

Annual Report 2017

4TU.Federation



Introduction

The continuing increase in registrations for the universities of technology and the urgent shortage of engineers in the labour market were the most important 4TU.Federation themes covered by the media in 2017.

In February, FME and 4TU joined forces in a pact in which a call was made to politicians to make more resources available for technical education. At the same time, there were efforts to identify possibilities for increasing teaching capacity by further promoting the use of lecturers from the business community. The 4TU.Federation is pleased to look back on the clear priority that the coalition agreement assigns to the developments in science and technology. The extent to which funds will be made available to address the increasing shortage of capacity remains to be seen.

Changing activities

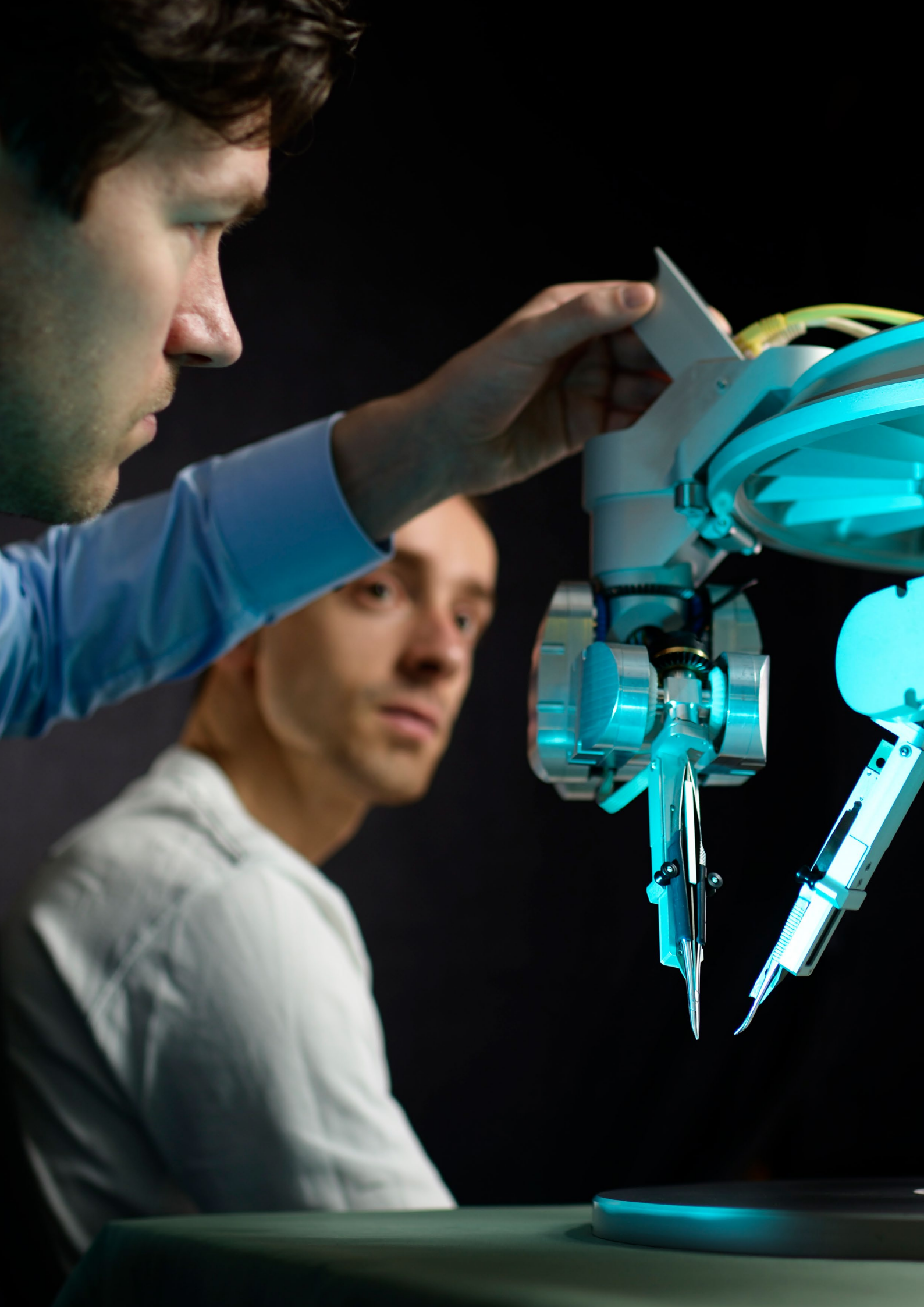
The programme of activities for the 2014-2017 period was concluded over the past year. Following the evaluations by the Education Management Committee and the Research Management Committee, it was decided to continue a number of activities, including those of 4TU.Research Data, 4TU.Stan Ackermans Institute and 4TU.Centre for Engineering Education. Other activities are undergoing a process of change, in which the 4TU.Research Centres will be focusing on their coordinating role as a network organisation, and the Foundation for the Promotion of Science and Technology will work towards affiliation with the House of Technology.

The joint Master's degree programmes will continue more independently of each other, allowing for customisation in how they are matched up and for restrictive arrangements to be freed up. A budget will be made available to develop joint educational products for these programmes. The research programmes that are incorporated into the 4TU.Research Centres will be discontinued, and a call has been issued for new programmes around the theme of ['High Tech for a Sustainable Future'](#), with a focus on the creation of new tenure-track positions.

Finally, the joint Valorisation Plan, along with its associated budget, was approved at the end of 2017. The plan sees the valorisation directors' consultations being subsumed within a new Centre, 4TU.Impact, which reports to the Valorisation Management Committee.

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 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.



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Board

1 General Management Board & Executive Committee

General Management	Karel Luyben, Tim van der Hagen, Anka Mulder (TU Delft) Frank Baaijens, Jan Mengelers, Jo van Ham (TU/e) Thom Palstra, Victor van der Chijs, Mirjam Bult (UT) Arthur Mol, Louise Fresco, Rens Buchwaldt (WU)
Executive Committee	Victor van der Chijs (UT, Chairman), Tim van der Hagen (TU Delft), Jan Mengelers (TU/e), Louise Fresco (WU)
Support staff	Karin Horsman (WU), Lotte Melenhorst (TU Delft), Renee Westenbrink (TU/e), Maurice Bouwens (UT)
4TU	IJsbrand Haagsma

The Executive Committee and the Governing Board each met four times. During a number of these meetings, decisions were also taken by board members from the financial administration foundation who were in attendance.

Political system

In 2017, elections for the House of Representatives were held and a new governing coalition was formed. The Executive Committee and the Governing Board devoted considerable attention to raise awareness in political circles regarding the deficient funding of the universities of technology in relation to increased numbers of students. To this end, the relevant figures were collected and organised in a major joint effort. This resulted in [comprehensive problem analysis](#), which proved useful in the many discussions that were held with stakeholders.

Substantive collaboration

In 2017, the green light was given for the activities plan prepared by the Management Committee. This plan was funded by the allocation made to TU Delft, TU Eindhoven and Twente University after the end of the second Technology Sector Plan. Wageningen University has reserved a proportionate share of its allocation for 4TU collaboration. The four partners agreed that the budget assembled in this manner will be made available for joint activities at least till the end of 2021.

T02

In 2017, the T02 institutes were evaluated, and the Advisory Council for Science, Technology and Innovation (AWTI) published a [report](#) on applied research in the Netherlands. The 4TU.Federation contributed to both the T02 evaluation and the AWTI report. The attention to applied research has strengthened ties between 4TU and T02. Another meeting of the chairs of the two organisations will be held in 2018, with the goal of adopting a joint, proactive approach to following up the recommendations of the two reports.

Legal proceedings

The attention paid to shared interests led to the start of two legal proceedings in 2017, under the direction of 4TU. The first action was intended to prevent the loss of funding, caused by the increase in the number of doctorates in the Netherlands, from becoming a structural element of a new allocation component. The second action was a consequence of having not taken proper account of the perspective submitted for the new Master's programme in Mechanical Engineering at the University of Groningen. In late 2017, it was announced that the objections to the

model-based process of capping the doctorate component have been rejected. Decisions on the other action will be taken in 2018

Visibility of 4TU

The media attention received by 4TU has also made the federation more visible, so that external parties are increasingly seeing it as a service desk for the universities of technology themselves. The approval of the joint valorisation plan and the setting up of 4TU. Impact to implement it will result in part of this service-desk function being effectively anchored within the federation

Key indicators

The number of assistant, associate and full professors (in FTEs) in the 2006-2016 period is given in the tables below. One trend of note is the significant increase in the number of women academic staff members

Numbers of academic staff (assistant, associate and full professor in FTEs), male and female, 2006-2016

MALE	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	16/15	16/06
TUD	677	710	737	747	751	754	734	726	731	735	744	1,3%	10,0%
TUE	444	456	457	465	462	453	447	438	435	432	454	5,0%	2,2%
UT	380	376	391	423	486	467	452	434	421	417	418	0,3%	10,1%
WU	395	401	401	404	398	397	408	408	405	405	390	-3,7%	-1,3%

FEMALE	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	16/15	16/06
TUD	88	99	111	124	128	139	146	161	167	178	185	4,5%	111,3%
TUE	47	48	55	59	62	65	58	73	81	98	108	10,2%	130,2%
UT	64	71	92	106	117	121	118	117	114	115	119	3,6%	87,6%
WU	91	94	101	104	106	115	121	123	132	144	152	5,6%	66,5%

2 Research Management Committee

Board	Arthur Mol (Chairman, WU), Karel Luyben (TU Delft), Frank Baaijens (TU/e), Thom Palstra (UT)
Support Staff	Meike Sauter (secretary, WU), Lotte Melenhorst (TU Delft), Lisette Appelo (TU/e), Maurice Bouwens (UT)
4TU	IJsbrand Haagsma, Linda Baljeu

In 2017, the Research management committee consisted of the Research portfolio holders of the Executive Boards of the universities of technology. The committee is responsible for the realisation and supervision of the collaboration and planning of the universities with regard to research, as conducted in the 4TU.Research Centres, among other locations. The committee also has the specific task of supervising the operations and management of the 4TU.Research Centres, which are operated jointly for the four universities.

The Research Management Committee's agenda for 2017 contained a number of recurring items, including the progress of the Dutch Academic Calendar and the transition taking place at the Netherlands Organisation for Scientific Research (NWO). The matters set out below were also the most important topics of discussion.

4TU Talent Stimulus: High Tech for a Sustainable Future

The Research management committee has drafted a new activities plan for the 2018-2021 period: the 4TU Talent Stimulus. Within the framework of its development, the existing Research Centres reported on their results. In addition, a session was held with all of the deans and managing directors of the four universities, in which they explored what the content of the new activities plan should be. Several basic principles for a new plan emerged from this brainstorming session:

- 'High Tech for a Sustainable Future' as the theme of the plan
- Continuation of the network function of some or all of the existing Research Centres and the possibility of extending the existing programmes of the newer Research Centres
- The embedding of new activities in previously selected societal (or other) topics

Each of the four universities subsequently proposed topics for which they would like to develop joint programmes and provided an approach for establishing these programmes: a call for new programmes.

Call for new programmes

One component of the 4TU Talent Impuls is a call for new programmes within the theme 'High Tech for a Sustainable Future'. The 4TU.Federation seeks to encourage university/cross-faculty/multidisciplinary research programmes that contribute to societal, national or international sustainability objectives. The programmes should be scientifically challenging, innovative and with high potential, and they should offer prospects for scientific breakthroughs. The goal is to start substantial, ambitious programmes that will run for four years (2018-2021). The programme proposals should correspond to at least one of the following research topics: High Tech to Feed the World; Sensing Science and Technology; Robotics; Health and Vitality; Resilience; Advanced Materials; Energy Conversion and Storage. More than 300 scientists from the four universities of technology have notified 4TU.Research of their interest in submitting programme proposals within the framework of this call. On 10 November, 150 of these

researchers participated in a Matchmaking Event in Wageningen. At this event, researchers with overlapping interests could meet in order to work together to elaborate a programme proposal. The deadline for submitting programme proposals within the framework of the call was 19 February 2018.

