness.

In cooperation with the Royal Institute of Engineers in the Netherlands (KIVI), 4TU.Ethics developed the Ethics, Technology, and Engineering MOOC as part of the certification programme that KIVI offers its members. This course has been offered worldwide since spring, via the online Coursera platform.

With the organisation of the Philosophy of the City Summer Colloquium 2018 in Twente, 4TU.Ethics contributed to the development of the philosophy of the city, where the interaction between technology and city is studied.

4TU.Ethics ran the Ethics and Innovation – Let's Start at the Beginning session at the national Innovation Expo 2018 in Rotterdam, where the role that ethics can play in innovation was brought into the limelight.

As part of the National Applied Ethics Conference, METU Ankara, 4TU.Ethics ran a Teaching Ethics workshop to share experiences with teaching ethics to engineers and to familiarise Turkish professors with ethics teaching methods that have been developed within 4TU.Ethics.

In 2018, members of 4TU.Ethics acquired funds for eight new projects:

NWO	€1,050,000
EU/ERC	€2,500,000
EU/H2020	€1,805,515
Other	€276,000
Total	**€5,631,515**

In addition, the centre and the Ethics Institute of Utrecht University submitted a Gravitation proposal entitled Ethics of Socially Disruptive Technologies (€26,760,000). The proposal had reached the final selection round at the time of writing this report. In addition, the proposal entitled Ethics Education for Engineers (€293,376) was submitted for the SURF call for proposals for Open and Online Education: Open Educational Resources, and this proposal has since been approved for funding.

Agenda for 2019

National and international workshops will be organised during the year, including workshops in cooperation with the 4TU.NIRICT centre (Cybersecurity Ethics Workshop) and 4TU.Resilience Engineering centre (From the Ethics of Risk to the Ethics of Resilience: Integrating Participatory Approaches). The second edition of the international 4TU.Ethics Bi-annual Conference will be held in Eindhoven on 7 and 8 November, on the theme of Ethics of Disruptive Technologies.
In August, the two-year Ethics Education for Engineers project will begin, where case-based exercises for teaching ethics to Bachelor's and Master's students will be combined for publication as an open educational resource via a 4TU.Ethics open repository.

8 High-Tech Materials

Scientific director	Jilt Sietsma
Coordinator	Reina Boerrigter
Management team	Sybrand v/d Zwaag (TUD) Rint Sijbesma, Marc Geers (TU/e), Remko Akkerman, Julius Vancso (UT), Joris Sprakel (WU)
Board	Theun Baller (TUD), Jeroen Cornelissen (UT), Philip de Goey (TU/e), Raoul Bino (WU)

The primary objective of the 4TU.High-Tech Materials Research Centre (HTM) is to stimulate and take a fresh approach to outstanding materials science research within the four universities of technology through collaboration and new initiatives relating to both research and education. The researchers involved represent many aspects of materials science, ranging from fundamental to applied research and from nanotechnology to constructions. Since 2015, 4TU.HTM has been able to bring together materials research in the Netherlands in this way.

Research

With its New Horizons in Designer Materials research programme, started in 2015, HTM spurs on academic materials science research in the Netherlands, so that new lines of research at the four universities of technology are initiated which will also contribute in the decades to come to the high level of materials science research and education. Within this programme, six research projects have been carried out by high-potential post-docs. Two of them have received personal grants that have allowed them to continue their research topics, in collaboration with new post-docs within the original research project. Two post-docs now have a tenure track position.

Cooperation within the six research projects continued in 2018, with the international experts who were involved in the HTM research programme and with various research groups within 4TU and elsewhere in the Netherlands.
In Maciej Kopeć's research project, collaboration with Krzysztof Matyjaszewski (professor at Carnegie Mellon University, US, and pioneer of ATRP polymerisation technology) was important for the application of an advanced variant of ATRP where glycopolymer materials can be synthesised under standard circumstances and with minimal use of copper as a catalyst. These materials have potential for use in e.g. controlled delivery and molecule identification.
Nick Tito's research project has generated new knowledge and application potential for polymeric materials with reversible properties. Insights and simulations where entropy effects create the balance conditions form the basis for the development of polymer gels with reversible bonds, so the material can be hardened without changing its intrinsic elasticity.

The research in the six projects has resulted in e.g. various academic publications in leading international journals, such as *Advanced Materials, Advanced Optical Materials, Advanced Functional Materials, Nature Communications, Nature Chemistry, Soft Matter*, etc. In addition, in 2018 four projects contributed to the journal *Innovatieve Materialen/Innovative Materials*. 4TU.HTM will present an overview of all scientific results of the research programme in a publication for the public in the second half of 2019.

