4TU.Federation

Annual Report 2016

April, 2017

Introduction

2016 was a memorable year for the 4TU.Federation. It was the first year in which the federation no longer received any direct financial support from the Dutch Government, and it was the year in which Wageningen University & Research (WUR) became the fourth university of technology to join the federation. It was jointly decided to preserve the name and house style of the federation as far as possible in order to signal that there would be no radical changes to its vision, mission or strategy.

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. These activities are based on an activity plan for the period of 2014-2017 approved by the relevant management committee. The five Master's degree programmes each comprise a joint degree programme based on a shared arrangement made by the former 3TU.Federation. In 2016, partly on the basis of input received from the Accreditation Organisation of the Netherlands and Flanders (*Nederlands-Vlaamse Accreditatie Organisatie*, NVAO), a number of changes will be implemented concerning the manner of co-operation within the degree programmes. The ties between the four universities of technology in the domain of valorisation were strengthened and the joint 4TU.Valorisation Plan has been tabled for approval from the federation's management.

In 2017, the activities carried out over the past period will be wound up as new plans are set in motion for the period of 2018-2021. WUR will play an integral part in these activities and potential opportunities at the interface between Agri & Food and High-Tech will be explored.

Finally, 2017 marks the tenth anniversary of the 4TU.Federation and, just as in 2012, a celebration is on the agenda!

Contents

Activity reports:

1 General Management Board & Executive Committee

The Executive Committee, which comprises the presidents of the Executive Boards of the universities that make up the 4TU.Federation, convened on four occasions in 2016. The General Management Board, which consists of every member of the Executive Boards of the four universities, also met four times. During several of these meetings, decisions were also taken by board members from the financial administration foundation who were in attendance.

From 3TU to 4TU

2016 was the first year in which Wageningen University & Research (WUR) became a full member of the federation. The charters of the two foundations, the administrative regulations, the code of conduct and the joint regulations were adapted in order to permit the admission of WUR and brought up-to-date. The employee participation bodies and Supervisory Boards were involved in the formal process and all parties noted that the co-operation between the four universities of technology brought considerable added value. The establishment of the 4TU.Federation was officially announced on 27 May 2016. The accompanying press release emphasised the following three aspects of the partnership: (1) opportunities created by the substantive collaboration, particularly at the interface between Agri & Food and High-Tech; (2) strong joint representation of the universities of technology within the domain of technology; and (3) strengthening co-operation with the business sector.

Substantive collaboration

Representatives of the federation's existing activities, in the form of the research centres, the Centre for Engineering Education, the Stan Ackermans Institute and the Centre for Research Data, lost no time in descending on centrally-located Wageningen in order to identify opportunities for collaboration with the newest member. New connections were thus forged on the shop floor and a new joint proposal was rapidly put together on the subject of 'Resilience'. This collaboration was facilitated by WUR with cash or 'in kind' contributions where required. Preparations were made for new joint activities over the period of 2018-2021, to which all members of the federation will contribute financially.

Successful Technology Pact

The four universities of technology are all undergoing significant growth, both in terms of intake of new students and collaborative research projects with companies, government bodies, social organisations and other knowledge institutions. They are all now reaching the limits of this growth since government funding is not growing commensurately with their remit in the areas of education and research. At the start of the academic year the Dutch employers' organisation in the technology industry, FME, said that, in its view, the student quotas imposed on technical degree programmes must be removed. The issue was then taken up by politicians and, under pressure from a motion submitted by MPs Michel Rog (CDA) and Pieter Duisenberg (VVD), the Ministry of Education, Culture and Science (OCW) worked with 4TU to investigate the financial and other bottlenecks being caused by this growth. It was swiftly concluded that the universities of technology are only producing half the number of engineers that the job market requires. This analysis also demonstrated that the 2020 budget of €450 million per year must increase in order to be able to accommodate all of the students who are applying to the universities and, at the same time, to continue to guarantee a strong relationship between education and research.

Business community

One of 4TU's first joint activities involving WUR was to draw up a 4TU.Valorisation Plan, which consists of concrete proposals to strengthen co-operation with the business community by making use of various instruments that have been developed by the members of the federation. The Ministry of Economic Affairs manifested considerable interest in these plans, particularly since 4TU enables the ministry to simultaneously make agreements with the four universities that are the most active in the area of valorisation. The co-operation model based on joint programmes involving PhD candidates developed by Eindhoven University of Technology (TU/e) was praised by the business community and is currently being introduced at the other three universities, or will be in the near future.

Coordination

Regular consultations take place between the Executive Committee and the General Management Board concerning input for the evaluation of Applied and Engineering Sciences (TTW, previously Technology Foundation STW), the large national institutes for applied research (*TO2-instituten*) or other matters that are also discussed within the Association of Universities in the Netherlands (VSNU).

Key indicators

The number of assistant, associate and full professors (in FTEs) in the period from 2006 up to and including 2015 is given in the tables below. One trend of note is the significant increase in the number of female academic staff members.

Numbers of academic staff (assistant, associate and full professor in FTEs), male and female, 2006-2015

MAN	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	15/14	15/06
TUD	677	710	737	747	751	754	734	726	731	735	0,5%	8,6%
TUE	444	456	457	465	462	453	447	438	435	432	-0,6%	-2,7%
UT	380	376	391	423	486	467	452	434	421	417	-1,0%	9,7%
WU	395	401	401	404	398	397	408	408	405	405	0,1%	2,6%
VROUW	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	15/14	15/06
TUD	88	99	111	124	128	139	146	161	167	178	6,3%	102,3%
TUE	47	48	55	59	62	65	58	73	81	98	21,4%	108,9%
UT	64	71	92	106	117	121	118	117	114	115	1,4%	81,1%
WU	91	94	101	104	106	115	121	123	132	144	9,2%	57,8%

2 Research Management Committee

In 2016, the Research Management Committee consisted of the research portfolio holders of the Executive Boards of the universities of technology, Prof. Ed Brinksma (University of Twente, UT, chairman), Prof. Karel Luyben (Delft University of Technology, TU Delft), Prof. Frank Baaijens (Eindhoven University of Technology, TU/e) and Prof. Arthur Mol (Wageningen University and Research Centre, WUR). The committee is responsible for shaping and supervising planning and cooperation between the universities in the field of research, under the banner of 4TU.Research — a process in which the 4TU.Research Centres are also involved. It is also specifically tasked with supervising the operations and management of the 4TU.Research Centres, which are jointly run by all four universities.

The 4TU.Research Management Committee's agenda for 2016 included a number of recurring items, such as the progress of the Dutch Academic Calendar, the transition taking place at the Netherlands Organisation for Scientific Research (*Nederlandse Organisatie voor Wetenschappelijk Onderzoek*, NWO), and coordination with the Netherlands Federation of University Medical Centres (*Nederlandse Federatie van Universitair Medische Centra*, NFU). The matters set out below also came under discussion.