Centre for Resilience Engineering

In 2016, a 4TU initiative group consisting of Paulien Herder (TU Delft), Rik Leemans (WU), David Smeulders (TU/e), Theo Toonen (UT) and Kenneth Heijns (TU Delft) submitted a proposal to the Lloyd's Register Foundation (LRF): 'Resilience in Critical Infrastructures'. Although the proposal was not funded, it did generate considerable energy for the topic within the 4TU.Federation. As a result, the initiative group submitted a proposal to the 4TU.Research management committee to fund a 4TU.Resilience Engineering Centre. This proposal was funded: the Centre was awarded a grant of €150k per year for network activities for a period of four years.

Visit to TU Austria

On 1 and 2 June, the 4TU rectors and the 4TU.Research management committee paid a visit to TU Austria, the federation of Austrian universities of technology (TU Vienna, TU Graz and MU Leoben). In addition to general introductions, the programme included such topics as knowledge exchange concerning international collaboration, digitisation and excellence. In 2019, TU Austria will pay a visit to the 4TU.Federation in the Netherlands.

Transition of the M2i Foundation

The Materials Innovation Institute (M2i) performs ground-breaking materials research. This research is necessary to economic growth in the Netherlands and contributes to the sustainable development of Dutch society. The incorporation of this federation into the 4TU.Federation will guarantee the continuity of the activities of M2i for the long term. As the largest university partner, TU Delft will serve as the coordinating university. In October 2017, after coordinating within the 4TU community, the TU Delft Executive Board approved the transition of the M2i foundation to TU Delft. This transition will take effect as of January 2018. As part of this transition, supporting tasks in the areas of Finance, HR, IT and Facilities will be arranged by the 4TU organisation through TU Delft..

Key indicators

The decrease in the number of Doctorates is consistent with the decrease in the number of employee-PhD candidates four years before. The number of employee-PhD candidates is increasing again, following several years of decline.

Number of doctorates 4TU, 2007-2017

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	17/16	17/07
4TU	801	789	842	915	917	973	1.064	1.145	1.130	1.182	1.063	-10%	33%
TUD	229	236	264	333	319	303	353	371	357	395	359	-9%	57%
TUE	176	191	192	189	199	245	218	243	234	224	212	-5%	20%
UT	147	160	191	188	203	196	220	244	234	267	197	-26%	34%
WU	249	202	195	205	196	229	273	287	305	296	295	0%	19%

Number of PhD candidates on pay-roll 4TU, 2006-2016

M	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	16/15	16/06
TUD	721	732	745	724	699	691	696	693	686	725	779	7,4%	8,0%
TUE	458	460	501	528	600	608	566	577	586	600	653	8,8%	42,5%
UT	437	422	439	463	460	485	485	432	407	379	384	1,4%	-12,1%
WU	254	253	251	276	270	302	316	298	294	284	267	-5,7%	4,5%
F													
TUD	245	262	279	289	263	269	252	268	284	286	313	9,5%	27,6%
TUE	172	186	183	218	240	221	208	207	220	233	235	1,0%	36,3%
UT	181	177	188	209	211	237	220	202	192	194	188	-3,2%	3,8%
WU	215	241	289	333	338	381	411	393	369	339	324	-4,3%	50,0%
4TU	2.683	2.733	2.875	3.040	3.081	3.194	3.154	3.070	3.038	3.040	3.143	3,4%	17,1%

Prizes

All of the aforementioned prizes were awarded in the 2017 reporting year. The titles of the grants should not serve as a guide. For example, the Vici 2016 grant was awarded in May 2017, and was therefore included in this annual report.

Innovational Research Incentives Scheme

Veni 2017: awarded in July 2017

Vidi 2016: awarded in May 2017

Vici 2016: awarded in Feb 2017

ERC grants

Starting 2017: awarded in Sept 2017

Advanced 2016: awarded in Apr 2017

Consolidator 2017: awarded in Nov 2017

	Veni/Vidi/Vici	ERC
TU Delft	<p>Veni 2017 Javier Alonso-Mora Franklin Nobrega Anne Pluymakers Andrea Sciacchitano</p> <p>Vidi 2016 Marie-Eve Aubin-Tam Alexis Bohlin Elmar Eisemann Claudia Hauff Fritz Körmann Liedewij Laan Tim Taminiau Joost de Winter</p> <p>Vici 2016 Pieter Desmet</p>	<p>Starting 2017 Liedewij Laan Manuel Mazo Espinosa Wilson Smith Monique van der Veen</p> <p>Advanced 2016 Cornelis Wapenaar</p> <p>Consolidator 2017 Ronald Hanson</p>
TU/e	<p>Veni 2017 Emanuela Bosco Ivo Filot Koen Hendriks Tugce Gizem Martagan Ghislaine Vantomme Mark Vis Jimmy Melskens</p> <p>Vidi 2016 Daniel Lakens Patricia Dankers Tom de Greef Björn Baumeier Tom Oomen Alex Alvarado Job Beckers</p> <p>Vici 2016 Jaime Gómes Rivas</p>	<p>Starting 2017 Alex Alvarado Richard Lopata</p> <p>Advanced 2016 -</p> <p>Consolidator 2017 -</p>
UT	<p>Veni 2017 Ismet Baran Arnd Hartmanns Erik Horstman Saskia Kelders Chuan Li</p> <p>Vidi 2016 Alexander van Deursen David Marpaung Saskia Nagel</p> <p>Vici 2016 Alexander Brinkman Marieke Huisman</p>	<p>Starting 2017 Tatiana Filatova Jeroen Leijten</p> <p>Advanced 2016 Han Gardeniers Detlef Lohse</p> <p>Consolidator 2017 Nathalie Katsonis</p>
WU	<p>Veni 2017 Robbert Biesbroek Mirte Bosse Anneke Horstman Dieuwertje Kok Sonja de Vries Pim de Zwart</p> <p>Vidi 2016 Joris Sprakel Mark Zwart</p> <p>Vici 2016 -</p>	<p>Starting 2017 -</p> <p>Advanced 2016 Maarten Krol</p> <p>Consolidator 2017 Elise Nederveen</p>

Gravitation programmes

In 2017, six research teams of leading scientists from various Dutch universities were awarded €18.8 million each for collaborating to establish excellent scientific research programmes in the coming years. Members of four teams, including two principle applicants, are affiliated with one of the four universities of technology.

There is also good news with regard to gender diversity within the consortiums. Both of the principal applicants are women, and a large share of the researchers within the consortiums are women. This was not the case in previous rounds.

Principal applicant Carlijn Bouten (TU/e) - Materials-driven regeneration: Regenerating tissue and organ function with intelligent, life-like materials.

In the Center for Materials-Driven Regeneration, materials scientists, cellular biologists, tissue technologists and physicians are collaborating on a new approach, in which the body is enticed to self-recovery using intelligent biomaterials. With this approach and combination of specialisations, the consortium seeks to address one of the greatest and most costly challenges within the field of healthcare: curing chronic diseases.

Principal applicant Marleen Dogterom (TU Delft) - BaSyC – Building a Synthetic Cell

Constructing a synthetic biological cell is one of the greatest scientific challenges of the 21st century. We do not yet understand how the molecular building blocks work together to make life possible. In BaSyC, therefore, we are bringing together our knowledge of chemistry, physics and biology to build a synthetic cell. A fundamental understanding of life within a cell will bring huge intellectual, scientific and technological rewards.

Co-applicants: Ronald Hanson and Stephanie Wehner (TU Delft) - Quantum Software Consortium

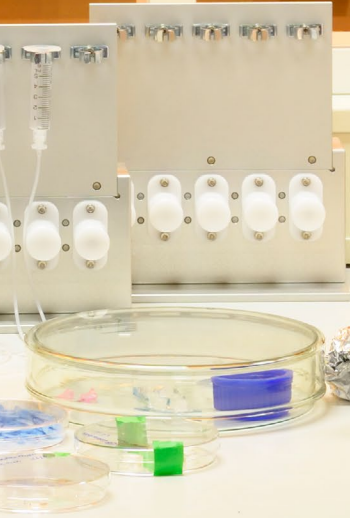
Quantum computers and quantum networks have the potential to effect a radical change in our information and communication technology through the power of quantum superposition, interference and entanglement. The 'Quantum Software Consortium' brings together researchers from the fields of computer science, mathematics and physics in order to invent the first applications for these computers and the internet of the future.

Co-applicants: Lina Sarro (TU Delft) and Albert van den Berg (University of Twente) - Netherlands Organ-on-Chip Initiative

For many frequently occurring diseases, good laboratory models are lacking. Using stem cells from our patients, we are working to develop 'disease-specific miniature organs on microchips', in order to improve the investigation of disease processes and the effects of medicines



SYRINGES



MANUALS

3 Education Management Committee

Board	Frank Baaijens (TU/e, Chairman), Anka Mulder (TU Delft), Thom Palstra (UT), Arthur Mol (WU)
Support staff	Lilian Halsema (TU/e, secretary), Eric Logtenberg (TU Delft), Lisette Woud (UT), Eva Verschoor (WU)
4TU	IJsbrand Haagsma, Linda Baljeu

In 2017 the Education Management Committee consists of the education portfolio holders of the Executive Boards of the universities of technology. The committee has the task of shaping and supervising cooperation and planning of the universities in the field of teaching.

Explosive growth in the number of students

In 2017, there was once again an enormous increase in the number of students at the Dutch universities of technology. The 4TU.Federation collects data on the student population and analyses the explosive growth of the number of students over the past ten years, in order to develop strategies to cope with the growth without causing the quality of the programmes to suffer. The four universities have exchanged best practices and experiences with regard to the student-selection criteria and procedures for Bachelor's and Master's degree programmes. Attention has also been devoted to the manners in which the right students arrive in the right Bachelor's degree programmes. Various scenarios have been reviewed, ranging from Programme-Choice Check to increased requirements for admission (e.g. a score of at least 7 for Mathematics B). The universities have also exchanged data on the increasing intake of international students and possibilities for arriving at an ideal 'international classroom'. The institutions 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.

The significant increase in the number of students during the 2007-2017 period is illustrated in the following figure.