Results

At the annual HTM Dutch Materials symposium, the keynote speeches were delivered by two international speakers in Computational Materials Science. In addition, there were contributions from various 4TU research groups, and the public consisted of colleague researchers from many material sciences groups within the four universities of technology and researchers from the industry.

With its funding and support, the centre has helped to make various activities possible to promote the excellence and accessibility of materials science research in the Netherlands. Examples are the 12th International Symposium on Polyelectrolytes (WU) and the 16th Conference of the International Association of Colloid and Interface Scientists, organised by researchers from Delft and Wageningen.

In order to present materials science and materials scientists working within various research groups at the four universities of technology, HTM is developing a variety of activities. A web application has been developed to provide an overview of the expertise of materials scientists within HTM (http://hightechmaterials.4tu.nl) for e.g. students, the press and contacts in industry. A website is well under way that will provide an overview of the materials science infrastructure in the Netherlands: http://materialsequipment.4tu.nl. This will be completed in 2019.

In 2018, plans were made which will define the agenda for the years to come. HTM wants to make a difference by focusing specifically on education, on the materials infrastructure and on the relationship with the industry, e.g. via a strategic partnership with the Materials Innovation Institute (M2i). Cooperation with HTM and M2i will focus on areas such as meetings (including themed meetings) with industrial partners and researchers (for the purpose of calls for proposals), creating stronger ties between academics and industrial partners, and teaching.

Agenda for 2019

In 2019, HTM will provide an overview of the post-graduate courses on offer in Materials Science. The centre will take the initiative, where necessary, to see that the gaps in the courses on offer are filled. The annual HTM symposium will be organised in December 2019 in cooperation with M2i, during Meeting Materials. As in past years, the centre will continue to encourage joint initiatives aimed at increasing the quality and impact of materials science research and increasing participation in national and European research agendas, where efforts will be taken together with M2i to encourage interaction with the industry as well.

9 Humans & Technology

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 will be 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.

Programme

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 March, a PhD School was organised on the theme of affective and social computing. PhD candidates and talented Master's students were given the opportunity to learn about this theme and the research of leading researchers in the field. Group papers where produced as a result of this, and a proposal was drafted for a workshop for the International Society of Research on Emotions (July 2019).

The young researchers also organised several other group activities, such as hacking events and meetings on methodology. The aim of the hacking events was to help each other with existing problems and to arrive at joint research. The meetings about methodology revolved around replicability and multidisciplinarity. As a result, a well-attended workshop was organised at the most important conference in the field of intelligent virtual agents in Sydney. This led to a sequel at the IVA conference 2019 in Paris.

Several other events were also organised on the theme of affective and social computing. In December, a symposium took place in Delft to arrive, together with social scientists, at a research agenda in the field of technical research into interaction in groups.

In addition to these events targeting academic participants, the centre also organises events where businesses and civil society organisations are involved. These serve to address issues in society in the field of human-technology interaction and match them up with the expertise of academic institutions and businesses. Events organised in the past dealt, for instance, with dementia and tactile interaction, and in 2018 with virtual

reality in relation to mental health. The aim is to form consortia for research proposals, and this has since produced positive results for various subjects.

4TU.HT has taken the initiative to submit a proposal for the 4TU call for proposals for High Tech for a Sustainable Future. Together with 4TU's Design United, this has led to approval of the Pride and Prejudice programme.

Agenda for 2019

The line of activities will be continued in 2019 with a number of seminars and workshops. Themes are ethics, artificial intelligence, mental health, and multi-modal interaction. The year will be closed with a symposium where the results will be presented of the research programme and other projects which have been acquired thanks to the centre's networking activities.

10 Netherlands Institute on Research on ICT

Scientific director	Inald Lagendijk (TUD); Mark van den Brand (TU/e) as from 1 Sept.
Programme manager	Eveline Vreede (TUD); Margje Mommers (TU/e) as from 1 Sept.
Board	Birna van Riemsdijk (TUD), Maarten van Steen (UT), Sander Stuijk (TU/e), Bedir Tekinerdogan (WU)

Information and communications technology (ICT) research at the universities of technology concentrates on refreshing and prioritising individual sub-disciplines. The 4TU research centre Netherlands Institute on Research on ICT (4TU.NIRICT) concentrates on bringing together, positioning and prioritising all aspects of ICT research through both multidisciplinary and chain approaches in this rapidly digitising world. Since more than 50% of research conducted at universities of technology in the Netherlands concerns ICT, the centre can effectively devote itself to strengthening the national ICT research network.