Activity plan 2018-2021

Now that WUR has joined the 4TU.Federation, the Activity plan 2018-2021 relating to research, education and valorisation will concentrate on co-operation and synergy with the new university. Research-related activities will seek to gain ground within the common 4TU domains, in terms of the focal areas and quantity of research, joint participation in national science and innovation policy, and effectively influencing research agendas in the Netherlands and Europe.

Centre for Resilience Engineering

In March of 2016, the 4TU.Federation submitted a proposal to Lloyd's Register Foundation (LRF), entitled 'Resilience in Critical Infrastructures'. The proposal for this global tender was expeditiously drawn up by a 4TU initiative group (comprising Prof. Paulien Herder, Prof. Rik Leemans, Prof. David Smeulders, Prof. Theo Toonen and Kenneth Heijns MSc) and was one of the last four remaining proposals in contention. Although it was ultimately rejected, the LRF praised the quality of the 4TU proposal and noted that it contained several above-average points that it wished to discuss further with the federation in relation to the future implementation of the foundation's programme.
Not only does this serve as an example of the speed with which a substantively compelling proposal can be put together within the 4TU network and of the commitment displayed by the 4TU management, but it also illustrates that 'Resilience' is a distinctive theme within the 4TU.Federation. The Activity plan 2018-2021 therefore includes exploring the possibility of establishing a 4TU.Resilience Centre.

AgriFoodTech Platform

The AgriFoodTech Platform[1] is an initiative launched by the Southern Agriculture and Horticulture Organization (*Zuidelijke Land- en Tuinbouworganisatie*, ZLTO), FME, the Dutch Food and Grocery Federation (*Federatie Nederlandse Levensmiddelen Industrie*, FNLI), WUR, and the 4TU.Federation with the objective of solving issues of social

[1] http://agrifoodtechplatform.nl

importance through technology and other forms of innovation. The AgriFoodTech Platform enters into dialogue with society with the aim of devising solutions to social problems together with civil society organisations, farmers, entrepreneurs, designers, government knowledge institutes and industry. Themes that have been raised with civil society organisations include food wastage, footprints, food safety, a liveable environment, optimal nutrition, and food as medicine.

Valorisation indicators

As agreed in the General Agreement of December 2012, the 4TU.Federation contributed to the VSNU's report on valorisation indicators, which was presented to the Ministry of OCW. It described the process of compiling the report, the indicators selected, the figures relating to valorised projects, and also how the indicators have been administratively embedded within the institutions concerned. In order to enliven all the figures, the report also included narratives of inspiring examples of valorisation.
The initial three universities of technology jointly tackled the task of drawing up the valorisation indicators and produced a provisional set, drawing on the 2011 report entitled 'Valuable – Indicators for valorisation' by STW and the Rathenau Institute and Technopolis as a point of departure.

Citations analysis 2004–2013

In line with a long tradition, the initial three universities of technology (WUR was not yet involved when the latest analysis was carried out) conduct a citations analysis over a four-year cycle, which forms part of their quality policy. The most recent analysis was completed in 2016, with a separate analysis for groups with low funding levels, and it explored the possibility of conducting a further strategic analysis using new statistics methodologies and techniques.
The study shows that the three universities may differ in size (volume of output), but in terms of impact they all sit well above the global average, among the top 10 to 15% of the world's largest universities. The faculties mostly closely related to the natural sciences at all three are at the highest level. At the level of their various departments and institutes, performance is more varied both in terms of impact and collaboration.

Doctorates

The number of doctorates conferred and the number of PhD candidates on pay-roll of 4TU for the period of 2006-2016 are set out in the tables below. One noteworthy point is that the number of doctorates awarded is greater than the number of PhD candidates. This is indicative of a large number of external PhD candidates working at the universities.

Number of doctorates 4TU, 2006-2016

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	16/15	16/06
4TU	754	801	789	842	915	917	973	1.064	1.145	1.130	1.182	4,6%	56,8%
TUD	214	229	236	264	333	319	303	353	371	357	395	10,6%	84,6%
TUE	148	176	191	192	189	199	245	218	243	234	224	-4,3%	51,4%
UT	168	147	160	191	188	203	196	220	244	234	267	14,1%	58,9%
WU	224	249	202	195	205	196	229	273	287	305	296	-3,0%	32,1%

Number of PhD candidates on pay-roll 4TU, 2006-2015

M	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	15/14	15/06
TUD	721	732	745	724	699	691	696	693	686	725	5,6%	0,6%
TUE	458	460	501	528	600	608	566	577	586	600	2,4%	31,0%
UT	437	422	439	463	460	485	485	432	407	379	-6,9%	-13,3%
WU	254	253	251	276	270	302	316	298	294	284	-3,5%	11,8%
W												
TUD	245	262	279	289	263	269	252	268	284	286	0,7%	16,5%
TUE	172	186	183	218	240	221	208	207	220	233	5,6%	34,9%
UT	181	177	188	209	211	237	220	202	192	194	1,3%	7,3%
WU	215	241	289	333	338	381	411	393	369	339	-8,4%	57,7%
4TU	2.683	2.733	2.875	3.040	3.081	3.194	3.154	3.070	3.038	3.040	0%	13,3%

Prizes in 2016

The 4TU.Federation has a significant number of scientists in its midst who were awarded individual prizes in 2016, including prizes from the Innovation Impulse Programme and grants from the European Research Council (ERC).

	Research Incentives Scheme	ERC
TUD	*Veni* Thomas Geijtenbeek Gerwin Smit Matthieu de Schipper Mathijs Vleugel Anna Louise Smith Frank Versluis Volkert van der Wijk Guanna Li *Vici* Pieter Desmet	*Starting* Daniel Tam Sander Wahls *Consolidator* Caspar Chorus Rienk Eelkema Christian Poelma
TU/e	*Veni* Joachim Arts Marcos Guimarães Danqing Liu Hanneke Gelderblom (deels UT)	*Starting* Ronald Toth *Consolidator* Evgeny Pidko
UT	*Vici* Rob Lammertink *Veni* Slawomir Porada Alfons Laarman Hanneke Gelderblom (deels TU/e)	*Starting* Wiebe de Vos Annalisa Pelizza *Consolidator* Jeroen Rouwkema
WUR	*Vidi* Nina Fatouros Jeroen van der Heijden *Veni* Ingrid Boas Raymond Staals Ingrid van der Laan-Luijkx Thomas Edward Kodger Wilma van Esse Nora Sutton Elmar W. Tobi	

The ERC Advanced 2016 grants were yet to be announced at the time of writing.

3 Education Management Committee

In 2016, the Education Management Committee consisted of the Education portfolio holders of the Executive Boards of the universities of technology: Prof. Frank Baaijens (TU/e, chairman), Anka Mulder MSc (TU Delft), Prof. Ed Brinksma (UT) and Prof. Arthur Mol (WUR). The committee is responsible for shaping and supervising planning and cooperation between the universities in the field of education and teaching under the banner of 4TU.Education.