Number of enrolments, male/female, Dutch/international
 4TU student population, 2006-2016, all students (primary enrolment as of 1 October)

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	17/16	17/07
TUD	14.441	15.490	16.570	17.329	17.721	17.874	19.148	20.034	21.475	22.220	23.325	5%	62%
TUE	7.065	7.066	7.267	7.307	7.519	7.762	8.377	9.209	10.116	10.759	11.372	6%	61%
UT	7.952	8.134	8.530	8.886	9.398	9.314	9.315	9.263	9.082	9.391	9.921	6%	25%
WU	4.711	5.157	5.695	6.457	7.071	7.491	8.302	9.032	9.720	10.696	11.446	7%	143%
4TU	34.169	35.847	38.062	39.979	41.709	42.441	45.142	47.538	50.387	53.056	56.064	6%	64%
M	25.332	26.243	27.535	28.178	29.022	29.280	30.967	32.363	34.025	35.290	36.983	5%	46%
F	8.837	9.604	10.529	11.803	12.688	13.162	14.178	15.176	16.365	17.779	19.081	7%	116%

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	17/16	17/07
INT	3.598	4.255	4.814	5.650	6.453	6.830	7.234	7.671	8.707	9.870	10.905	10%	203%
NL	30.571	31.592	33.248	34.329	35.256	35.611	37.908	39.867	41.686	43.196	45.159	5%	48%

Intake BSc m/f, NL/international

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	17/16	17/07
TUD	2.336	2.637	2.782	2.730	2.790	2.756	3.057	3.125	3.274	3.353	3.641	9%	56%
TUE	1.384	1.394	1.524	1.501	1.591	1.729	1.967	2.144	2.276	2.396	2.616	9%	89%
UT	1.283	1.337	1.384	1.788	2.000	1.780	1.792	1.814	1.691	2.060	2.113	3%	65%
WU	774	887	1.016	1.113	1.102	1.181	1.457	1.484	1.521	1.655	1.713	4%	121%
4TU	5.777	6.255	6.706	7.132	7.483	7.446	8.273	8.567	8.762	9.459	10083	7%	75%
M	4.205	4.503	4.770	4.746	5.116	5.092	5.657	5.793	5.956	6.149	6.725	9%	60%
F	1.572	1.752	1.936	2.386	2.367	2.354	2.616	2.774	2.806	3.310	3.358	1%	114%

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	17/16	17/07
INT	377	445	486	671	844	725	741	768	805	1.158	1.307	13%	247%
NL	5.400	5.810	6.220	6.461	6.639	6.721	7.532	7.799	7.957	8.301	8.776	6%	63%

Developing and exchanging expertise

The four universities of technology are collaborating to improve education through the Centre for Engineering Education (CEE). The 4TU.CEE collects and develops 'evidence-based knowledge' with regard to engineering education. The centre is regularly invited to the board meetings of 4TU.Education, in order to provide information and advice to the members with regard to educational innovations. See Section 15, 4TU.CEE for detailed information on this centre.

Blended learning

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. In 2017, one of the 4TU.Master's programmes submitted a plan to the management committee for the development of MOOCs for collective use. These projects provide insight into the challenges of online collaboration between various universities (e.g. resulting from the fact that not all universities use the same Learning Management System).

4TU.Master's programmes

The four universities offer a number of joint programmes, including five Master's degree programmes. The board decided that they will continue more independently of each other, allowing for customisation in how they are matched up and for restrictive arrangements to be freed up. A budget will be made available to develop joint educational products for these programmes.

For international marketing purposes, an overview chart of all programmes (Bachelor's, Master's and PDEng) at the four universities was developed for publication on the 4TU website. The overview is expected to be made available in the spring of 2018.

The 4TU.School for Technological Design, the Stan Ackermans Institute, offers a two-year post-Master's programme in Technical Design. Quality assurance is a topic of collective attention within this programme.

Professionalisation for lecturers

The four universities are collaborating on the Basic Teaching Qualification (BTQ) and other forms of professional development for lecturers. In 2017, the four institutions concentrated primarily on the possibilities for a 'light' basic teaching qualification for supporting lecturers (e.g. doctoral candidates and post-docs), as well as on increasing the number of BTQ certificates earned within the institutions.

Collaboration with businesses

In response to the increasing numbers of students and work pressure within the universities of technology, the 4TU Federation is cooperating with businesses for joint internship and graduation contracts, as well as for projects with FME, the Dutch employers' organisation in the technological sector. They signed [a pact](#) together in February

Key indicators

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 is also evident in the numbers of Bachelor's and Master's degree certificates that have been issued. Furthermore, the 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.

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

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	17/16	17/07
TUD	1.263	1.049	1.368	1.156	1.240	2.089	2.327	2.519	2.207	2.882	3393	18%	169%
TUE	279	338	494	487	621	717	887	976	655	1.117	1180	6%	323%
UT	597	464	667	314	567	847	688	667	471	1.072	1122	5%	88%
WU	671	736	890	1.095	992	1.325	1.310	1.300	1.228	1.676	1750	4%	161%
4TU	2.810	2.587	3.419	3.052	3.420	4.978	5.212	5.462	4.561	6.747	7445	10%	165%
M	1.840	1.623	2.205	1.795	2.098	3.170	3.243	3.516	2.893	4.131	4577	11%	149%
F	970	964	1.214	1.257	1.322	1.808	1.969	1.946	1.668	2.616	2868	10%	196%

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	17/16	17/07
INT	1122	1223	1429	1.637	1.711	1.858	1.867	2.219	2.773	2.889	3117	8%	178%
NL	1.688	1364	1.990	1.415	1.709	3.120	3.345	3.243	1.788	3.858	4328	12%	156%

Number of BSc and MSc degree certificates issued, male/female, Dutch/international students
BSc degree certificates, 2006-2016

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	16/15	16/06
4TU	2.890	3.350	3.182	3.493	4.338	5.542	4.875	4.955	5.565	5.175	5.617	9%	94%
M	2.038	2.320	2.271	2.393	2.996	3.863	3.166	3.205	3.651	3.284	3.608	10%	77%
F	852	1.030	911	1.100	1.342	1.679	1.709	1.750	1.914	1.891	2.009	6%	136%
INT	117	155	175	201	312	335	399	480	483	541	470	-13%	302%
NL	2.773	3.195	3.007	3.292	4.026	5.207	4.476	4.475	5.082	4.634	5.147	11%	86%

MSc degree certificates, 2006-2016 (incl. 'doctoraal')

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	16/15	16/06
4TU	4.769	4.521	4.829	4.861	5.054	5.892	5.556	5.987	6.416	6.960	7.540	8%	58%
M	3.269	3.101	3.276	3.259	3.373	3.805	3.643	3.845	4.080	4.366	4.701	8%	44%
F	1.500	1.420	1.553	1.602	1.681	2.087	1.913	2.142	2.336	2.594	2.839	9%	89%
INT	832	870	1.129	1.247	1.398	1.649	1.674	1.845	1.967	2.164	2.643	22%	218%
NL	3.937	3.651	3.700	3.614	3.656	4.243	3.882	4.142	4.449	4.796	4.897	2%	24%





Centres

4 Impact

Board	Kees Eijkel (UT, director) Paul Althuis (TU Delft), Steef Blok (TU/e), Sebastiaan Berendse (WU)
Duport Staff	Roelyn van der Hoek (UT)

For the Dutch knowledge economy, it is essential for a sufficient level of innovation to emerge in order to keep the economy operating and keep the people in the Netherlands prosperous and happy. In this regard, it is important to generate enough ideas and successful results that can ultimately be sold on the market. The four universities of technology play an active role in improving the Dutch knowledge system, endeavouring to bolster the degree of innovation in our economy.

In early 2016, the four valorisation managers drafted a plan for the years 2016 and 2017, and an allocation of 500k euro was received from the 4TU budget, in order to elaborate the 4TU Valorisation plan and to start up the first activities. Wageningen University contributed in kind.

IMPACT 2018

The 4TU Valorisation plan – known as the 4TU IMPACT Plan – was created to stimulate the development and up-scaling of the knowledge economy, building on the current valorisation (and other) programmes and joint projects. This is done by maintaining a high level of scientific research and further developing the cooperation with businesses in applied research. By training smart, young and ambitious people and providing them with the opportunity to engage in entrepreneurship and, above all, to provide a ‘labour force’ that matches the needs of businesses, 4TU occupies a prominent position in the development of the knowledge economy. In the past, this was addressed primarily at the regional level. Proceeding from a collective approach, even more can be accomplished in the relatively short term.

Components

The 4TU impact plan consists of four modules: Cooperation with businesses in the Stimulation model (1); Living labs (2); Business Development & Entrepreneurship (3); and Start-up financing (4).

1. The Stimulation model focuses on research in cooperation with businesses, with the research being funded by the businesses, knowledge institutions, government and other public organisations. The ambition for the coming five years is to realise €393 million in long-term research efforts with businesses and to acquire €600 million (including from EU/H2020) for adjacent research funding. These funds will be used to create 1,000 junior research positions.
2. The Living Lab model focuses on the joint development and implementation of innovative projects with a reasonably short turnaround time to the market. In thematic projects, which primarily involve cooperation between the SME sector, students and researchers, self-serving teams are being developed to deliver these concrete services and products. The ambition is to make an additional collective investment of €137 million in this efforts.
3. The third module, Business Development and Entrepreneurship, is organised from a variety of pillars, in order to convert research results into societal value. For years, the knowledge institutions of 4TU have been leaders in start-up development, and they are aiming to achieve an additional 500 start-ups, 100 spin-offs and 30 scale-ups. The ambition is to train 20,000 students in entrepreneurship.
4. Through a professionally supervised funding process involving finance funds that start with pre-seed funding (feasibility testing and organisational set-up), a foundation will be laid for market introduction.

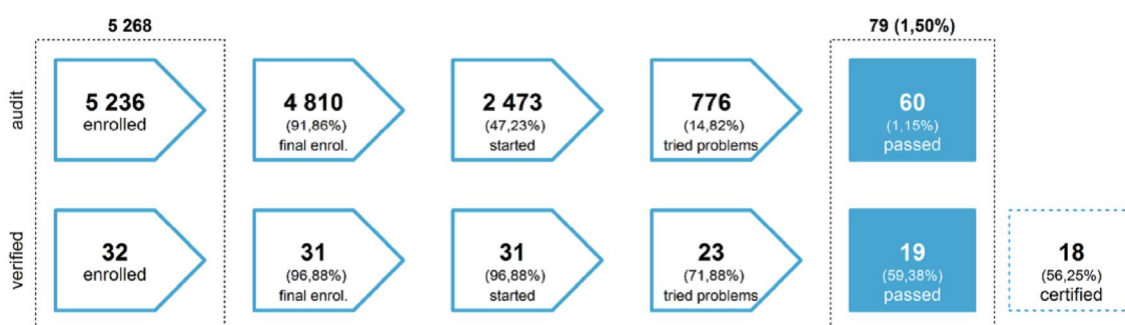
The plan corresponds closely to the national ambition to belong to the world’s five leading knowledge economies by 2020. This is expected to generate 26,000 new jobs.

Harnessing strengths

The strength of the 4TU IMPACT Plan resides in the cooperation between the knowledge institutions and businesses, regional and national governments and other parties (e.g. STW and the T02 institutes). Parties closely involved with the 4TU IMPACT plan include the Ministry of Education, Culture and Science (OCW) and the Ministry of Economic Affairs. 4TU has deliberately built the plan in a modular fashion, so that other parties can easily join. Business cases play a central role in the collaboration, and the strengths of the participating institutions and organisations are used in an optimal manner. The open sharing and collaboration with each other will drive an eco-system of valorisation that will have a major synergetic effect and will be of great benefit to all parties involved. The plan was approved in late 2017, and the means requested for this purpose were provided from the 3TU budget. Wageningen University contributes in kind and, wherever necessary, in cash

Activities of the plan that have already been accomplished

The 4TU.MOOC Entrepreneurship was launched in May 2017. Due to the great success, budget is reserved for the MOOC to be implemented and kept up to date in the coming years. Another MOOC will be made available.



The ambition was to establish a High-Tech Seed Fund valued at €75 million. This goal has been achieved through the establishment of the Innovation Industries Fund on 17 June 2017. Innovation Industries is a new technology fund that will be investing €75 million in approximately 20 promising high-tech companies in the Netherlands in the next ten years. The objective of the fund is to accelerate the conversion of the high-quality knowledge available at the universities of technology, TNO and ECN into successful national and international companies and to support the growth of existing high-tech companies (i.e. 'scale-ups').

In the past, each university worked with its own investment fund or method to assist start-ups, and there was no national system. Innovation Industries offers the desired coordination, reinforcement and up-scaling opportunities for innovative entrepreneurs, thereby providing the most effective endorsement of the valorisation objectives of the knowledge institutions.

Proceeding from Modules 1, 3 and 4, serious efforts are being devoted to coordinate these activities with NWO/TTW and StartupDelta. This has further reinforced the plans and generated a stronger lobby.

Perspective on 2018

In 2018 further efforts will be devoted to the 4TU IMPACT plan. In each module, one or more task groups have been established, with representatives from each TU. In addition, the members of 4TU are working together to ensure good contributions and representation at the Hannover Messe and the Innovation Expo in Rotterdam.