ICT Research Community

In order to promote cooperation between universities of technology, it is vital to build on a network in which all participants are aware of and have mutual respect for each other's ICT research. NIRICT organises an annual community day with an interactive and varied programme on joint educational and research efforts and national ICT developments.
As from 2018, the focus of NIRICT has been on the call to proposals for research community funding. The aim of this is to strengthen the collaboration between researchers and the NIRICT community, thus increasing the impact of ICT research in the Netherlands. NIRICT has made ten activities financially possible, with topics such as wirelessly powered smart dust, cybersecurity ethics, GPGPU applications, expressive robots and interdisciplinary insights into group dynamics.

ICT.OPEN

In 2018, NIRICT was a partner of ICT.OPEN, the biggest conference for the ICT research community in the Netherlands. NIRICT focuses on researchers who are at the start of their careers. That is why ICT Next Generation (ICTng), with the assistance of NIRICT, organised a 'share your failures' happy hour with the underlying message of admitting mistakes encountered on the way to success. As academics are usually focused on positive results and success, this event was refreshing and well received.

Big Software on the Run

In the 2014-2017 period, Big Software on the Run (BSR) was NIRICT's largest research programme. Several appointments and sub-projects will continue to operate in the coming years. The aim of BSR is to analyse software 'in the wild' using big data methods, and to use the results to improve software development methods. BSR Summer Schools will be used to convey the results to a large group of international, young researchers.
As a whole, the BSR project has led to a number of dissertations, several of which will be defended in 2019. In addition, the research has contributed to a better understanding of the behaviour and use of software and how insight into this can be gained. The techniques developed in the project will enable software engineers to automate the identification of software behaviour with a view to conducting a more focused search for possible errors or unexpected behaviour.

Agenda for 2019

In 2019, successful events such as Community Day, ICT.OPEN and ICTng Drinks will be organised again. The call for proposals for research community funding will also be continued. A number of current board members have indicated that they will be stepping down. In replacing these board members, the aim is to achieve a balanced board in respect of electrical engineering/computer science and gender.

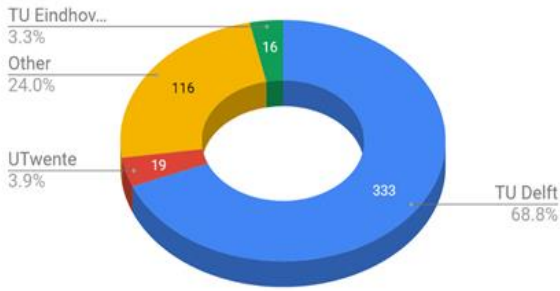
11 Centre for Research Data

TUD	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), Robin Duinker (Communication Officer)
TU/e	Leon Osinki (Data Librarian), Sjef Öllers (Scientific Information Specialist)
UT	Maarten van Bentum (Data Librarian)

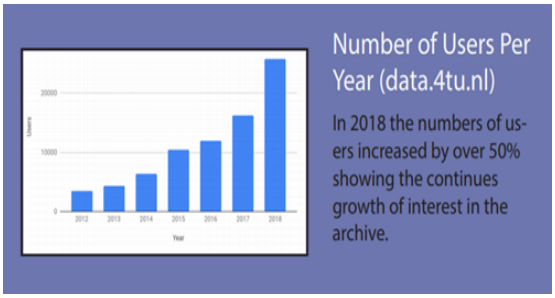
The 4TU Centre for Research Data (4TU.RD) was founded in 2008 as a consortium of the universities of technology in Delft, Eindhoven and Twente. The core task of 4TU.RD is to provide a data archive for long-term storage, access and curation of research data, with a focus on science and technology. The 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. Its own annual report has now been published.

Expansion

In 2018, the archive grew by 468 new datasets. Most of the new datasets come from TU Delft researchers; slightly more than 31% comes from other organisations (see figure).



Source of datasets uploaded in 2018



In 2018, more than 25,000 users visited the data archive's website. This increase of more than 50% shows growing interest in the archive. A peak in use was visible at the start of the academic year.

Number of users per year - https://data.4tu.nl/

In 2018, new functionality was added to the archive. It now offers, for example, the full range of Creative Commons licences for datasets. The addition of CC0 (Creative Commons Zero) as a standard enables researchers to easily share datasets for reuse without legal barriers.
Datasets can now also be connected to funding in a more structured manner, since information such as the name of the funder and the grant number can now be entered in special fields. This information is shown along with the funder ID on the dataset's landing page.

To make them more findable, the dataset landing pages now contain metadata to help search engines understand the content of the web pages. As a result, datasets placed in 4TU.RD are now automatically indexed in Google Dataset Search.