Student numbers

In 2016, one of the main subjects of discussion between the four universities was the sharp increase in student numbers attending the universities of technology in the Netherlands. The 4TU.Federation collects data relating to the student population and is analysing the growth in student numbers over the past ten years in order to develop strategies to cope with the steady rise while maintaining the quality of the degree programmes. In particular, the four universities have exchanged best practices and their experience relating to student selection procedures for both Bachelor's and Master's degree programmes.
The significant increase in student intake over the period between 2006 and 2016 is illustrated in the figures below.

Number of enrolments, male/female, Dutch/international

4TU student population, 2006-2016, all students (primary enrolment as of 1 October)

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	16/15	16/06
TUD	13.781	14.441	15.490	16.570	17.329	17.721	17.874	19.148	20.034	21.469	22.199	3%	61%
TUE	7.199	7.065	7.066	7.267	7.307	7.519	7.762	8.377	9.209	10.116	10.764	6%	50%
UT	7.755	7.952	8.134	8.530	8.886	9.398	9.314	9.315	9.263	9.082	9.396	3%	21%
WU	4.479	4.711	5.157	5.695	6.457	7.071	7.491	8.302	9.032	9.720	10.697	10%	139%
4TU	33.214	34.169	35.847	38.062	39.979	41.709	42.441	45.142	47.538	50.387	53.056	5%	60%
M	24.899	25.332	26.243	27.535	28.178	29.022	29.280	30.967	32.363	34.025	35.290	4%	42%
V	8.315	8.837	9.604	10.527	11.801	12.687	13.161	14.175	15.175	16.362	17.766	9%	114%

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	16/15	16/06
INT	3.095	3.600	4.257	4.820	5.658	6.461	6.839	7.246	7.688	8.726	9.895	13%	220%
NL	30.119	30.569	31.590	33.242	34.321	35.248	35.602	37.896	39.850	41.661	43.161	4%	43%

Intake BSc m/v, NL/international

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	16/15	16/06
TUD	2.047	2.336	2.637	2.782	2.730	2.790	2.756	3.057	3.125	3.274	3.353	2%	64%
TUE	1.315	1.384	1.394	1.524	1.501	1.591	1.729	1.967	2.144	2.276	2.396	5%	82%
UT	1.248	1.283	1.337	1.384	1.788	2.000	1.780	1.792	1.814	1.691	2.060	22%	65%
WU	650	774	887	1.016	1.113	1.102	1.181	1.457	1.484	1.521	1.655	9%	155%
4TU	5.260	5.777	6.255	6.706	7.132	7.483	7.446	8.273	8.567	8.762	9.464	8%	80%
M	3.983	4.205	4.503	4.772	4.746	5.117	5.092	5.658	5.792	5.956	6.154	3%	55%
V	1.277	1.572	1.752	1.934	2.386	2.366	2.354	2.615	2.775	2.806	3.310	18%	159%

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	16/15	16/06
INT	328	377	445	488	672	845	728	745	771	806	1.162	44%	254%
NL	4.932	5.400	5.810	6.218	6.460	6.638	6.718	7.528	7.796	7.956	8.302	4%	68%

Sharing expertise

The four universities of technology work together to boost engineering education through the Centre for Engineering Education (CEE). The 4TU.CEE has gathered and developed up-to-date expertise relating to teaching engineering. New improvements to educational methods identified at the CEE have been implemented within the universities and the effectiveness thereof continues to be monitored and analysed. The

four partners then exchange their expertise and experiences in order to benefit each other. The 4TU.CEE facilitates teaching staff to improve their teaching competencies by developing, exploring and demonstrating the newest educational methods. Various events are run which provide a platform for teaching staff at universities of technology to share their experiences and inspire their colleagues. Refer to Chapter 15: 4TU.CEE for further reading.

Blended learning

The 4TU.Applied Mathematics Institute (4TU.AMI) is a forerunner in developing blended learning and open education techniques. It is currently developing and evaluating didactics for blended learning and aims to broadly apply them throughout the four universities in relation to different subjects such as Calculus, Linear Algebra and Statistics. This innovative project won the support of 4TU.Education and was named a model project (*Boegbeeld project*) by the Minister of Education, Jet Bussemaker.

Master's degree programmes

The four universities offer a range of joint study programmes, including five MSc programmes. In 2016, the Education Management Committee decided to support the collaboration between these MSc programmes by developing and facilitating blended learning options. The members consider this form of collaboration the best suited to the universities' future needs. The first results are expected to be published in 2017. Furthermore, for international marketing purposes, a map of all of the MSc programmes across the four universities will be posted on the 4TU website.
The 4TU.School for Technological Design, the Stan Ackermans Institute, offers a two-year post-Master's Technological Designer programme. The addition of Wageningen University to the 4TU.Federation opens up further possibilities for new PDEng programmes.

Teaching

Another area in which the four universities work closely together is the basic University Teaching Qualification (*basiskwalifikatieonderwijs*, BKO). In 2016, a new set of competencies and an improved manual were introduced for the BKO. The four universities also took the first steps towards a basic teaching qualification for teaching staff who have a temporary appointment with only a small scope and already possess an advanced teaching qualification.

Confidentiality

In collaboration with industry, the 4TU.Federation is developing a joint standard for confidentiality pertaining to Master's theses as part of its sustained effort concerning open education. 4TU has proposed that Master's theses remain confidential for up to five years. Moreover, where the confidentiality clause applies, a public version of the thesis should be made available upon the student's graduation.

Numbers

The following tables illustrate that the number of Master's students at the four universities of technology has more than doubled over the past ten years. Moreover, the relative number of female Master's students has risen. This trend 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 sparkling reputation both within the Netherlands and abroad.

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

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	16/15	16/06
TUD	1.074	1.263	1.049	1.368	1.156	1.240	2.089	2.327	2.520	2.209	2.882	30%	168%
TUE	266	279	338	494	487	621	717	887	976	655	1.117	71%	320%
UT	562	597	464	667	314	567	846	688	667	471	1.073	128%	91%
WU	654	671	736	890	1.095	992	1.325	1.310	1.300	1.228	1.677	37%	156%
4TU	2.556	2.810	2.587	3.419	3.052	3.420	4.977	5.212	5.463	4.563	6.749	48%	164%
M	1.667	1.840	1.623	2.205	1.795	2.098	3.169	3.243	3.517	2.892	4.134	43%	148%
V	889	970	964	1.214	1.257	1.322	1.808	1.969	1.946	1.671	2.615	56%	194%

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	16/15	16/06
INT	661	720	754	925	1.122	1.223	1.431	1.637	1.712	1.858	1.869	4%	213%
NL	681	1.155	865	1.631	1.688	1.364	1.988	1.415	1.708	3.119	3.343	116%	136%