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 2017 (by the date on which the project was signed). The full value of the contract for each project acquired in 2017 is provided. This includes only actual research projects and not proposals. This final figure provides a clear picture of the universities' order portfolio.

Acquisition in euro's in 2017

	4TU
Government grants	163.962.054
Contract research	
Industry	68.849.859
Dutch government	44.248.311
EU government	115.018.188
Other	46.397.701
Total contract research	274.514.059
Grand Total	438.466.113

Commercial activity

The indicator for business activities is measured as the number of spin-offs and start-ups. The definitions of these terms used by the Association of Universities in the Netherlands have been adopted for the purpose of this report:

'A spin-off is a company expressly established to develop or exploit IP or know-how created by a Public Research Organisation and with a formal contractual relationship for the use of this IP or know-how, such as a license or equity agreement. Include, but do not limit to, spin-offs established by PRO staff. Exclude start-ups that have no formal agreement for commercially developing IP or know-how created by the institution.'

'A start-up is any new registered company involving either people (staff or students) from the Public Research Organisation that is not directly involved with the exploitation of the IP generated within the PRO.'

	Spin-offs	Startups
TUD	23	14
TU/e	5	33
UT	6	0
WU	1	5

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

* Wageningen reports only spin-offs of Wageningen University (and thus not of Wageningen Research)

5 Applied Mathematics Institute

Scientific director	Kees Vuik (TU Delft)
Board	John Schmitz (TU Delft), Johan Lukkien (TU/e), Peter Apers (UT), Richard Visser (WU)
Secretary General	Olga Houben-van Herwijnen (TU/e). Per 15 november 2017: Laurie Baggen (TU/e)
Management team	Luc Florack (TU/e), Arnold Heemink (TU Delft), Jaap Molenaar (WU), Anton Stoorvogel (UT)
Project Blended Learning	Hans Cuypers (TU/e), Bart van den Dries (TU Delft), Jan Willem Polderman (UT), Joost van Opheusden (WU)
Stuurgroep Blended Learning	Stephan van Gils (Chair, UT), Marko Boon (TU/e), Maarten de Gee (WU), Jan van der Veen (4TU.CEE), Kees Vuik (TU Delft)
SRO coordinators	Energy: Johann Hurink (UT) Water: Henk Schuttelaars (TU Delft) Health: Stephan van Gils (UT) Big Data: Nelly Litvak (UT)

More and more technology sectors are in great need of advanced and application-oriented knowledge and expertise in mathematics. The four universities join forces in the 4TU.Applied Mathematics Institute (4TU.AMI) programme, which is initially focusing on four Strategic Research Orientations (SROs): Energy, Water, Big Data and Health. These SROs serve as a platform with which the knowledge and expertise of the four universities of technology will be of benefit to technological businesses and knowledge institutions.

Given the strong need for expertise and preparation, the AMI is investing in educational projects in blended learning, proceeding from service teaching in mathematics and the correspondence between higher professional education (HBO) and university-level education (WO).

Teaching

At the annual InterTU study day, service-teaching lecturers exchange experiences with each other. This year, the topics addressed included blended learning and digital testing. In 2017, the Blended Learning group developed several initiatives further. The project, which was launched in the autumn of 2016, grew out of previous educational initiatives. It has caught the attention of the universities' Executive Boards and the Minister of OCW, and it will be exhibited as a model project as part of SURF.

Together with the German mathematical institute Matheon, 4TU.AMI once again organised the Mathekalender, an annual mathematics contest for secondary-school students. In 2017, there were 264 Dutch participants, including 187 secondary-school students.

Research

In 2017, various conferences and symposiums were organised through 4TU.AMI. The theme of the annual Spring Congress was 'Mathematics for Health'. This conference (organised by SRO Health) focused on the application of mathematics within the field of healthcare from various angles. The keynote speaker, Stanford professor and TU Delft alumnus David Lentink, spoke about the advantages of simple designs within the field of aviation (see also the articles in the [Technisch Weekblad](#) and [De Ingenieur](#) in response to his presentation).

Another highly successful symposium was 'Big Data: Mathematics in Action!', organised by SRO Big Data. The symposium was intended to strengthen the ties between applied quantitative research at Dutch universities of technology and business partners.

The SROs submitted several research proposals. SRO Energy submitted a proposal for NWO Energy System Integration & Big Data. This proposal has been funded. SRO Health submitted a proposal for the STW Open Competition. It will be evaluated in early 2018

Other valorisation

To reinforce communication and branding in 2017, the services of a communication specialist were used to update the website and set up a newsletter.

4TU.AMI has honoured several requests for funding, including an International Workshop on the Planning of Emergency Services and a workshop on 'Future and Emerging Mathematical Technologies in Europe'. 4TU.AMI also made a financial contribution to the travelling exhibition entitled 'Imaginary'.

Agenda for 2018

4TU.AMI will continue to serve as a connecting factor between the mathematics groups of the four universities of technology. AMI will further reinforce the cooperation with businesses and knowledge institutions through such efforts as organising a network event. In addition, the annual events (e.g. the InterTU study day and the Spring Congress) will be continued.

The Blended Learning project group will continue developing a variety of online and blended short courses (e.g. for students transferring from universities of applied science and international students). Materials will also be designed for the study-choice check, and a pilot project on digital summative tests will be conducted.

In late 2018, the book Mathematics of Marine Modeling will be published from SRO Water, and an event will be organised around this topic. SRO Energy will re-submit the MSOEN proposal in 2018. In addition, this SRO will organise the Spring Congress 2018. Within SRO Health, a call for the STW Open Competition is being prepared. Following the success of the symposium of November 2017, SRO Big Data would like to organise more workshops to seek connections to upcoming calls and to businesses.

Further, 4TU.AMI will contact the NAM with an offer to conduct independent fundamental research on the emergence and possible prevention of earthquakes resulting from gas-drilling activities in Groningen.

6 Design United

Scientific director	Daan van Eijk (TU Delft)
Managing director	Bart Ahsmann (TU Delft)
Board	Ena Voûte (TU Delft), Aarnout Brombacher (TU/e), Geert Dewulf (UT)
Liaison officers	Janneke Vervloed (TU Delft), Stephan Wensveen (TU/e), Julia Garde (UT).

Design United contributes to the specialisation of design professionals by developing new knowledge and increasing access to existing knowledge. This will improve the industry's powers of innovation, achieve economic growth and help solve problems in society.

Design United forms a community for Dutch Research in Design and targets both designers and researchers, as well as relevant industries and organisations.

The research centre's activities have produced the following results:

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

Programme

These objectives will be achieved through the various activities in the research programme:

- Visiting professors: practising professionals with a solid track record and a strong network will be invited to work with a given faculty in a part-time capacity over an extended period.
- Research fellows: international guest lecturers will be invited for shorter periods of time.
- Demonstrators: provide support for projects and prototypes in order to present the research in the relevant industrial/social context.

The research programme focuses on two substantive research priorities: Design for Healthcare and Product Service Systems (PSS).

Results

In 2017, ten visiting professors were appointed within the research programme. In the past year, a strong stimulus was given to the connection of private parties involved with the faculties through public-private partnerships (PPP). In addition, ten research fellows worked in the faculties for shorter periods of time.

In all, 42 'demonstrator projects' were conducted, many of which were part of the fourth edition of the 'Mind the Step' exhibition at Dutch Design Week in Eindhoven.

The implementation of the research programme is supported by the core activities of the coordination programme, including the annual 'DRIVE' knowledge symposium, the exhibition and communication about the researchers involved, and the completed cases through the website (as an integral part of the 4TU website).

All of this was done in collaboration with and co-financed by the Top Consortium for Knowledge and Innovation (TKI) CLICKNL, the research and innovation network of the Creative Industry top sector.

In 2017, the Netherlands Organisation for Scientific Research (NWO) developed its new programming for the 2018-2019 period, which corresponds closely to the topics on the agenda of Design United. The NWO is devoting increasing attention to calls in the design domain and once again recruited researchers from the various design faculties to assist with formulating the text for the calls. In the last year of the previous NWO programme, only limited calls were available.

The research project within the framework of Smart Industry – the call ‘Next UPPS - Integrated design methodology for Ultra-Personalised Products and Services’ – has started.

Agenda for 2018

There is a clear direction to the current agenda. Assuming that systematisation continues, the ‘solution area’ of Product Service Systems will serve as a framework for the field of research. The experimental environment of the living labs and field labs remains an important element enabling the development of an interactive approach at system level. In the socio-economic domain, Design-Driven Innovation applications are still inextricably connected with ‘Health’. The circular economy is another hot topic from the perspective of the design sector. The design disciplines have a key role to play in bringing about real change.

Finally, from the Technology sector comes the development of Smart Industry (Big Data/Advanced Manufacturing). This, too, requires business propositions that enable flexible production processes and customer intimacy.

In this regard, Design United strives to enact an agenda focusing on the following:

- a design approach to complex Product Service Systems;
- design in experimental environments such as field labs and living labs;
- a healthy society, a circular society and economy, and a Smart Industry economy through Design-Driven Innovation.

In 2017, the new Knowledge and Innovation Agenda (KIA) of the Creative Industries top sector was launched. Design United has contributed to these efforts, in part through input from the visiting professors and research fellows. The agenda of Design United connects to important topics. In the development of new collaborations, the KIA will serve as a co-director. The new NWO programming for the 2018-2019 period includes components that will be implemented by this KIA (using research funding of approximately €8.4 million).



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7 Ethics and Technology

Scientific Director	Philip Brey (UT)
Managing Director	Michael Nagenborg (UT)
Assitant Director	Myrthe van Nus (UT), as of 1 September 2017 Karen Buchanan (UT)
Management Team	Scientific and Managing Director, the head of departments and one additional representative from TU/e and TU Delft
Board	The Deans of the three faculties

Het 4TU.Centre for Ethics and Technology (4TU.Ethics) was established in 2007 to conduct research on 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.

Programme

The centre works according to its own research agenda, which is based on the research agendas of the three core departments, each of which influences the others. The focus areas are as follows:

- Robotics & Information Technology
- Health & Medical Technology
- Sustainable energy
- Risks, Safety & Security

At the end of 2017, 4TU.Ethics had a total of 10 professors, 21 senior researchers, 6 post-docs and junior researchers, 19 doctoral candidates and 76 affiliated members.

Most important activities and their impact

In the course of the year, a plan was developed for the Wageningen University Philosophy group (PHI) to join 4TU.Ethics. The MT has consented to this plan, and the process of joining has been started.

In June, 4TU.Ethics celebrated its 10th anniversary with a conference, in which prominent researchers shared their vision on the theme 'Ethics of Technology: The Future Agenda'. The event was well attended (200 participants), and its success has led to the intention to organise a conference every two years. The next conference will be held in Eindhoven.

4TU.Ethics organised and sponsored a variety of national and international workshops. At the 'Computer, Data Protection and Privacy' conference in Brussels, a 4TU.Ethics panel was held on the topic of 'AI, Privacy and Ethics'. Together with the 4TU.High Tech Materials research centre, a workshop was organised on the ethical implications of materials science. The workshop on 'Ethics and Policy of Robots in Healthcare' was presented in collaboration with the Foundation for Responsible Robotics.

The interdepartmental Task Forces of 4TU.Ethics organised and sponsored activities in their areas of attention. For example, the Task Force on Risk, Safety and Security sponsored activities including the workshop on 'Security & the Political Turn in Philosophy of Technologies' and cooperated with the Task Force on Robotics to organise the

workshop on the 'Ethics and Security of Robots and ICT in policing and the military'. The Task Force on Energy and Sustainability cooperated with SPRU (Sussex, UK) to organise the workshop on 'Energy Ethics without Borders' concerning the extension of the evaluation of energy technologies to include non-Western ethical systems.