Cooperation

Alliances were high on the agenda in 2018 and have led to new opportunities.
Research data on the climate and atmosphere form the largest part of the archive. Most of these datasets are coded in netCDF, a data format which is suited above all for storing multidimensional array-oriented data. This report explores the possible options of offering not only technical services for storing and archiving netCDF, but also services such as advice and assistance, and the benefits that could be enjoyed by building a community.
Based on interviews with members of 4TU centres in the field of research data management, the report on Research Data Management in the 4TU Research Centres illustrates the opportunities and challenges for researchers in today's research data management.
4TU.RD has, along with 13 other research centres and universities, contributed to writing and publishing the Open Science Training Handbook.

Meetings

Various meetings and workshops have ensured that different aspects of research data management and open science are reaching an increasingly broader group of stakeholders.
In the context of open science and the importance of software management, in 2018 4TU.ResearchData became a member of The Carpentries, an international programme for training researchers in coding and data science skills. The first software carpentry workshop was held at TU Delft in November.
In cooperation with RDNL, the Essentials 4 Data Support introductory course was given in 2018 to 30 participants who represent research support functions.
Workshops were also held on electronic lab notebooks, the impact of the GDPR on research and rewarding research in the context of open science

Agenda for 2019

A number of items are on the agenda for 2019. These includes the connection with the five HTSF programmes and continuous contact with the 4TU centres. Exploration of software sustainability and completion of the procurement process of an external provider for the new data repository system are planned. In addition, there is the evaluation and ratification of a new 4TU.ResearchData strategy and the implementation of the recommendations from the NetCDF report. An MOOC will be published, based on the Essentials 4 Data Support training.

12 Centre for Engineering Education

Director	Jan van der Veen (UT); Perry den Brok (WU) as from 1 Oct.
TUD	Aldert Kamp (leader), Renate Klaassen (coordinator)
TU/e	Birgit Pepin (leader), Chantal Brans (coordinator)
UT	Jan van der Veen (leader as from 1 Oct.), Chris Rouwenhorst (coordinator)
WU	Emiel van Puffelen
Advisory Board	Kristina Edström (KTH Stockholm), Marc de Vries (TUD), Lex Lemmens (TU/e), Rikus Eising (UT), Erik Heijmans (WU), Christiaan Meijer (TUD student)

The 4TU.Centre for Engineering Education (CEE) encourages innovations and research in engineering education. It does this by linking educational innovation to previous or new research, strategy development and international cooperation.
For each activity, the CEE brings together lecturers and researchers from each university. The spectrum of projects and activities runs from a range of short innovation projects to projects and doctoral programmes of longer duration. Connecting to international experts and relevant literature is an element of the CEE approach. Results are regularly presented at conferences, during workshops and the CEE's own events, and in academic and other journals.

The substance of the Strategic Plan for the 2019-2022 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 October 2018, Jan van der Veen (UT) retired as the chair of the CEE and was succeeded by Perry den Brok (WU).
The CEE organised the 2nd National Conference on Interdisciplinary Education in Eindhoven and an international meeting for the CDIO, an important worldwide network for engineering education, in Delft.
In 2018, a working visit was paid to KU Leuven, where learning analytics was one of the main topics of discussion. Various international experts were invited and gave workshops and lectures for the professors of the four universities of technology: Monika Rummler (TU Berlin, about activating large groups), Babi Mitra (MIT, about future engineering education), Eugenio Bravo (Universidad de Chile, about mechanical engineering), Siddhartan Govindasami and John Geddes (Olin College, about interdisciplinary engineering education), Thomas Reeves (University of Georgia, about didactical design research) and Ruth Graham (Royal Academy of Engineering UK, about future engineering education).
Professors from the universities of technology gave various workshops on topics such as supervising interdisciplinary projects (TUD), virtual and augmented reality in education (TU/e), future engineers (UT) and intercultural education (WU).

Database innovation projects

The CEE website houses an ever-growing database (Innovation Map), which now contains more than 179 education innovation projects from the universities of technology, in which 242 researchers are involved. By now, the CEE Innovation Map is

seen as a model for a national innovation map for higher education that is being set up under the direction of NWO. The CEE's website was visited more than 20,000 times in 2018. In addition, in 2018 the CEE published various electronic newsletters and blogs, which reached numerous professors and support staff. Several dozen articles, book chapters and presentations at conferences saw the light of day.