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

BSc degree certificates, 2006-2015

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	15/14	15/06
4TU	2.890	3.350	3.182	3.493	4.338	5.542	4.875	4.955	5.565	5.170	-7%	79%
M	2.038	2.320	2.271	2.393	2.996	3.863	3.166	3.205	3.652	3.279	-10%	61%
V	852	1.030	911	1.100	1.342	1.679	1.709	1.750	1.913	1.891	-1%	122%
INT	117	155	175	201	312	335	400	482	484	542	12%	363%
NL	2.773	3.195	3.007	3.292	4.026	5.207	4.475	4.473	5.081	4.628	-9%	67%

MSc degree certificates, 2006-2015 (incl. 'doctoraal')

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	15/14	15/06
4TU	4.769	4.521	4.829	4.861	5.054	5.892	5.556	5.987	6.416	6.959	8%	46%
M	3.269	3.101	3.276	3.259	3.373	3.805	3.643	3.845	4.080	4.367	7%	34%
V	1.500	1.420	1.553	1.602	1.681	2.087	1.913	2.142	2.336	2.592	11%	73%
INT	832	871	1.129	1.247	1.400	1.649	1.674	1.845	1.968	2.165	10%	160%
NL	3.937	3.650	3.700	3.614	3.654	4.243	3.882	4.142	4.448	4.794	8%	22%

4 Valorisation Centre

In order to maintain the Dutch knowledge economy, it is essential to continue to innovate to a sufficient extent. In this regard, it is important that enough ideas and successful results are generated that can ultimately be sold in the market. The four universities of technology play an active role in improving the Dutch knowledge system, endeavouring to bolster the wave of innovation washing into our economy.

Valorisation plan

At the start of 2016, the valorisation directors of the universities of technology produced a more detailed version of the previous 4TU.Valorisation plan in order to be able to commence the initial activities. WUR joined this effort later in 2016.
The 4TU.Valorisation plan sets out the joint strategy in respect of valorisation and includes activities that the universities carry out on both a joint and individual basis. The plan also covers (1) the research collaboration between the universities, (2) the Living Labs, (3) business development, and (4) funding.

Research collaboration (1)

The objective of the 4TU.Incentive programme is to create an innovative eco-system which promotes collaboration with the business community and where high-impact research relating to socially-relevant issues is conducted on a continuous basis. This contributes to a model for research collaboration that is affordable for industry and delivers results which the business community can market in accordance with acceptable terms.

Living Labs (2)

Effective co-operation with small and medium-sized enterprises (SMEs) is vital for knowledge valorisation. SMEs make up 98% of all Dutch companies, account for 83% of jobs and are the source of 81% of all innovation. However, SMEs require a different type of collaboration to larger enterprises as they are subject to a shorter time-to-market and smaller budgets.
Living Labs is a collective name for various testing environments, centres of excellence and other open innovation clusters, and form 4TU's solution to the particular style of collaboration required for SMEs. The four universities have all successfully applied this concept on an individual basis in recent years. This form of valorisation will now be taken to new levels within the partnership. The objective of the 4TU.Living Labs is to enable valorisation with SMEs and to stimulate entrepreneurship among students.

Business development (3)

In the first place, the objective of this component is to raise the level of the individual valorisation programmes of the four universities to increase their reach and enable them to process the growing stream of business cases they are handling.
Secondly, it aims to valorise the results of joint 4TU activities in order to enable as many good business cases as possible to receive funding (4).

Funding (4)

The objective of the funding component is to create financial programmes to fund this growing number of business propositions until they are out of the so-called 'valley of death' zone. Banks and large investment funds frequently fail to respond during this difficult phase and therefore many promising business propositions go untapped.

The valorisation plan provides a significant boost for innovative ideas developed by new, well-trained researchers and entrepreneurs in the Netherlands by carrying out new activities and intensifying the interaction between the country's knowledge infrastructure and industry. At the same time, the mutual co-operation between the four universities of technology and the TO2 institutes will be strengthened to enable the Dutch knowledge economy to optimally profit from the synergy between different disciplines.

Total value of projects acquired

This annual account reports on the following valorisation indicators: the total value of projects that have been acquired and levels of commercial activity.
The figure below is the total amount of contract and commercial funding received by the university in question in 2016 (by the date on which the project was signed). The full value of the contract for each project acquired in 2016 is provided. This only includes actual research projects and not proposals. This final figure provides a clear picture of the universities' order portfolio.
In 2016, WUR did not yet have this figure at its disposal. The figures in the table below therefore relate only to the combined totals of TU Delft, TU/e and UT.

Acquisition in millions of euro's in 2016

		TUD/TUe/UT
2e geldstroom		**97.803**
3e geldstroom		
	Industry	**43.000**
	NL government	**26.356**
	EU government	**98.461**
	Other	**38.602**
Total 3e geldstroom		**206.379**
Total 2e en 3e		**304.152**

Commercial activity

The commercial activity indicator is measured by the number of spin-offs and start-ups, adopting the international (EU and ASTP-Proton) definitions of these terms, which are also used by the VSNU:

'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.'

	Spinn-offs	Start-ups
TUD	25	8*
TU/e	8	31
UT	At least 5	Unknown
WUR	1	3

**TU Delft still only registers start-ups which have a relationship with the university but no licence or shares – so-called high-tech start-ups*

Three start-ups were established in Wageningen in 2016. Livestock Robotics works on the latest developments in the automation of livestock farming and robotics. The student owners of Tinyfoods offer a wide range of tastily-prepared insects via their website. Mushroom producer Mycocycling aims to demonstrate that commercial undertakings need not necessarily have a negative impact on the world.

Sprinkhanen Smokey BBQ, available from Tinyfoods from €4.49
Photo: tinyfoods.nl

5 Applied Mathematics Institute

4TU.AMI	People involved
Scientific director	Prof.dr.ir. Kees Vuik (TUD)
Board	Prof.dr.ir. Rob Fastenau (dean TUD), prof.dr. Jakob de Vlieg (dean TU/e), prof.dr. Peter Apers (dean UT) and prof.dr. Richard Visser (dean WUR)
Secretary General	Dr. Olga Houben-van Herwijnen (TU/e)
Management team	Prof.dr.ir. Arnold Heemink (TUD), prof.dr. Luc Florack (TU/e), prof.dr. Anton Stoorvogel (UT) and prof.dr. Jaap Molenaar (WUR)
Project Blended Learning	Prof.dr. Hans Cuypers (TU/e), dr. Bart van den Dries (TUD), dr. Jan Willem Polderman (UT) and dr. Joost van Opheusden (WUR)
Steering Committee Blended Learning	Prof.dr.ir. Kees Vuik (TUD), dr.ir. Marko Boon (TU/e), prof.dr. Stephan van Gils (UT), dr. Maarten de Gee (WUR), dr. Jan van der Veen (4TU.CEE)
SRO coordinators	Energy: Prof.dr. Johann Hurink (UT Water: Dr. Henk Schuttelaars (TUD) Health: Prof.dr. Stephan van Gils (UT) Big Data: Dr. Nelly Litvak (UT)

More and more technology sectors are in great need of advanced and application-oriented mathematics expertise. 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, Health and Big Data. The 4TU.AMI is also investing in developing blended learning techniques for service teaching in Mathematics and for the transition from higher professional education (HBO) to university-level education (WO).