Various members of 4TU.Ethics have provided national and international policy recommendations. For example, Filippo Santoni de Sio wrote a white paper on responsible innovation in self-driving systems for the Ministry of Infrastructure and the Environment. In the spring, Jeroen van den Hoven was appointed as a member of the European Expert Group on Ethics in Science and New Technologies (EGE). This group of 15 prominent scientists advises the European committee on all policy areas in which ethical, societal and constitutional issues touch upon the development of science and new technologies.

In cooperation with KIVI, 4TU.Ethics developed the MOOC on 'Ethics, Technology and Engineering'. This short course is part of the certification programme that KIVI offers to its members.

In addition to working on the 37 ongoing research projects, members of 4TU.Ethics have raised funds for five new projects:

NWO	381.000 euro
NOW-MVI	606.000 euro
EU/H2020	62.500 euro
Other	25.000 euro
Total	1.455.500 euro

The 4TU.Ethics Gravitation proposal entitled 'Ethics and Responsible Innovation of Socially Disruptive Technologies' (principal applicant Philip Brey, scope €17,438,500) was ultimately not funded, but the centre regards the fact that it reached the final round of interviews in the competition as a success.

Agenda for 2018

In 2018, the process in which the PHI group from Wageningen PHI is joining 4TU.Ethics will be completed. In January, the executive committee of 4TU.Ethics will be transferred to TU Eindhoven, and Anthonie Meijers will be appointed as the director of research. The MOOC on 'Ethics, Technology and Engineering' will be launched on the Coursera platform.

Throughout the year, national and international workshops will be organised, anchored by the Annual Research Day (6 June, TU Eindhoven).

The 4TU.Ethics Graduate School will once again organise short courses and writing retreats for the doctoral candidates. The 4TU.Ethics centre will once again form the core of a consortium that will submit a Gravitation proposal in 2018.





8 Fluid & Solid Mechanics

Scientific Director	GertJan van Heijst (TU/e)
Steering Committee	GertJan van Heijst (WD JMBC), Marc Geers (TU/e; EM), Lambertus Sluys (TU Delft), Stefan Luding (UT)
Advisory Board	The combined industrial advisory boards of Engineering Mechanics and JM Burgers Centre, in which various Dutch companies, GTI's, are represented (e.g. Philips, Shell, Deltares, Océ, ASML, Unilever and TNO)

The Research Centre Fluid and Solid Mechanics was created by the merger of the Centre of Competence in Fluid and Solid Mechanics and the Centre of Excellence on Multiscale Phenomena. The backbone of this Research Centre has historically been formed by two strong research schools, which had each existed independently for more than 20 years: the Engineering Mechanics (EM; solid mechanics) research school and the JM Burgers Center (JMBC: fluid mechanics). The Research Centre comprises around 65 university research groups, with a total of about 500 doctoral candidates (150 EM, 350 JMBC) and 60 post-docs.

The objectives of 4TU.FSM are as follows:

- to create added value for industry and society through knowledge, expertise and education;
- to facilitate and stimulate cooperation with leading international talent;
- to support junior scientists (tenure trackers) and outstanding PhD candidates in furthering their academic careers;
- to encourage partnerships between mechanics groups across the boundaries of faculties and universities;
- to provide training and education for doctoral candidates and post-docs through the embedded research schools;
- to provide the national coordination of developments within the field of mechanics in the Netherlands, which is highly renowned internationally.

Results

To achieve these objectives in 2017, 4TU.FSM directed its allocated basic budget to the support of various activities.

For example, initiatives to attract prominent, international scientists have received encouragement and financial support. The further development of the international profile of talented junior scientists was encouraged and facilitated by travel grants for working visits to high-level international groups. In addition, financial means were made available to facilitate FSM groups in the use of the laboratory infrastructure and equipment of other faculties and universities;

Several valorisation projects receive financial support to encourage the valorisation of nearly completed PhD projects.

Subsidies have been granted to international symposiums and conferences organised in the Netherlands by FSM groups and for the fabrication of technical animations for purposes of profiling FSM projects at conferences, meetings, workshops, websites, media and other forums.

In October, EM (solids) organised a 20th anniversary celebration. This successful day was attended by representatives from businesses, knowledge institutions and leading technological institutes.

The cross connections between EM (solids) and JMBC (fluids) were strengthened by the organisation of a workshop and special sessions on 'fluid-structure interaction' at the annual research symposiums of the two research schools.

The groups within 4TU.FSM are involved in a variety of collaborative projects funded by STW, FOM and NWO. In addition, many research projects are financed through contract funding, in direct cooperation with industry. Collaboration with research groups at Wageningen University is increasing. This collaboration is expected to intensify in the coming years.

The 4TU.FSM Research Centre reflects the leading international level of the field of mechanics in the Netherlands, as evidenced in the results of the various research accreditation inspections, as well as in terms of citation analyses and the acquisition of research grants and prizes. Again in 2017, various grants were awarded within the FSM groups, including ERC Advanced grants.

The centre connects research in seemingly different disciplines, all of which draw upon the foundations and innovations in FSM. The centre would like to retain this recognition and invest further in the outstanding and international reputation of the multi-disciplinary mechanics research in the Netherlands. The limited basic budget that has been allocated to 4TU.FSM in recent years is subcritical for a research centre of such a large scale. Nevertheless, it has proved possible to apply the allocated means in a targeted manner to activities that promote exposure and international embeddedness, and thus FSM research. Unfortunately, the allocation of a 4TU basic budget for FSM has been discontinued as of 2018.

2018

In 2018, the 4TU.FSM Research Centre aims to continue working towards the objectives from 2017. In collaboration with the Burgers Center and Engineering Mechanics, 4TU.FSM will focus primarily on roles having to do with coordination and stimulation.

9 High Tech Materials

Scientific Director	Jilt Sietsma (TU Delft)
Secretary general	Reina Boerrigter (TU Delft)
Management Team	Rint Sijbesma, Marc Geers (TU/e), Remko Akkerman, Julius Vancso (UT), Joris Sprakel (WU), Sybrand van der Zwaag, Jilt Sietsma (TU Delft)
General Board	Theun Baller (TU Delft), Jeroen Cornelissen (UT), Philip de Goey (TU/e), Raoul Bino (WU)

The primary objective of the 4TU.High-Tech Materials Research Centre (4TU.HTM) is to stimulate and take a fresh approach to 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. In this way, 4TU.HTM brings together materials-science research in the Netherlands.

New Horizons in Designer Materials

The objective of the 4TU.HTM research programme is to develop new topics in materials science into research areas at the four universities of technology. Within this programme, six research projects are being conducted by post-docs with high potential. In this way, the research centre aims to provide a strong stimulus to materials science in the Netherlands, with a view to initiating new research lines at the universities of technology, which will continue to contribute to the high level of materials-science research and education in the Netherlands for the decades to come. Two of the six post-docs have since received personal grants that have allowed them to continue their research topics, in collaboration with new post-docs within the original research project. In 2017, five of the international experts who have been involved with the HTM research programme travelled to the Netherlands and visited several universities

Results

In 2017, the annual 4TU.HTM Dutch Materials symposium revolved around the theme 'Materials for Energy and Composite Materials'. The symposium included contributions from various 4TU research groups, from both junior and keynote speakers, from the post-docs within the research programme and from guest speakers from DIFFER and ECN Solar Energy/AMOLF. Scientists from many materials-science groups within the four universities of technology participated in the symposium.

4TU.HTM has a programme for Joint Materials Science Activities, in which the participating research groups from the four universities of technology can receive funding and support for activities aimed at promoting excellence and the accessibility of materials-science research in the Netherlands. In 2017, various activities have taken place in this regard, including the Soft Matter CryoTEM Workshop at TU/e, with participants from Eindhoven, Twente and Delft; the International Conference on Liquid Phase Electron Microscopy 2017 at TU/e, with participants from the four universities of technology; and the 4TU.Orthopaedic Bioengineering conference at TU/e, which was organised by TU/e, the University of Twente and TU Delft. During the 2017 Dutch Polymer Days, this programme awarded a poster prize and a workshop prize on behalf of 4TU.HTM.

With its collaborative activities, 4TU.HTM has focused on the accessibility and visibility of materials science. Wageningen University and TU Delft jointly held the symposium 'The Unexpected Science of Chocolate and Steel', with international speakers and speakers from the industry, along with demonstrations involving steel and chocolate. It was an event for a scientific audience, with the primary target group consisting of Bachelor's and

Master's students, as well as researchers at the four universities of technology. It also generated a brief report on the production of steel in the informative children's television programme Willem Wever.

The first week of June was devoted to the Ameland Summer School on Smart Materials, a collaborative partnership between 4TU.HTM and MESA+, the Zernike Institute (University of Groningen) and the Institute for Molecules and Materials (Radboud University Nijmegen). For this programme, 30 doctoral candidates and post-docs working at various research groups at the four universities of technology, the University of Groningen and Radboud University Nijmegen spent five days on the island of Ameland, where they attended workshops given by 12 national and international speakers.

In order to visualise materials science and materials scientists working within various research groups at the four universities of technology, 4TU.HTM is developing a variety of activities.

- A web application has been developed (<http://hightechmaterials.4tu.nl>) to provide an overview of the expertise of HTM materials scientists for students, the press and industrial contacts.
- Development has begun on a website that will provide an overview of the materials science infrastructure in the Netherlands. The initiative will start in Delft and, in 2018, it will expand further within the four universities of technology.
- HTM presented itself at Materials 2017, the SME trade fair and conference relating to materials, in collaboration with TU/e, and with a PDEng programme (TDI) from the 4TU.Stan Ackermans Institute. Many speakers from TU/e and TU Delft were present as well.
- Activities relating to materials science at the four universities of technology were announced on the 4TU.HTM website and through social media (LinkedIn and Twitter).

In 2017, 4TU.HTM established collaboration on various aspects with other 4TU.Centres.

- In March 2017, 4TU.HTM organised a joint workshop with 4TU.Ethics and Technology. The workshop consisted of a one-day programme with speakers from both disciplines and roundtable discussions, with the objective of making researchers aware of ethical issues relating to materials and to discuss common challenges within the area of Ethics and Materials Science, which could lead to joint research proposals. This initiative also resulted in a talk on materials and ethics during the Dutch Materials 2017 event.
- 4TU.HTM has held exploratory discussions with the 4TU.Centre for Research Data to take inventory of the possibilities for expanding the centre's services with regard to the management of data and software, as well as with regard to data storage. The 4TU.Centre for Research Data also presented itself during Dutch Materials 2017.

Agenda for 2018

In 2018, 4TU.HTM will continue its focus on enhancing the visibility and accessibility of materials science and the research facilitates for research in materials science through an up-to-date website and the development of promotional materials. In addition, the web application hightechmaterials.4tu.nl, which was developed in 2017, will be extended on several points. In 2018, the post-docs within the New Horizons in Designer Materials research programme will present their results in the bilingual journal 'Innovatieve Materialen/Innovative Materials', which will be distributed to a broad audience. The 2018 programme for the annual 4TU.HTM symposium will centre on the theme Computational Materials Science, and international speakers will be involved. As in past years, the centre will continue to encourage joint initiatives to increase the quality and impact of materials science research and to increase participation in national and European research agendas.

10 High Tech Systems

Scientific Director	Maarten Steinbuch (TU/e)
Assistent	Ties Leermakers (TU/e)
Board	Theun Baller (TU Delft), Geert Dewulf (UT), Philip de Goey (TU/e)
Participating faculties	Faculty Mechanical, Maritime and Materials Engineering (TU Delft), Faculties of Engineering Technology and Electrical Engineering, Mathematics and Computer Science (UT) and Faculties of Mechanical Engineering and Electrical Engineering (TU/e).