A noteworthy result of the CEE in 2018 was the first defence of a doctoral dissertation for a project sponsored by the CEE: Inken Gast (UT) took a PhD for her research on professor development teams in engineering education. Her research showed that a team approach offers many opportunities for the professional development of professors. Goals-oriented support from the organisation by an external expert is important in this respect, especially during the first design process of new teams. Universities ought to organise more learning activities where professors can make new contacts in order to share experiences. This will make it easier for professors to find each other and learn from each other in an informal manner.
Gast's defence of her doctoral dissertation resulted in, among other things, an article in the *Review of Educational Research*, the top journal of didactics.

In Twente, the CEE was also actively involved in the development of the Senior Teaching Qualification (STQ) as well as the supervision of tracks, and a brochure was produced with the results of the STQ projects.
Another noteworthy achievement was the NWO Comenius Leadership grant that was won by Wageningen University, aimed at the further development of boundary crossing skills by students and the development of curricula and tools to promote this. Delft was especially active in forming a vision for engineering education of the future, particularly via the publication of that name by Aldert Kamp and various think tank workshops, which also provided a framework. TU/e conducted an interesting study on the use of blended educational resources for students in mathematics education and worked on an overview of education in modern innovation spaces in education.
Finally, the CEE asked Ruth Graham to make a *road map* for rewarding excellence in teaching, and the framework for rewarding good teaching was taken on board by the Association of Universities in the Netherlands (VSNU) and other universities in the Netherlands.
A more extensive account is given in the 4TU.CEE Progress Report 2017-2018.

Agenda for 2019

In 2019, 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 addition, the CEE will work in particular on strengthening its international contacts and expanding its network of PhD candidates in the area of engineering education. An educational trip will be organised for professors on the topic of innovative learning environments. The CEE will also focus more on the dissemination of good practices within the four universities of technology.
Finally, 2019 will see serious preparations being made for the SEFI conference 2020 in Twente, under the direction of the CEE.

13 Centre for Resilience Engineering

Scientific director	David Smeulders (TU/e)
Managing director	Marjolein Dohmen-Jansen (UT)
Board	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 (technical solutions in system designs) in interaction with social-ecological systems.

Programme

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 of the four universities of technology. At the end of 2018, 4 of the 16 tenure track staff had been recruited. The others will follow in 2019. The emphasis within the programme lies on three challenges:

- Thinking and designing resilience (concepts, resilience engineering approaches, resilience as a design perspective, dealing with cascading effects in social-technical environmental systems (STE systems));
- Measuring, quantifying and modelling the resilience of STE systems (progress in data analysis, simulation methods, and the advent of new technologies) from an interdisciplinary perspective;
- Coordination and management of resilient STE systems in order to improve the power of these systems in the case of a calamity.

Main activities and results

The Centre for Resilience Engineering started on 1 January 2018. The organisation was set up, and the basis for internal and external communication was laid, in its first year. About 250 people within and outside 4TU have since received four editions of the electronic newsletter.

NWO: NWA-ORC

In addition to various individual proposals submitted by members of the centre, a pre-proposal was submitted for a large project entitled Transforming Mobilities - Smart Systems for Adaptive Resilient Cities (€7 million) in the first round of the NWA-ORC call for proposals by NWO. The consortium consisted of 15 PIs (from four universities, three universities of applied sciences and two TO2 institutions) and 21 public and private funding partners. Unfortunately, this proposal just missed being selected, but a new plan will be submitted for the second NWA call for proposals in 2019.

SURF: Open & Online Higher Education

The centre submitted a proposal regarding urban resilience in SURF's call for proposals for Open & Online Higher Education - Open Educational Resources. The aim of the project is to develop, publish and use open educational resources related to urban resilience in Delta Programme regions, so that resilience thinking is consistently included in the many curricula offered by the four universities of technology. This proposal has since been

approved for funding. The total project budget amounts to €368,000, €175,000 of which will be funded by SURF, with €194,000 matched by the universities involved in the project (mainly time commitment by DeSIRE tenure track staff).

Events

4TU Centre for Resilience Engineering launch event

In June, about 70 participants from within and outside 4TU were present at the kick-off of 4TU-RE. Two keynote speakers presented their view of resilience engineering: Hans Heinimann (Future Resilient Systems, Singapore-ETH Center) and Wim Kuijken (Delta Programme Commissioner). The event was connected to Rotterdam Resilience Day, where Mayor Aboutaleb of Rotterdam spoke to those present. 4TU-RE also signed a strategic alliance agreement with the country's most resilient cities, i.e. Rotterdam and The Hague.

Kick-off of 4TU programme DeSIRE

June also saw the kick-off of DeSIRE, which made a start with community building and brainstorming about plans for the university programme for research and education.
The centre took part in various events, such as the Infrastructure Resilience International Conference, Zurich/Singapore, and the International Expert Meeting - Societal Resilience Institute VU.