Platforms have been established for each of the SROs through which the technology-related business sectors can benefit from the combined knowledge and expertise from the four universities of technology by means of co-operation between companies and other knowledge institutions. The appointment of tenure-track assistant professors, the increase in student numbers and the investments in blended learning all contribute towards building critical mass in the area of advanced, application-oriented Mathematics. This will also make it possible to continue to meet the needs of the technological sectors in future.

Results

The Blended Learning project commenced in the autumn of 2016. It is based on previous education initiatives, including e-learning, the Mathematics teacher training programme and efforts to improve the transition from VWO (pre-university education) to WO (university education).
The Spring Congress on Mathematics and Big Data, organised in collaboration with the 4TU.NIRICT Research Centre, took place on 8 April 2016 and was extremely well attended.
The Applied Mathematics roadmap for each SRO was worked out in detail. Such good progress has been made with the Logistics SRO that it no longer requires additional

support from the 4TU.AMI and therefore the Big Data SRO was established in its place. The SROs have made a useful contribution to combining the knowledge of the initial three universities of technology; WUR also joined this effort in 2016.

The partnership agreement between the 4TU.AMI and the Matheon Research Center was renewed in October 2016. A number of joint European grant applications were submitted and the Matheon Calendar for the year was collectively expanded.
The numbers of Mathematics students at the four universities of technology has risen significantly; this in turn requires more lecturers and has accordingly increased the available research capacity. Six tenure trackers were appointed in various areas including Computational Science & Engineering, Mathematical Programming, Stochastics, Partial Differential Equations and Financial Mathematics.
A preliminary registration programme (Phase 1) and a pre-application (Phase 2) entitled *BRAIN* was submitted in response to the 2015-2016 STW Perspective call. The initial three universities of technology were all involved in this process and initiated various partial projects. Unfortunately, the pre-application was rejected. Nevertheless, AMI partners will benefit from taking part in a consortium in future.

Agenda for 2017

By and large, good progress was made with the current programme. The Blended Learning project will be implemented more widely. It has caught the attention of the universities' Executive Boards and the Minister of OCW and will be exhibited as a model project as part of SURF. On this basis, a subsequent application will be prepared.
The partnership with the Matheon Research Center will be promoted and intensified by offering visitors grants.
In addition, the 4TU.AMI intends to enhance its national and international communications and branding. A communications officer (0.4 FTE) was appointed as of 1 February 2017 for this purpose.
Water SRO: on Springer's request, work has commenced on a book entitled *Mathematics & Water*. The SRO intends to organise a workshop on this book and a specific theme.
Energy SRO: the SRO intends to submit proposals in response to the NWO call 'System integration, Big Data and Energy' and an application to the European Industrial Doctorate programme together with Matheon.
Health SRO: a Spring Congress on the theme of Mathematics and Life Sciences will be held on 24 May 2017. The keynote speech will be given by Dr David Lentink (Stanford University). An application has been prepared for the STW Open Competition.
Big Data SRO: an application will be submitted for the STW Perspective programme. It will be investigated whether the SRO could focus more on topics such as precision agriculture, nutrition, food safety and breeding.

6 Built Environment

4TU.BE	People involved
Scientific Director	Prof. Ulrich Knaack
Managing Director	Alexander Schmets
Curator	Siebe Bakker
Management team	Prof. André Dorée (UT), Prof. Bauke de Vries (TU/e), Dr. Frank van der Hoeven (TU Delft), Prof. Erik Schlangen (TU Delft) and a vacancy for Wageningen University
Steering committee	Prof. Elphi Nelissen (TU/e, Voorzitter), prof. Geert de Wulf (UT), prof. Bert Geerken (TU Delft), prof. Peter Russell (TU Delft) and a vacancy for Wageningen University

In its strategic plan 2013, the 4TU.Center of Excellence for the Built Environment (4TU.Bouw) chose 'Energy innovation in the Built Environment' as its central theme for the period of 2014-2016. The shared focus is on bolstering research, responding to challenges facing society and mutually strengthening the co-operation between the participating faculties. Taking this collective approach and implementing projects jointly will make it possible to build bridges to relevant parties from industry and government.

Programme

The 4TU.Bouw programme based on these objectives commenced in the spring of 2014. The three main aspects of the implementation programme are research, education and working on the future agenda, as follows:

- Research: Conduct Lighthouse Projects based on the theme of 'Energy efficiency in the Built Environment'. These may equally produce a proof of concept or a proof of failure, but in either case will produce a tangible result (demonstrator, object, protocol, methodology, etc.) on the basis of which explicit connections can be forged with industry.
- Education: Implement a PDEng programme to bridge the gap between academic education and research on the one hand, and the knowledge required by industry on the other.
- Working on the future agenda: Jointly formulate a long-term vision on education and research related to the built environment – in the broad sense.

In addition to the highlights above, a number of supporting programmes will be run in the areas of education and research, including running educational workshops with industry, researchers contributing to various activities relating to the Construction campus, participating in trade fairs, etc. These 4TU.Bouw projects involve more than 200 researchers and students.

Results

The most significant results from the 4TU.Bouw implementation programme 2011-2016 that were achieved in 2016 are set out in the summary below (not an exhaustive list):

- Fifteen Lighthouse Projects were continued or completed, some of which have secured subsequent (external) funding and/or follow-up projects in collaboration with industry;

- The Lighthouse concept has been adapted by third parties (such as STW) and several external parties have expressed concrete interest in adopting and funding a Lighthouse Project (two in 2017);
- Several Lighthouse Project proposals that 4TU.Bouw was not in a position to fund have subsequently found suitable funding;
- Eight PDEng projects were continued or completed in 2016;
- Lighthouse and PDEng researchers ran workshops and training sessions, which lead to research questions being refined and news about the projects being disseminated more widely via infographics, audio-visual productions and other forms of publicity;
- On the basis of its contribution to the National Academic Calendar, 4TU.Bouw jointly initiated the National Academic Calendar route entitled Smart & Liveable Cities. Furthermore, 4TU.Bouw was closely involved in the further specification of the National Academic Calendar routes Circular Economy and Energy Transition;
- Substantive content for the Built Environment thematic map was offered to Minister of Infrastructure and the Environment Melanie Schultz van Haegen and Minister of Security and Justice Stef Blok at the opening of the Construction campus on 13 January 2016;
- A vision for a 'Smart Reality' construction industry was drawn up, which translated areas of urgency and trends in society into tasks for the industry to tackle;
- Workshops and training sessions were organised relating to 3D printing (Real Additive Manufacturing), the Internet-of-Things, the 2016 Amsterdam Innovation Expo, the opening of Arnhem Central Station, etc.;
- 4TU.Bouw made its presence felt with an inspiring stand at the Bouwbeurs construction industry trade fair, Construction Week, InfraTech, etc. accompanied by media coverage;
- Research to Reality: an annual conference which brings together the ambitions and proposals of researchers with the ambitions and questions of parties from industry through general debates and specific pitch sessions. Participants undergo a boot camp of intensive training in professional pitching techniques. During the 2016 conference, on the basis of fifteen pre-selected pitches, eight new Lighthouse Projects were chosen for 2017. In addition, a dozen 'completed' Lighthouse Projects gave pitches to investors, with a view to securing initial capital for start-ups.
- 4TU.Bouw positioned itself as the point of contact and representative of the shared interests of the participating faculties within the golden triangle.