4TU.HTS used the basic funding from 2017 primarily for the following purposes:

- To draw attention to the robotics research taking place in the Netherlands by supporting the RoboNed platform, which has now been re-named Holland Robotics, with strong input from the industry
- To provide an additional stimulus to research on the use of electric cars in the Netherlands by supporting the Dutch-INCERT Initiative, as well as by contributing to a national research agenda for the use of electric cars
- To participate in the HTSM top sector
- To raise the external profile of the 4TU.Federation at high-tech fairs
- To set up and maintain the Master's programme in Systems & Control

Results

Since April 2010, the robotics activities in the Netherlands have been coordinated by RoboNED. The objective of the Dutch robotics platform is to stimulate synergy amongst the various fields of robotics application and to focus research and development within a strong network. This network brings together industry, research, education, government and consumers in order to work together to strengthen the ecosystem of innovation. RoboNED is also dedicated to increasing social acceptance of robotics.

Robotics research in the Netherlands focuses on developing intelligent robots that are capable of interacting safely and robustly with an unknown and evolving environment that includes some human beings. In order to make these robots a reality, various problems relating to navigation, safe interaction, learning and social behaviour as well as other ethical and legal issues need to be solved. Robotics research is of relevance to high-tech industry and various sectors (including healthcare, logistics and agriculture), and it makes a significant contribution to the Dutch economy.

In 2017, 4TU.HTS primarily contributed to the High Tech NL Robotics platform (see <http://www.hightechnl.nl/innovation/holland-robotics>), in addition to contributing to the Robotics agenda.

4TU is a partner in [Dutch INCERT](#) and in [Nederland Elektrisch](#). The Dutch-INCERT (Dutch Innovation Centre for Electric Road Transport) consortium was established in 2008 on the initiative of the 3TU universities and the Rotterdam and HAN Universities of Applied Sciences to serve as a platform to ensure that scientific and practically-oriented research, technological innovation and educational innovation are closely involved in the transition to electric transport in the Netherlands. The knowledge platform facilitates rapid transfer of knowledge, as well as coordination and co-operation between the affiliated parties. Dutch-INCERT works with innovative businesses and government bodies that are playing a pioneering role in the introduction of e-mobility.

'Nederland Elektrisch' is the leading online portal for anyone who drives an electric car, is interested in e-mobility or who is professionally involved with the use of electric cars in the Netherlands. Results for 2017 are:

- Improved the online portal Nederland Elektrisch;
- Played an active and visible role through 4TU in the Formula E-Team (advisory body for the Ministry of Economic Affairs);
- Established and provided partial funding for the national EV innovation agenda.

Profiling

The director of research, Martin Steinbuch, is a member of the Supervisory Board of the HTSM top sector. Various members of 4TU.HTS actively participate in the Mechatronics working group, which provides input for the roadmap for the top sector.

For purposes of external profiling, 4TU.HTS was present at the Hannover Messe 2017, Medica 2017 and the Precisiebeurs 2017. It also supported the technology-promotional foundation Stichting Techniekpromotie and sponsored the 'Wim van der Hoek Best Graduation Prize' in the area of mechanical construction.

4TU Master's programme in Systems & Control

The two-year MSc programme in Systems & Control is aimed at students with a technical BSc background who are interested in analysis and the administration of dynamic systems in the broadest sense of the word. The Master's programme is running well.

The future

The 4TU.Federation has not continued the financial support for this research centre in 2018. Activities relating to the presence of 4TU at the Hannover Messe have been incorporated into 4TU.Valueisation. The other activities will not be continued as 4TU activities, but some will be continued from within the TU/e High Tech Systems Center. Maarten Steinbuch of TU/e will remain on the board of Holland Robotics, Dutch INCERT and FET, as well as on the HTSM Executive Council.





11 Humans & Technology

Board	Dirk Heylen (UT, Scientific Director), Mark Neerincx (TU Delft), Wijnand IJsselsteijn (TU/e)
Secretary	Benno Pals (UT)
PI's	Khiet Truong/Gijs Huisman (UT), Marieke Peeters/Roel Boumans (TU Delft), Femke Beuts/Peter Ruijten (TU/e)

The 4TU.Humans & Technology Research Centre brings together social scientists and technical scientists to conduct research on the interaction between humans and information technology. Universities of technology strive to make visible high-level research on innovative forms of interaction between humans and technology for smart social systems and spaces. The objective of the Humans & Technology research centre is to establish a lining ecosystem for consultation and cooperation between the universities, the industry and other stakeholders in this field.

It also seeks to establish partnerships with general universities and other parties in the Netherlands and abroad. In addition to its interest in research and impact, the partnership focuses on providing high-quality education for both Master's and PhD students.

To achieve the objectives of 4TU.H&T, various activities have been organised, including workshops aimed at developing roadmaps and agendas for national and international research programmes. Efforts are also directed towards the developing a perspective matching programme proceeding from businesses. Highly talented individuals are coached within exchange programmes and summer schools in which Master's and graduate programmes are coordinated to each other.

Results

In 2017, activities were organised each month. They included a variety of research meet ups – organised primarily around topics in which the doctoral candidates in the research programme are involved. In addition, there was a three-day 'WriteAthon'. The workshops and seminars that were organised concerned topics including Computational Social Science, Empathic Technologies (in cooperation with NIRICT), Sound Technology, Persuasive Embodied Agents for Behaviour Change, Agent-Based Modeling, Wearables in Practice and Virtual and Augmented Reality.

Participation in these seminars ranged from 20 to 100 participants, and the seminars often lead to follow-up agreements and new project proposals. The form varied widely, ranging from presentations to roundtables, and from hands-on workshops to brainstorm sessions. Speakers from 4TU were joined by national and international speakers from other research institutions, as well as from businesses or other organisations.

One special objective for 2017 was to expand and strengthen the community. The centre has become more visible due to efforts including the establishment of a Twitter account from which tweets about 4TU.H&T events are sent and the distribution of a newsletter containing news about 4TU.H&T research and events.

Teaching

Several of the aforementioned workshops also included tutorials that are extremely well suited to PhD and Master's students. For example, in the 'Computational Social Science' workshop, students worked with the 'Natural Language Toolkit' in Python. Other activities include the organisation of a three-day writing retreat by and for the PhD students of 4TU.H&T (WriteAthon). The organisation of these workshops and educational activities will continue in 2018 as well, and PhD students will be invited to attend

Agenda for 2018

For 2018, we will continue to organise a variety of educational and research activities, particularly those targeting PhD students. A new writing retreat was planned for February 2018, and the winter school on Affective Computing and Social Signal Processing will take place in March 2018. The winter school was set up in collaboration with the 'International Association for the Advancement of Affective Computing' and the 'SIKS' research school. In addition to lecturers from the four universities of technology, international experts in Affective Computing will be present in order to contribute.

The schedule includes workshops on tele-presence, research methodology, artificial nature and embodied conversational agents. A national symposium on Affective Computing in the Netherlands will be organised as well, in order to bring together the various researchers who are working on this topic in the Netherlands.

12 Netherlands Institute on Research on ICT

Board	Inald Lagendijk (scientific director, TU Delft), Mark van den Brand (TU/e), Maarten van Steen (UT), Bedir Tekinerdogan (WU), Marieke Huisman (UT), Birna van Riemsdijk (TU Delft), Sander Stuijk (TU/e)
Programme Manager	Eveline Vreede (TU Delft)
BSR project	Wil van der Aalst (TU/e), Arie van Deursen (TU Delft), Jaco van de Pol (UT)

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

The focus in this regard is on researchers who are at the start of their careers. At the same time, broad collaboration in activities relating to research and education are encouraged through 'research community funding'. Between 2014 and 2017, the largest research programme, 4TU.NIRICT, operated the project entitled 'Big Software on the Run' (BSR). BSR is an independent research programme in which seven research groups from University of Twente, TU Delft and TU/e are taking part.

4TU ICT Research Community

In order to promote cooperation between universities of technology, it is vital to establish and develop a network in which all participants are aware of and have mutual respect for each other's ICT research. Each year, NIRICT organises a community session, and it has used 'research community funding' to sponsor 10 workshops. These workshops were organised by the research community itself on a variety of topics, including Human Computation, IoT, Empathic Lighting and Cyber Security. With the ICTng (ICT next generation) network, 4TU.NIRICT is concentrating on researchers who do not yet have extensive national networks. ICTng was established in close collaboration with the FES COMMIT/programme. Led by Przemek Pawelczak in 2017, who was succeeded by Cynthia Liem in 2018, a core team of young researchers from several Dutch universities was also created. Furthermore, COMMIT/ and 4TU.NIRECT helped to organise and fund a series of meetings featuring inspiring speakers and discussions. In addition, 4TU.NIRICT has established an exchange programme for stimulating mutual mobility, and it will undergo further growth in the coming years. In this programme, researchers can temporarily work one day a week at another TU. Finally, NIRICT enabled four post-doctoral appointments in 2017. These post-doctoral researchers received shared appointments at two universities of technology for joint research projects in which the combined expertise and mutual ties of the research groups constituted a major benefit.

Between 2014 and 2017, NIRICT used stimulus funding to encourage promising bottom-up initiatives in thematic research partnerships. It thereby developed and maintained a research portfolio of important issues with a good chance of receiving external funding. In this period, partnerships emerged on the following topics: Data Science, Cyber Security, Antenna Research, Empathic Lighting, Wirelessly-Powered Autonomous Systems, Smart Industry/IoT, Green ICT and Human Computation, in addition to GPGPU, enabling Constructive Public Discourse on Social Media and Model-based Engineering. Activities developed within these partnerships, include joint workshops, seminars, representation in the Dutch ICT landscape, and efforts have been devoted to writing successful joint project proposals, e.g. the IoT project of TU Delft and the University of Twente, which was funded in the NWO Smart Culture Creative Cities call, and the Human Computation collaboration within the Starting Stimulus (in Dutch, Startimpuls) programme entitled 'Responsible Value Creation with Big Data (VWData)'. With its focus on 'research community funding', 4TU.NIRICT is releasing this substantive line for the coming 2018-2021 period, and it will continue to make an important contribution to collaboration between ICT researchers of the 4TU by supporting concrete network-strengthening activities.

Educational collaboration

4TU.NIRICT aims to reinforce the efficiency, development and implementation of educational cooperation. Each of the universities of technology develops its own educational programmes. An inventory of programmes, courses, materials and MOOCs has been made and, as a result, ICT researchers from the universities of technology are better informed about their colleagues' activities and resources, which in turn helps promote collaboration and the sharing of best practices. In addition, 4TU.NIRICT has contributed to the publication of 'The Human in 2050' by the Future Image of Technology Fund (Stichting Toekomstbeeld der Techniek). Finally, the universities of technology are jointly responsible for implementing and designing the Master's degree programme in Innovation offered by EIT Digital. 4TU.NIRICT's Scientific Director represents the research centre on the EIT Digital General Assembly. Beginning in 2018, the three universities will be members of EIT Digital as independent entities, as a result of the organisational and administrative changes on the part of EIT Digital.

Big Software on the Run

4TU.NIRICT's largest research programme between 2014 and 2017 was the Big Software on the Run (BSR) project. 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. Software forms an integral part of the most complex things built by humans. BSR is therefore developing innovative technologies that identify how systems actually work, check where and when systems deviate from expected behaviour, predict reliability, performance and security, and make recommendations to address problems. This approach generates a huge amount of data (Big Data) and very complex software (Big Software). There is extensive co-operation between the participating research groups. A specific example of this is that PhD students are supervised by promotors from two different universities of technology. The groups also use the same infrastructure: in Eindhoven the groups compute large data sets in a single machine, while in Twente the focus is on distributed computing. This efficient use of resources has also been organised with a view to the future, so that it can respond to developments within joint projects in the coming years. Integrating the different disciplines and methods has generated new insights and creativity.