Agenda for 2019

Creating extra capacity is on the agenda for 2019. The remaining 12 tenure track staff for DeSIRE will be appointed, and a post-doctoral researcher will be recruited for the SURF project.
The Resilient Smart Urban Transportation Systems proposal will be submitted to NWO for NWA-ORC. Preparations will be made for the NWO Perspective programme Flood Resilience in Urban Deltas.
Within the SURF project, the development of online materials about urban resilience will be set in motion. The tenure track staff will set to work on their research and teaching, and various events are on the agenda for internal and external stakeholders, such as the 4TU-RE DeSIRE conference on 6 and 7 June 2019.

14 Energy

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

A consortium of 4TU researchers has formed around the subject of energy. This group, led by Paulien Herder (Delft), has been granted funding for the 2018-2021 period, so that the 4TU.Energy network organisation can be set up.

The Netherlands complies with the UN sustainable development goals (SDGs) in respect of CO2 reduction, such as affordable and clean energy, climate action and sustainable cities and communities. By formulating ambitions, such as in the Dutch Transition Agenda, and by signing international agreements, such as the Paris climate agreement, the Netherlands is forced to look ahead to the coming decades. Because this transition will have far-reaching impact on our industry, economy and society, it is vital to develop the necessary science and technology as well as human capital.

The four universities of technology embody a large, high-quality world of energy research. The mission of 4TU.Energy is to unite these communities and use them to accelerate society's transition to a carbon-neutral future. In addition to the existing research and teaching capacity, the four universities of technology also need substantially more human capital in several crucial areas, such as electrochemical conversion and storage, CO2 capture and storage, heat conversion and storage, and geo-engineering. 4TU.Energy thus strives to increase the permanent human capital and research structures at the four universities.

Programme

To accomplish its mission, 4TU.Energy will unite and build on the strong points of each of the four universities of technology and make it easier for researchers to coordinate their efforts and work together. More specifically, this will lead to:

1. Connecting human research capacity within the four universities of technology to energy conversion and storage and the creation of ways to increase that capacity in crucial areas:
    a. initiation of and support for the joint acquisition of additional funding from the NWO, the EU, the Dutch government and industry;
    b. building a strong network of PhD candidates (e.g. by setting up exchange programmes within 4TU and with international partners, or via an ITN programme or similar FP9 instrument);
    c. setting up an industrial PhD programme;

2. Coordinating necessary investments in crucial research structure, using and sharing new equipment, and creating opportunities for investment in new infrastructure;

3. Active participation in the Energy Top Sector and in mission-driven innovation programmes, and the promotion of other large-scale programmes and activities;

4. Making and offering shared educational programmes, such as minors, Master's tracks, PDEng programmes, courses for the Graduate School, MOOCs/ProfEds and alumni-oriented programmes.

15 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 for Delft	Pieter Swinkels
Coordinator for Twente	Timo Meinders

The Stan Ackermans Institute (SAI) is the banner under which the designer programmes at the universities of technology in the Netherlands will be presented to potential trainees and businesses. Graduates will 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 will also attend business days at the four universities of technology and elsewhere in the country. In 2018, a brochure was published containing a selection of design assignments that trainees have completed for companies.

The designer programmes have been made part of the Graduate Schools of Eindhoven University of Technology, TU Delft and the University of Twente. In addition, the deans of the Graduate Schools of the four universities of technology hold regular consultations in which the designer programmes are addressed. Within these consultations, Wageningen has announced that it is considering launching designer programmes.
The University of Twente and Delft University of Technology have four active degree programmes each, and Eindhoven University of Technology has 11, two of which are being phased out. The intake in the programmes has declined slightly from 173 to 170, and the number of graduates has risen from 140 to 181. An overview of intake and graduation figures by programme and institution is provided by the table in this section. Within TU Eindhoven, considerable attention has been directed towards revision of the designer programmes. The revised programmes commenced on 1 September 2018.

Representatives of all designer programmes and the CCTO meet annually. During the meeting, a plenary discussion is held on developments at the three institutions and the manner of certification by the CCTO. Plans call for shifting from certification by programme to certification by institution. To this end, quality assurance within the institutions must be adjusted according to the memorandum by the 4TU.SAI board entitled ‘Key Features of Designer Programmes’, which contains those characteristics that all programmes should meet with regard to quality assurance.