Agenda for 2017

In 2017, a number of workshops and training sessions will be given and various running projects will be continued. Eight Lighthouse Projects will be implemented and several past Lighthouse Projects from the portfolio will be submitted to venture brokers with the aim of converting research results into businesses. 4TU.Bouw will be involved in producing the 'Agenda for the Construction Industry' (*De Bouwagenda*) in the first half of 2017 as part of the elections for the House of Representatives. Other planned activities include:

- Participating in industry trade fairs such as InfraTech 2017 (January) and Construction Week (February);
- Publishing a book entitled *Research to Reality*, which presents the most significant research and education results over the period of 2014-2016 and elaborates on key themes for the construction industry (Resilience, the Energy Transition, the Circular Economy, Smart & Liveable Cities);
- Holding the annual two-day Research to Reality conference for concerned parties from the four universities of technology and the golden triangle.

7 Design United

4TU.DU	People involved
Scientific director	Prof. Daan van Eijk (TUD)
Managing director	Bart Ahsmann (TUD)
Board	Ena Voute (dean, TUD), Aarnout Brombacher (dean, TU/e) and Geert Dewulf (dean, UT)
Liaison officers	Matthijs Netten (TUD), Stephan Wensveen (TU/e) and Julia Garde (UT).

Design United contributes to the specialisation of Industrial Design professionals by developing new knowledge and increasing accessibility 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 strong track record and an impressive network will be invited to work with a given faculty in a part-time capacity over an extended period.
- Research fellows: international guest lecturers who 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).

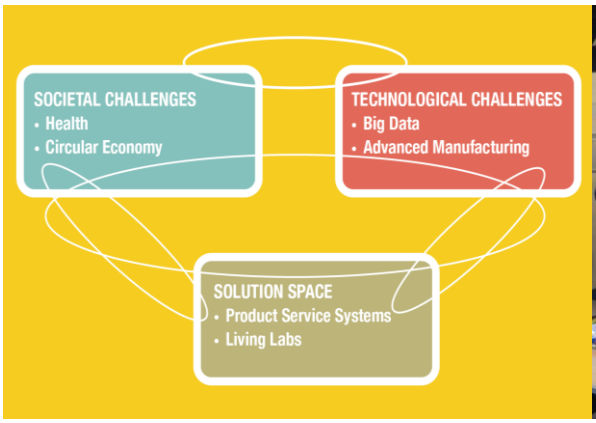
Results

Four visiting professors were appointed in 2016 and four research fellows worked in the faculties for shorter periods. A total of 29 demonstrator projects were carried out, of which a large number formed part of the 'Mind the Step' exhibition at Dutch Design Week in Eindhoven. The implementation of the research programme is supported by the following core activities from the coordination programme:

- Developing the agenda and the various programmes and managing the network;
- Organising the annual knowledge symposium 'DRIVE 2016' and the 'Mind the Step 2016' exhibition;
- Sharing information concerning completed cases and the researchers involved via the website (an integral component 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 design research and innovation network of the Creative Industry top sector. The most significant outcomes of the activities within the top sector in 2016 were as follows:

- 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.
- A growing number of research proposals to which one or more design faculties have contributed are receiving funding through NWO calls.
- Work has commenced on developing proposals put forward by the participating faculties from the initial three universities of technology. One research project has received funding through the Smart Industry call 'Next UPPS: Integrated design methodology for Ultra Personalised Products and Services', among other satisfying results.
- Moreover, an extremely innovative interdisciplinary Gravitation proposal in relation to healthcare has been prepared through a collaboration between the University of Amsterdam and Design United. Unfortunately the proposal did not reach the final phase, but it may lead to subsequent applications.
- There is also increasing interest from Brussels in Design Driven Innovation, which is viewed as an alternative approach to developing innovations of both economic and social relevance. The Netherlands is regarded as a model country in this regard and, due to its role in the top sector, Design United has been requested to give various presentations to both EU commissioners and wider European audiences.



Agenda for 2017

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 in the ability to continue to work on fresh developments using an interactive approach at system level. In the socio-economic domain, Design Driven Innovation applications are still inextricably connected with 'Healthcare'. 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 that focuses 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.

8 Ethics and Technology

4TU.Ethics	People involved
Scientific Director	Prof. dr. Philip Brey (UT)
Managing Director	dr. Michael Nagenborg (UT)
Assitant Director	Myrthe van Nus, MA LLM (UT)
Management Team	Scientific and Managing Director, the head of departments and one additional representative from TU/e and TUD
Advisory Board	The Deans of the three faculties

The 4TU.Centre for Ethics and Technology (4TU.Ethics) was founded in 2007 to study ethical issues in respect of the development, use and regulation of technology.
National and international innovation agendas are giving high priority to developing and applying methods and strategies for ethical and socially-responsible technological innovations. There is also awareness concerning this challenge in the industrial sector. 4TU.Ethics is seeking ways to promote socially-responsible innovations (*maatschappelijk verantwoord innoveren*) with a particular focus on technological issues in the top sectors and other relevant domains.

Programme

4TU.Ethics operates according to its own research agenda, which is based on and constantly adjusted in relation to the research agendas of the three core departments, which mutually influence each other. The centre's research agenda is used for communication and decision-making purposes. Its focus areas are as follows: Robotics & Information Technologies, Health & Medical Technology, Sustainable Energy, and Risk, Safety & Security.
Activities:
- Stimulating, facilitating and engaging in the acquisition of external funding
- Building national and international networks of academic and non-academic actors
- Hiring Ethics Officers and Assistant Professors
- Attracting top international talent to the centre's graduate programme
- Establishing interdepartmental Task Forces to emphasise the centre's focus areas
- Attracting visiting academics

Results

The Ethics and Technology PhD programme commenced in 2010, with support from the NWO via a Graduate School grant of €800,000. Since then, the number of PhD candidates has steadily increased. In 2016, the results of the Graduate School grant were positively evaluated by the NWO, testifying to the quality and success of the PhD programme. Nineteen PhD candidates (five from TU/e, seven from TU Delft and seven from UT) are currently taking part in the programme. All three departments contribute to the courses on offer. The vast majority of PhD candidates find suitable employment within six months after obtaining their PhD with employers such as King's College London, UNESCO, Oxford University and Philips.