Agenda for 2018

In 2018, 4TU.NIRICT will continue its partnership with ICT.OPEN, the largest gathering of the Dutch ICT research community, and make a substantive contribution towards multiple tracks and sponsoring the Cyber Security Awards. In addition, it will organise the annual Community Day. ICTng is organising a series of sessions and a get-together during ICT.OPEN2018. The new call for 'research community funding' will support a series of activities emerging from the ICT research community. BSR is organising a variety of national consultations and the second, concluding summer school – a major event – alongside the 8th European Business Intelligence & Big Data Summer School (eBISS 2018) in Berg en Dal. In addition, with its 'Tips and Tricks document' for the process of applying for grants, 4TU.NIRICT is focusing on increasing the chances of success for personal grant proposals by ICT researchers

13 Centre for Research Data

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

4TU.Centre for Research Data (short name: 4TU.ResearchData) offers services and advice to archive research data in a standardised, secure and well-documented manner.

As one of the three established data archives in the Netherlands, it provides the research community with:

- A long-term archive for storing scientific research data
- Permanent access to, and tools for the reuse of research data
- Advice and support on the curation of data management
- A voice advocating for good data management, both nationally and internationally

Highlights 2017

This year the archive expanded with 478 datasets, 3.23 TB byte of data. At the end of the year we celebrated our 7.500 dataset. In total 116 times a dataset at 4TU.ResearchData was downloaded.

Sand Motor data

Since 2011 researchers of the Sand Motor project (project of Rijkswaterstaat) explore the possibilities of sustainable and natural coastal protection through the construction of a peninsula near the coast of Ter Heijde. In 2016 the first phase of the research program was completed and in 2017 various data came [publicly available](#) at 4TU.ResearchData.

Datasets available via OpenAIRE

Via the OpenAIRE portal all European funded research output is made as much as possible, available to all. Every dataset published in the 4TU data archive, which has an associated article or project, now becomes automatically aggregated to the OpenAIRE portal, where it can be found alongside other research. This way we help researchers to comply with the EC's policies on Open Access, and help increase the visibility of our content.

Policies and documentation

In anticipation of the renewal of the Data Seal of Approval, that is succeeded by the new CoreTrustSeal, we have updated some policies and documentation and created new ones: [Preservation policy](#), [Data collection policy](#), [List of preferred formats](#) and [Guidelines for creating a README file](#).

Data funds

This year we introduced two funds to support researchers with their research data management: the Data Refinement Fund and the Data Paper Fund. [The Data Refinement Fund](#) offers researchers a budget to make their valuable research data available online by refining their data for proper discoverability and reusability. With the [Data Paper Fund](#) 4TU.ResearchData promotes publishing of data papers by funding the publishing costs.

NetCDF data services

In 2017 we started exploring our options for providing services related to netCDF data. Atmospheric and environmental research data form the bulk of the content of the 4TU.ResearchData archive. Most of these datasets are coded in net-CDF, a data format that is especially suited to store multi-dimensional array-oriented data. In the report that we will write we will be assessing the opportunities for creating not just technical services related to storing and archiving NetCDF, but for advice and guidance, and the advantages that could accrue from being recognised as a source of data in the area.

NIOZ pilot

At the beginning of 2017 two NIOZ research groups have decided to use the 4TU.ResearchData archive for making data underlying their publications available and discoverable. Datasets are deposited by either the data librarian of NIOZ or the researcher him/herself. A service that is highly appreciated by NIOZ is the 'DOI reservation'. The researcher receives a DOI for the dataset in advance to integrate the DOI into a paper that is in the publication process. In total, NIOZ has deposited 16 datasets last year.

Outreach to 4TU. research centres

In the second half of 2017 explored the research data management needs within the research centres of the 4TU. Federation and (re)introduced the services provided by 4TU.ResearchData that can cover those needs. The project included structured interviews with the Scientific Directors of each Research Centre. The results will be presented as a report, which will be shared with the 4TU.Federation.

FAIR Data Principles research project

We worked on a IDCC17 practice paper and a Excel spreadsheet that includes an overview of 37 evaluated research data repositories in context of the FAIR (Findable, Accessible, Interoperable and Re-usable) data principles. With this research project we wanted to test the effectiveness and relevance of the FAIR Data Principles. Simultaneously, analyses how easy it is for data archives to adhere to the principles.

The research was a part of the CESAER TFOS-RDM working group. We also analysed our own archive in the context of the FAIR Principles. This review focuses on the metadata that describes each dataset rather than the data sitting within each dataset.

Training Essentials for data support

This year we organised three rounds of our RDNL [Essentials 4 Data Support course](#), which resulted in another 40 educated data supporters. In February we coordinated a Train-the-Trainer version where we focused on how we organized our course and the content to a blended training. For two institutes: NVvTG and Fontys Hogescholen, we organised an inhouse datamanagement training. And at the LIBER conference in July we held a presentation on the FAIR aspects of the Essentials 4 Data Support training.

Showcases

Our showcases highlight engaging stories related to data sharing. This year we collaborated with TU Delft Library Magazine who interviewed several researchers about their research and their at 4TU. archived data.

<http://www.onlinemagazine.library.tudelft.nl/?p=1850>

<http://www.onlinemagazine.library.tudelft.nl/?p=1960>

14 Centre for Engineering Education

TU Delft	Aldert Kamp (Leader), Renate Klaassen (coordinator)
TU/e	Birgit Pepin (Leader), Chantal Brans (coordinator)
UT	Jan van der Veen (Leader, Chair), Chris Rouwenhorst (coordinator)
WU	Emiel van Puffelen (Leader), Marijke van Oppen (coordinator)
Advisory Board	Kristina Edström (KTH, Stockholm), Marc de Vries (TU Delft), Lex Lemmens (TU/e), Rikus Eising (UT), Harm Biemans (WU), Christiaan Meijer (Student TU Delft)

The 4TU.Centre for Engineering Education (4TU.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 centre searches for lecturers and researchers from each university who can be engaged. Connection to international experts and relevant literature is an element of the 4TU.CEE approach. Each year, the centre presents its results at conferences and in journals.

Results in 2017

The 2017-2019 strategic plan was converted into actions and projects. A review study was completed (v/d Beemt, TU/e et al.) as a result of the common work package 'Interdisciplinary Engineering Education'. The framework developed within this project was presented at the CDIO 2017 conference in Calgary, as was the work concerning future engineering skills.

The embedding of the CEE within the international network was reinforced with the appointment of Aldert Kamp (initiator of CEE Delft) as co-director of [CDIO](#), an international network of 160 universities of technology and universities of applied sciences. The universities of Twente and Eindhoven joined this year as well. The other important international network, [SEFI](#), decided that 4TU.CEE will be able to organise the annual SEFI conference in Twente in 2020.

The preliminary study on the new topic of 'Virtual Reality' led to an inspiring VR day in Utrecht, with guests including Pierre Dillenbourg (EPFL, Lausanne) as the keynote speaker. In the workshops, lecturers from each of the universities of technology presented examples of VR applications within the context of education.

The members of the CEE board paid a visit to the EPFL in Lausanne and the ETH in Zürich. These two institutions offer evidence of the international trend towards arranging innovation worksites. The EPFL has considerable experience with MOOCs, which it also uses for its own students. The ETH has a good programme for the continuous professional development of lecturers.

Newsletters, blogs, an innovation map, education days and workshops are used to share inspiration and results with colleagues at home and abroad. The [innovation map](#) now provides a showcase of 126 technical-university education projects, including a large number by the new partner, Wageningen University.

In Delft, the focus was on five topics: innovation skills in the Master's programme, differentiating engineering roles, virtual reality, the development of a career MOOC for Master's students and young professionals, and the relationship of mathematics and physics to the engineering discipline. Studies and developments that were initiated or completed on topics including Enterprise Systems Engineering (in collaboration with UBC, Canada), interdisciplinary

education in the Master's programme across three faculties, student selection in the Bachelor's programme and the use of English in engineering education. The study on engineering roles resulted from the development of outcomes of the 'Free Spirits Think Tank' in 2016. The roles were validated in multiple workshops involving students, scientific staff and businesses. A subsequent study on the forces driving societal change resulted in a number of dimensions describing the expected behaviour of engineers in about 15 years.

Through the innovation fund, the CEE stimulated a number of projects at TU/e concerning hands-on education or more/different contact time with students. For example, a Remote Lab and a crowdsourcing platform were developed. All of the projects have research components examining success factors and transferability. Results are among the standard topics addressed at the innovation day. As inspiration for 'TU/e Education in 2030', international experts were asked to provide a session addressing both online and hands-on education. Publications were prepared on the use of digital resources in mathematics courses. This corresponds to the collaboration with 4TU.AMI on the topic of blended learning.

A pilot project on the Senior Teaching Qualification was set up and implemented at the University of Twente. Lecturers conducted design or research projects in their own teaching. Participation in the project of the Royal Academy of Engineering (UK) on valuation of education in career paths generated inspiration. For example, professors with emphasis on education will be appointed within all faculties of the University of Twente. The 4TU.CEE & AMI project resulted in the implementation of the first digital examinations in mathematics. Two doctoral programmes linked to the Twente Teaching Model (TTM) yielded publications on the TTM lecturer teams. Results were also shared with Directors of Studies and lecturers.

In 2017, Wageningen University elaborated its share in 4TU.CEE. Across the CEE topics, 44 projects were identified, and an innovation map was revealed. Wageningen UR is coordinating the topic of 'diversity & flexibility'. In 2017, three events were organised, including a workshop on 'Teaching Tricks', provided by Kristina Edström (KTH). An internal network for inspiration concerning educational innovation was established with Wageningen lecturers involved in all projects (150 lecturers). In 2017, 4TU.CEE generated the initiative for a study on educational motivations at Wageningen University and the sharing of experiences. An article on this study was published, and a second article has been submitted.

Looking ahead to the future 2018

In 2018, CEE will further implement its strategic plan through both joint and local projects. Joint efforts will be directed towards such aspects as interdisciplinarity, internationalisation, blended learning, VR applications, design education and the preparation of students for engineering roles and careers upon completion of their studies. Efforts will also be devoted to the connection of mathematics and physics to engineering. In Delft, this will be done in part through close collaboration between mathematics and aerospace lecturers, as well as through the development of a prototype of a lab-in-a-box. In Eindhoven, efforts have begun on a new round within the framework of digital (and other) skills testing. At the University of Twente, a second SKO round will be started, and support will be provided for serious innovation in the Master's programmes. Wageningen will begin a 4TU.CEE series of activities on 'diversity and flexibility'. Wageningen will also be working on a structural connection to the work of Education & Student Affairs and the chair in Education and Competence Studies. A large number of contributions will be submitted to the CDIO and SEFI conferences in 2018. In addition, several students will be participating in the CDIO design academy this year, which will take place simultaneously in Kanazawa (Japan).

15 Stan Ackermans Institute

Director/chairman	Jan Fransoo (TU/e), as of 1 November 2017 Paul Koenraad (TU/e)
Coordinator/secretary	Ben Donders (TU/e)
Board	Jan Fransoo, Ben Donders, Geert Dewulf (UT), André de Haan (TU Delft)
Coordinator TU Delft	Pieter Swinkels
Coordinator UT	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. This will be done through a website, brochures and videos.

Graduates will receive the degree of Professional Doctorate in Engineering (PDEng).

To recruit potential trainees, the SAI will attend business days at the four universities of technology and elsewhere in the country. Again this year, a brochure will be published containing a selection of design assignments that trainees have completed for companies.

Twente and Delft each have four active programmes, and Eindhoven has eleven. The intake in the programmes has declined from 198 to 173, and the number of graduates has declined from 166 to 141. An overview of intake and graduation figures by programme and institution is provided in this section.

In the reporting year, the 4000th PDEng degree was presented in a festive manner to Tudor Vercetru at the PDEng programme in User System Interaction in Eindhoven.