Overview of intake and degree certificates issued for designer programmes 2013-2018

	2013		2014		2015		2016		2017		2018	
	Diploma	Instroom	D	I	D	I	D	I	D	I	D	I
TU Eindhoven												
Process and Product Design (PPD)	20	24	23	22	22	24	19	28	23	28	30	21
Information and Communication Technology (ICT)[2]	9	15	8	14	11	6	14	10	3	12	10	5
Logistics Management Systems (LMS)[3]	14	10	6	11	12	4	7	10	4	0	8	0
Mathematics for Industry (MI)	12	14	10	15	15	6	14	0	5	0	0	0
Software Technology (ST)	11	21	16	19	20	17	15	20	16	17	20	18
Design and Technology of Instrumentation (DTI)	8	8	8	10	7	7	10	9	6	9	9	0
Architectural Design Management Systems (ADMS)	4	3	0	0	1	0	1	0	0	0	0	0
User-System Interaction (USI)	18	16	17	15	15	17	14	13	18	0	10	1
Automotive Systems Design (ASD)	7	13	6	13	12	14	11	15	14	14	14	14
Smart Energy Buildings & Cities (SEBC)[4]		10	8	9	10	8	8	6	8	13	1	12
Clinical Informatics (CI)	10	11	7	10	9	13	11	13	10	13	12	13
Qualified Medical Engineer		3	2	7	3	1	6	7	0	5	6	7
Data Science (DS)		0		0		0		11		20	9	20
Total	**113**	**148**	**111**	**145**	**137**	**117**	**130**	**142**	**107**	**131**	**129**	**111**
TU Delft												
Process and Equipment Design (PED)	11	9	7	10	10	9	9	9	8	13	10	10
Bioprocess Engineering (BPE)	8	11	5	9	12	7	10	8	7	7	8	7
Comprehensive Design in Civil Engineering (CDCE)		1	5	0	0	0	1	0	0	0	0	0
Chemical Product Design (CPD)		3		9	1	7	6	7	7	6	9	8
Civil & Environmental Engineering											0	5
Total	**19**	**24**	**17**	**28**	**23**	**23**	**26**	**24**	**22**	**26**	**27**	**30**
Twente												
Energy and Process Technology (EPT)		1	1	3	2	4	3	11	4	6	9	12
Robotics		1		4	1	2	4	5	2	4	4	3
Civil Engineering (CE)		3		5	6	6	3	7	4	2	4	7
Healthcare Logistics		0		0	0	0	0	0	0	0	0	0
Maintenance		0			0	2	0	9	1	4	8	7
Total		**5**	**1**	**12**	**9**	**14**	**10**	**32**	**11**	**16**	**25**	**29**
Total 4TU	**132**	**177**	**129**	**185**	**169**	**154**	**166**	**198**	**140**	**173**	**181**	**170**

[2] *Nieuwe naam: Design of Electrical Engineering Systems*
[3] *Nieuwe naam: Industrial Engineering*
[4] *Nieuwe naam: Smart Buildings & Cities*

16 High Tech for a Sustainable Future

With the award of a total of 22 million euros to five research programmes on the theme of High Tech for a Sustainable Future, the 4TU.Federation gives a huge boost to research on sustainable technology. This enables 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. The research proposals fit the focus areas of the government's Top Sector policy, the National Research Agenda and the UN Sustainable Development Goals. The programmes are described below.

DeSIRE

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.
Programme coordinator: Tatiana Filatova, University of Twente

Plantenna

The Plantenna programme focuses on the heavily intertwined problems of climate change, 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.
Programme coordinator: Peter Steeneken, TU Delft

Precision Medicine

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.
Programme coordinator: Michel Versluis, University of Twente

Pride and Prejudice

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.
Programme coordinator: Aarnout Brombacher, Eindhoven University of Technology

Soft Robotics

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.
Programme coordinator: Herman van der Kooij, University of Twente/TU Delft

17 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)

Year	Intake (TUD+TUe+UT)	Degree certificates (TUD+TUe+UT)	Total number of students (TUD+TUe+UT)
2014/2015	51+57+31= 139	42+35+18= 95	n/a
2015/2016	71+46+15= 132	52+35+22= 109	207+111+61= 379
2016/2017	71+32+38= 141	65+35+22= 122	216+97+65= 378
2017/2018	86+31+25= 142	65+38+21= 124	233+98+72= 403
2018/2019	62+16+13= 91	n/a	238+90+74= 402

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 Luttik (Eindhoven), André Kokkeler (Twente)