Over the past years, five Assistant Professorships have been funded fully or in part by 4TU.Ethics, whose responsibilities include some duties as Ethics Officer/liaison to

specific institutes or engineering programmes. In early 2016, Veronica Alfano (TU Delft) was hired to replace Phil Robichaud when he accepted a position at the VU University Amsterdam. A further two researchers were also paid from this budget in 2016: Lily Frank (TU/e) and Filippo Santoni de Sio (TU Delft).

In 2016, Colleen Murphy (University of Illinois, USA) was the joint visiting scholar at 4TU.Ethics. In addition, the centre and its Task Forces provided additional funding to support various other visiting scholars hosted by the individual departments.

In 2016, €43,000 has been made available to the four Task Forces, which are research groups consisting of researchers from the three universities of technology: Robotics, Energy & Sustainability, Risk, Safety & Security and Medical Technology. The Task Forces collaborated in conducting research, organising workshops and acquiring funding. For example, the Robotics Task Force succeeded in acquiring a COST Action on Wearable Robotics (approved in 2016), organised two international workshops, and its members produced various joint publications. It has been instrumental in establishing the Foundation for Responsible Robotics (http://responsiblerobotics.org), whose president Dr Aimee van Wynsberghe is a member of 4TU.Ethics.

In 2016, 4TU.Ethics started exploring the possibility of incorporating the members of the WUR Philosophy group into the centre. To date, there appears to be good potential for this, as there are complementary and overlapping research orientations and good chemistry between WUR and the centre.
4TU.Ethics is also exploring collaborating on joint research with 4TU.HTM on the following topics: Scarcity, Risk & Safety, Dual Use, Sustainability, Research & Professional Ethics, and Education & Ethics.

Acquisition of Research Funding in 2016 by 4TU.Ethics members

NWO-MVI funding	€ 2,37
EU/H2020 funding	€ 2,62 *(only part allocated to institution)*
Other acquired funding	€ 0,64
Total	**€ 5,63**

In addition, 4TU.Ethics's Gravitation proposal entitled "*Ethics and Responsible Innovation of Socially Disruptive Technologies*" (coordinating applicant: Dr Philip Brey, submitted to the NWO in May 2016) was selected for the second round of the funding procedure, with an interview scheduled in January 2017 (applying for a budget of €17,438,500 from the NWO).

Highlights in 2017

- On 28 March, the Executive Committees of 4TU.High-Tech Materials and 4TU.Ethics will host a joint workshop.
- On 12 and 13 June, 4TU.Ethics will celebrate its tenth anniversary by hosting a two-day international conference at the University of Twente. We are looking forward to welcoming more than 12 international speakers (including Andrew Feenberg, Shannon Vallor, Carl Mitcham and Deborah Johnson).
- The sixth 8TU-4TU International Workshop will take place on 15 June (alongside the SPT conference in Darmstadt).

9 Fluid & Solid Mechanics

4TU.FSM	People involved
Scientific Director	Prof. Gert Jan van Heijst (TU/e)
Steering Committee	Prof. van Heijst (WD JMBC), prof. Geers (TU/e; WD EM), prof. Sluys (TUD), prof. 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 4TU Fluid & Solid Mechanics research centre (4TU.FSM) is one of the federation's largest, comprising 61 research groups. The centre 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 centre has historically been formed by two strong research schools, which had each existed independently for more than 20 years: namely (JMBC: Fluid Mechanics) and (EM: Solid Mechanics).
The objectives of 4TU.FSM are:
- To create added value for both industry and society;
- To facilitate and stimulate co-operation with top international talent;
- To support junior scientists (tenure trackers) and outstanding PhD candidates in furthering their academic careers.

Results
The NWO Graduate Programme continued over the past period and is now in its final phase.
In order to achieve its objectives, 4TU.FSM took the following actions in 2016:
Technical animations were produced which were used to boost the centre's profile at conferences and meetings, on websites and in the media, etc.;
- A range of initiatives aimed at attracting leading scientists were pushed and given financial assistance;
- The centre's international profile was promoted to attract talented junior researchers by offering travel grants to junior academic staff;
- Various symposia and conferences in the Netherlands were supported financially;
- The relationship between EM and JMBC was strengthened via several annual research symposia (2017);
- Resources were made available in order to facilitate research groups to use the laboratory infrastructure and equipment of other faculties and universities (cross-lab and equipment support);
- Valorisation incentives were created in order to encourage parties from industry to valorise doctoral research on completion of the candidate's PhD.

The large number of joint programmes and projects with the STW, the Foundation for Fundamental Research on Matter (*Stichting voor Fundamenteel Onderzoek der Materie*, FOM) and NWO demonstrate the strength of the collaboration between the four universities of technology within the 4TU.FSM, and although WUR had not yet joined the centre in 2016, a good basis for co-operation has already been established. The addition of WUR presents a number of clear opportunities for 4TU.FSM.

The quality of the research conducted at the centre is very high, which is evidenced by the results of the various research visitations and the citations analysis. 4TU.FSM's excellence has also been recognised with prestigious prizes, such as the NWO's Spinoza Prize, and grants that have been awarded at all levels (AdG, CoG, StG grants from the ERC and Veni, Vidi, Vici grants from the NWO).

Agenda for 2017

4TU.FSM will continue to further its objectives from 2016 in 2017.

10 High Tech Materials

4TU.HTM	People involved
Scientific Director	Prof.dr.ir. Jilt Sietsma
Secretary general	Drs. Reina Boerrigter
Management Team	Profs. Sijbesma, Geers (TU/e), Akkerman, Vancso (UT), Sprakel (WUR), Van der Zwaag and Sietsma (TUD)
General Board	Theun Baller (dean, TUD), Jeroen Cornelissen (dean, UT), Philip de Goey (dean, TU/e) and Raoul Bino (Director, WUR)

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. Materials science researchers need to join forces and ensure cohesion between their work in relation to industrial applications in order to make sustainable technological developments over the coming decades possible.

Two years on since its establishment, 4TU.HTM has become a place which brings together innovative materials science research projects taking place within the four institutions. The most visible examples of this are the six ongoing projects within the New Horizons in Designer Materials research programme and the annual Dutch Materials symposium, which inspires scientists and students to develop new initiatives for materials science in the Netherlands.