Representatives of all designer programmes and the CCTO meet annually. This year, the meeting was held in November at the University of Twente. During the meeting, a plenary discussion was 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 of the 4TU.SAI board entitled 'Key Features of Designer Programmes', which contains those characteristics that all programmes should meet with regard to quality assurance.

TU/e, TU Delft and the University of Twente are examining how the designer programmes can be fit into the Graduate Schools of the respective institutions. In addition, the deans of the Graduate Schools of the four universities of technology have started to hold regular consultations, in which the designer programmes are addressed. Within this consultation, Wageningen has announced that it is considering launching designer programmes.

Within TU/e, considerable attention has been directed towards plans to revise the designer programmes. A framework was established for this purpose in the reporting year. The goal is to start the revised programme as of 1 September 2018.

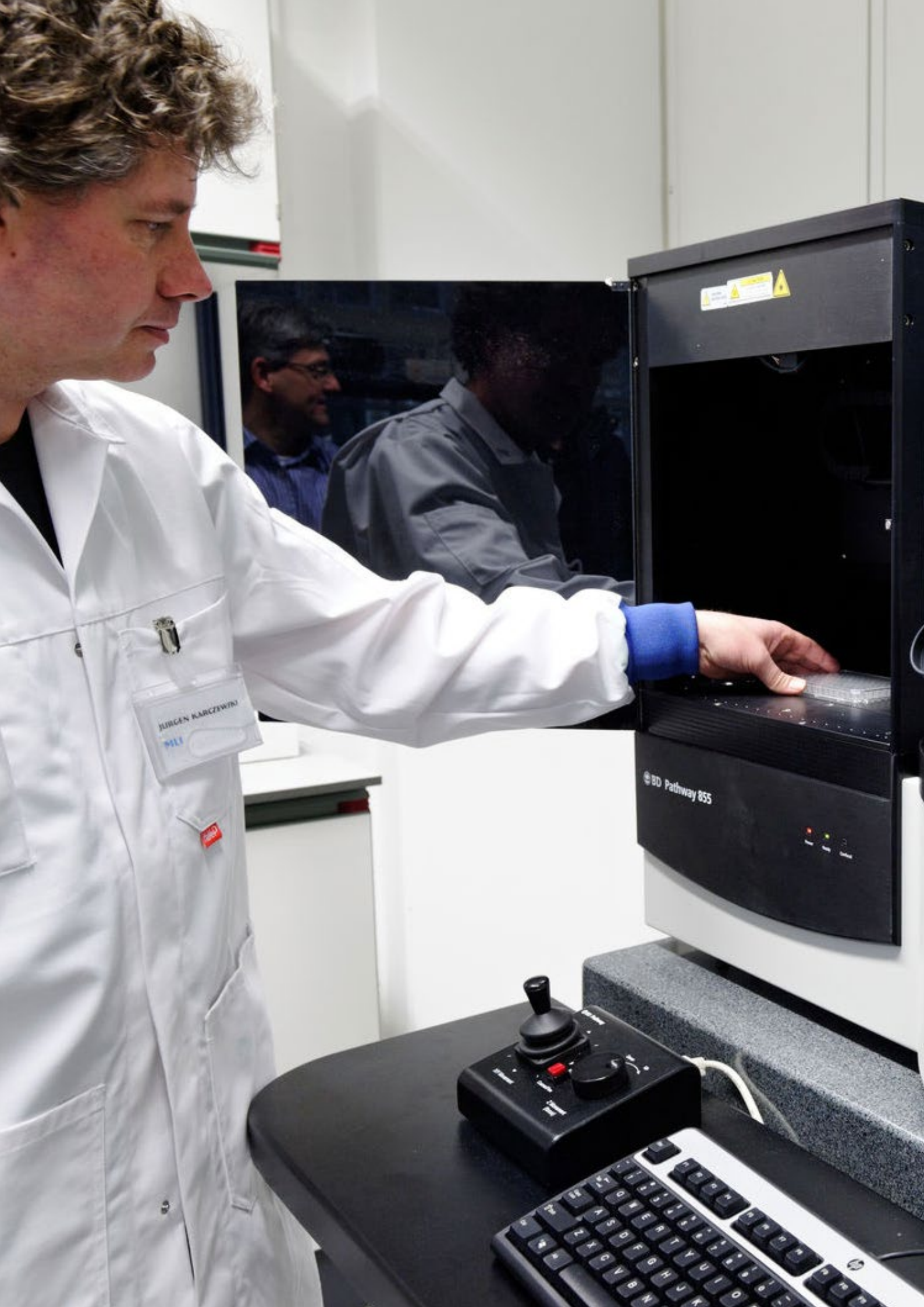
Overview of intake and degree certificates issued for designer programmes 2013-2017

	2013		2014		2015		2016		2017	
	Degree	Intake	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
Information and Communication Technology (ICT) ¹	9	15	8	14	11	6	14	10	3	12
Logistics Management Systems (LMS) ²	14	10	6	11	12	4	7	10	4	0
Mathematics for Industry (MI)	12	14	10	15	15	6	14	0	5	0
Software Technology (ST)	11	21	16	19	20	17	15	20	16	17
Design and Technology of Instrumentation (DTI)	8	8	8	10	7	7	10	9	6	9
Architectural Design Management Systems (ADMS)	4	3	0	0	1	0	1	0	0	0
User-System Interaction (USI)	18	16	17	15	15	17	14	13	18	0
Automotive Systems Design (ASD)	7	13	6	13	12	14	11	15	14	14
Smart Energy Buildings & Cities (SEBC) ³		10	8	9	10	8	8	6	8	13
Clinical Informatics (CI)	10	11	7	10	9	13	11	13	10	13
Qualified Medical Engineer		3	2	7	3	1	6	7	0	5
Data Science (DS)		0	0	0	0	0	11			20
Total	113	148	111	145	137	117	130	142	108	131
TU Delft										
Process and Equipment Design (PED)	11	9	7	10	10	9	9	9	8	13
Bioprocess Engineering (BPE)	8	11	5	9	12	7	10	8	7	7
Comprehensive Design in Civil Engineering (CDCE)		1	5	0	0	0	1	0	0	0
Chemical Product Design (CPD)		3	9	1	7	6	7	7	7	6
Total	19	24	17	28	23	23	26	24	22	26
Twente										
Energy and Process Technology (EPT)		1	1	3	2	4	3	11	4	4
Robotics		1	4	1	2	4	5	2	4	
Civil Engineering (CE)		3	5	6	6	3	7	4	2	
Healthcare Logistics		0	0	0	0	0	0	0	0	
Maintenance		0	0	0	2	0	9	1	1	
Total		5	1	12	9	14	10	32	11	11
Total 4TU	132	177	129	185	169	154	166	198	140	168

¹ New name: Design of Electrical Engineering Systems

² New name: Industrial Engineering

³ New name: Smart Building & Cities





Masters

16 Master Programmes

Construction Management & Engineering

The Master in Construction Management and Engineering (CME) is a two-year English taught Master's programme. It addresses the growing need for reforms within the building and construction (BC) industry and teaches students how to deal with present and future transitions. The BC industry is currently under a lot of pressure, as there is an increasing need for greater transparency, client orientation and innovation. Furthermore, today's society is longing for a shift towards more sustainable solutions.

Education directors:
 TU Delft: Jules Verlaan
 TU/e: Harry Timmermans
 UT: Andreas Hartmann

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	
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	73+16+10= 99		233+98+72= 403

Embedded Systems

Embedded systems are hardware-software systems embedded into a larger product. The master programme focuses on how to design good, i.e. efficient and reliable, embedded systems.

Education directors:
 TU Delft: Hans Tonino
 TU/e: Bas Luttkik
 UT: André Kokkeler

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	
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	66+79+18= 163		191+171+76= 438

Science Education & Communication

A key aspect of the Science Communication curriculum in the Master Science Education and Communication is making science communication as effective, accessible and professional as possible.

Education directors:

TU Delft: Marc de Vries

TU/e: Ruurd Taconis

UT: Jan van der Meij

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	
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	33+16+14= 63		87+63+49= 199

Sustainable Energy Technology

The programme provides engineers with broadly based energy technology competences. Graduates can apply their acquired knowledge and skills in projects involving a system-based and interdisciplinary approach. On programme completion the engineer will be able to apply the fundamentals of SET to provide technical solutions for sustainable energy related problems, taking into account economic, social, environmental and ethical factors. The engineer will become an expert in at least one of the sub-areas of the field and be able to take part in the ongoing research in that area.

Education directors:

TU Delft: Rene van Swaaij

TU/e: Camilo Rindt

UT: Jim Kok

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	
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	112+41+35= 188		297+112+66= 475

Systems and Control

The programme in Systems and Control is aimed at students with a technical BSc background interested in analysis and control of dynamic systems in their widest sense. The programme addresses both fundamental and application-specific features, emphasizing the multidisciplinary character of the field. It gives attention to applications in mechanical engineering, electrical engineering, applied physics, chemical and aerospace engineering.

Education directors:

TU Delft: Hans Hellendoorn

TU/e: Camilo Rindt

UT: Jan Willem Polderman

Year	Intake (TUD+TUE+UT)	Degree certificates (TUD+TUE+UT)	Total number of students (TUD+TUE+UT)
2014/2015	49+42+18= 109	38+15+10= 63	
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	110+37+15= 162		282+119+49= 450

Specialisatie: Cyber Security

The 4TU.CybSec master specialisation program provides computer science students with deep technical knowledge and a good understanding of all relevant socio-technical issues. Cyber security is a multidisciplinary field with a computer science core (for example cryptography, formal methods, secure software engineering, and machine learning) and a broad range of supporting disciplines (for example law, economics, criminology, management, and psychology).

Specialisation programme coordinators:

UT: Pieter Hartel

TU Delft: Hans Tonino

Year	Intake	Degree certificates	Total number of students
2015/2016	11	10	11
2016/2017	11	5	37
2017/2018	17		39

External parties

17 External parties

The 4TU.Federation has entered into agreements with several external parties. This section reports on the results of these agreements in 2017.

Nemo Kennislink

For more than 15 years, NEMO has been using [Kennislink](#) to make scientific information accessible to a broad audience, specifically to students and teachers in secondary school. This is done using news items, background articles, files and multimedia across the breadth of science. The 4TU.Federation has supported Kennislink since 2011 and, in 2017, the contract was renewed for an additional two-year period. Supplementary to the previous contract, a set of KPIs was developed jointly to be reported on Kennislink. The federation's support is also reflected in Kennislink's production figures in the area of Technology: The additional hours for Technology are divided between the two editors, who have regular contact with the public relations officers of the universities of technology, although they obviously do their own news gathering as well.

Activities for teachers/secondary students/Bachelor's students in which NEMO Kennislink was involved:

- Science night (inspirational evening for teacher in the exact sciences)
- Hypathia youth panel (secondary students contribute ideas with regard to product development)
- Workshop on scientific communication for TU/e students
- Report on the Delft Hyperloop contest by Roel van der Heijden
- Various contacts with Science Support Desks/secondary-to-university preparatory networks (on Faces of Science and NEMO Kennislink)
- Discussion with Studiekeuze123 on possible future information exchange
- Judging of Fame-lab

KIVI

All full-time professors with a permanent appointment are offered a collective KIVI membership, unless they raise an objection.

Registerautoriteit Bèatechniek

The 4TU.Federation is one of the co-founders of the 'Registerautoriteit Bèatechniek' (Science and Technology Registration Authority). 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

In 2017, explorations were conducted with regard to incorporating the Foundation for the Promotion of Science and Technology into the House of Technology, in which the Science and Technology Platform and Techniektalent.nu are the most important partners. This reduced the number of parties involved in the promotion of technology and made the playing field more manageable.

RAI Amsterdam

In 2017, Secretary IJsbrand Haagsma participated in the jury for the HISWA 'Product of the Year' contest.