Year	Intake (TUD+TUe+UT)	Degree certificates (TUD+TUe+UT)	Total number of students (TUD+TUe+UT)
2014/2015	37+70+29= 136	26+23+10= 59	n/a
2015/2016	61+74+16= 151	28+54+17= 99	138+147+58= 343
2016/2017	58+63+36= 157	36+47+15= 98	164+153+60= 377
2017/2018	69+86+33= 188	53+55+20= 128	191+171+76= 438
2018/2019	74+63+13= 150	n/a	205+177+81= 463

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)

Year	Intake (TUD+TUe+UT)	Degree certificates (TUD+TUe+UT)	Total number of students (TUD+TUe+UT)
2014/2015	27+27+25= 79	27+05+16= 48	n/a
2015/2016	41+32+17= 90	31+27+13= 71	88+76+59= 223
2016/2017	41+27+10= 78	37+24+14= 75	92+67+48= 207
2017/2018	37+23+24= 84	47+31+14= 92	87+63+49= 199
2018/2019	23+27+0= 50	n/a	65+65+0= 130

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)

Year	**Intake (TUD+TUe+UT)**	**Degree certificates (TUD+TUe+UT)**	**Total number of students (TUD+TUe+UT)**
2014/2015	70+62+25= 157	85+47+19= 151	n/a
2015/2016	113+43+22= 178	89+46+20= 155	243+125+48= 416
2016/2017	109+49+19= 177	74+49+19= 142	273+118+48= 439
2017/2018	113+43+49= 205	98+49+12= 159	297+112+66= 475
2018/2019	118+40+31= 189	n/a	309+102+94= 505

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)

Year	**Intake (TUD+TUe+UT)**	**Degree certificates (TUD+TUe+UT)**	
2014/2015	49+42+18= 109	38+15+10= 63	n/a
2015/2016	85+20+07= 112	39+17+12= 68	189+ 84+33= 306
2016/2017	98+51+24= 173	65+33+7= 105	239+112+37= 388
2017/2018	123+39+21= 183	68+32+9= 109	282+119+49= 450
2018/2019	87+41+31= 159	n/a	306+125+72= 503

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.

Year	**Intake (UT)**	**Degree certificates (UT)**	**Total number of students (UT)**
2015/2016	11	10	11
2016/2017	11	5	37
2017/2018	21	28	39
2018/2019	19	n/a	52

18 External relationships

The 4TU.Federation has entered into agreements with several external parties. This section reports on the results of these agreements in 2018.

NEMO Kennislink

For more than 15 years, NEMO has been using 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. The extra hours for Technology are divided by two editors.

In 2018, a total of 3,416,153 people visited NEMO Kennislink's website. That is more than a 12% increase in comparison with 2017. Together, they visited the website 5,358,725 times. The number of subscribers to the newsletter increased considerably, from 13,677 to more than 25,000 subscribers. A total of 132 articles were published in the field of 'Technology'. Fifty-one of these articles were based on research by the four universities of technology or expressed the views of a researcher affiliated with one of the universities of technology, such as the article entitled 'Drone is Just as Nimble as a Fruitfly'.
In the Faces of Science series, scores of blogs were published by young PhD candidates, many of them affiliated with one of the four universities of technology. Such as this one by Dan Jing Wu (PhD candidate at Eindhoven University of Technology) where she gives ten reasons why everyone should obtain a doctorate.

To engage in dialogue with society, the NEMO Kennislink brand was used for a growing number of offline events. For instance, The Cultured Meat Question was organised in 2018, a stakeholders' event following NEMO's purchase of the first cultured meat sausage available on the commercial market. Six editions of NEMO Kennislink Live were organised as well. These are question and answer sessions about current developments in science. One edition was about how we will pay for things in the future, about becoming a cashless society and about the rise of cryptocurrency. Other editions were about the future of our food and techniques to postpone old age.

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 euros in the coming ten years for research, valorisation and implementation. The twelve partners will be working together intensively to bring together the necessary human and financial resources, both with each other and with new partners.

KIVI

All full-time professors with a permanent appointment are offered a collective KIVI membership, unless they raise an objection. In 2018, 500 people accepted this offer.

Science and Technology Registration Authority (*Registerautoriteit Bètatechniek*)

The 4TU.Federation is one of the co-founders of the Science and Technology Registration Authority (*Registerautoriteit Bètatechniek*). 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. This has been delayed by setting up this new organisation, born out of the Science and Technology Platform, TecWijzer and TechniekTalent.nu.

RAI Amsterdam

In 2018, Secretary IJsbrand Haagsma participated in the jury for the HISWA 'Product of the Year' contest. The award this year went to Finsulate, a TU Delft spin-off. Finsulate is a self-adhesive film that can be wrapped around a ship's hull as an environmentally friendly antifouling alternative.