Results

In 4TU.HTM's first two years, approximately 150 professors and associate professors have become affiliated with the centre, bringing together numerous aspects of materials science research from throughout the Netherlands, from fundamental to applied, from nanotechnology to construction projects.
In 2016, six post-doctoral researchers with great potential commenced work on a research project within the 4TU.HTM New Horizons in Designer Materials research programme. This programme aims to develop new themes centring on materials science into lines of research within the universities of technology. For each of the six research projects, the programme takes a conceptually and substantively innovative scientific approach in a field of research that none of the four universities was previously investigating at this level. Via this approach, new materials are being designed on the basis of a full understanding of their physical composition, in many cases at nanoscale level. This research will likely attract personal grants that could launch the academic careers of post-doctoral researchers at the universities of technology.
In 2016, the annual Dutch Materials HTM symposium focused on 'Materials at the atomic scale' and 'Bio- and bio-inspired materials'. The entire 4TU.HTM research community actively participated in the symposium, along with partners from industry.
In 2016, 4TU.HTM established a programme for Joint Materials Science Activities to fund and support various activities that promote outstanding materials science research being conducted in the Netherlands, such as master classes for students and young researchers, workshops, access to major research facilities, summer schools, etc. Each of these activities involves participants from at least two of the universities of technology. In 2016, within this framework, 4TU.HTM sponsored two large conferences

and made it possible for UT and TU/e to host a joint two-day workshop, featuring Dutch and international speakers, entitled Liquid Crystal as functional material.

Access

4TU.HTM aims both to increase the accessibility of working in materials science within the four universities of technology and to make this work more transparent for parties outside of this sphere, such as professional engineers, partners from industry, prospective students and researchers, as well as policy makers. Therefore, a web application is being developed to chart out this work and the positioning of the various research groups in this regard. This diagram will clarify which sub-sectors are the subject of joint study and help identify opportunities to collaborate on research projects or to make use of certain equipment. It will also rapidly direct interested external parties to the appropriate research group. The web application will be available in the spring of 2017.
In order to boost its external visibility, 4TU.HTM attends a range of workshops and fairs and invites interested parties to visit the various research groups. Activities relating to materials science in the Netherlands are publicised on its website and via social media, such as LinkedIn and Twitter.

Agenda for 2017

4TU.HTM will continue to focus on increasing the accessibility and visibility of materials science in 2017. Several promotional videos will be produced for this purpose.
The research centre aims to stimulate graduate courses for PhD candidates from the four universities since such courses form a good framework for helping the more than 500 candidates from research groups affiliated with 4TU.HTM to develop into full-fledged materials science researchers with a broad-based, well-founded overview of the field. A list of relevant graduate courses will be published on the 4TU.HTM website.
In addition to the centre's existing contacts, it will stimulate joint initiatives to increase the quality and impact of materials science research and make it possible to participate in national and European research agendas to a greater extent. As a concrete example, the centre organised a joint workshop between WUR and TU Delft entitled *The Unexpected Science of Steel and Chocolate* in the spring of 2017.
In tandem with the 4TU.Ethics & Technology research centre, various initiatives will be taken to ensure that ethical aspects (such as sustainability and safety) are routinely considered within materials science research and education, including an initial joint workshop in the spring of 2017.
4TU.HTM will intensify its co-operation with various partners from industry: In this regard, 4TU.HTM will respond to the changing role of M2i and DPI and the transition within the NWO.
4TU.HTM will also contribute to increasing mutual access to advanced equipment, including through on-site workshops (e.g. as part of the Joint Materials Science Activities CryoTEM workshop sponsored by 4TU.HTM in 2017), and increasing the discipline's visibility (e.g. through Prof. Koenraad's keynote lecture concerning TU/e's National Atom Probe Facility during the 4TU.HTM symposium 2016).

11 High Tech Systems

4TU.HTS	People involved
Scientific Director	Professor Maarten Steinbuch (TU/e)
Assistent	Dr.ir. Ties Leermakers (TU/e)
Board	Professors Theun Baller (TUD), Geert Dewulf (UT) and Philip de Goey (TU/e)
Participating faculties	Faculty Mechanical, Maritime and Materials Engineering (TUD), Faculties of Engineering Technology and Electrical Engineering, Mathematics and Computer Science (UT) and faculties of Mechanical Engineering and Electrical Engineering (TU/e).

The objectives of the 4TU.High-Tech Systems (4TU.HTS) research centre are as follows:
- To put robotics research in the Netherlands on the map by supporting the RoboNED platform;
- To provide an additional boost to research into electric cars in the Netherlands by supporting the Dutch-INCERT Initiative;
- To participate in the High-Tech Systems and Materials (HTSM) top sector;
- To raise the external profile of the 4TU.Federation at high-tech fairs;
- To set-up and maintain the Master's in Systems & Control.

Results

Since April 2010, robotics-related activities in the Netherlands have been coordinated via the Dutch robotics platform RoboNED, which aims to stimulate synergy between the various fields of application for robotics and to sharpen the focus of research and development. It is working to achieve these objectives by bringing together the various stakeholders and forming a strong network, in which industry, researchers, educators, government bodies and consumers can connect and co-operate to strengthen the innovation eco-system. 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, and other ethical and legal issues need to be solved. Robotics research is of relevance to high-tech industry and sectors such as healthcare, logistics and agriculture, and makes a significant contribution to the Dutch economy.

Results
- RoboNED has made a contribution to the Dutch Robotics Strategic Agenda[2]
- Organised RoboNED conference (most recent in 2015)
- Submitted Gravitation proposal (SIRIS: Seamlessly integrating robots in human society). The proposal was ultimately rejected, but will certainly give rise to opportunities for collaboration.

[2] www.roboned.nl/sites/default/files/RoboNED

- The establishment of internal organisations at the universities of technology in the field of Robotics has had a strong impact on RoboNED's activities in the mutual partnership. At present, 4TU.HTS is working with the Ministry of Economic Affairs and the business community to finalise a new nationwide partnership.

1. The Dutch-INCERT [3] (Dutch Innovation Centre for Electric Road Transport) consortium was set up in 2008 on the initiative of the 3TU universities – TU/e, TU Delft and UT – and the Rotterdam and HAN Universities of Applied Sciences (subsequently joined by the Fontys and Amsterdam 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. To that end, Dutch-INCERT works with innovative businesses and government bodies that are playing a pioneering role in the introduction of e-mobility. The platform takes a pre-competitive approach and focuses on knowledge and technology developed by independent parties. It aims to make a strategic contribution to the development of vital innovations and to the success of the transition to e-mobility in the Netherlands.
   Results
   - Joint organiser of the AVERE e-Mobility Conference 2016
   - Supported AutomotiveNL[4] 2016
   - Supported Nederland Elektrisch website
   - Played an active and visible role via 4TU in the Formula E-Team (advisory body for the Ministry of Economic Affairs)
2. HTSM partnership
   Results
   - WD 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.
   - In the autumn of 2016, work commenced to formally affiliate TU/e's High Tech Systems Center with the 4TU.Federation. A consortium day was held with 150 participants from industry in which TU Delft, UT and WUR were actively involved with preparing and presenting the various workshops. This is expected to lead to larger-scale research projects with businesses, funded by direct cash contributions from the latter.
3. 4TU.HTS aims to raise the external profile of the 4TU.Federation in general, including through stands at relevant conferences and trade fairs in the field of HTS.
   Results
   - Stands at Hannover Messe (2015 and 2016), Medica (2015 and 2016), EUSPEN (2014-2016) and the Precision Fair (2014-2016)
   - Supported the Foundation to Promote Science and Technology (2015 and 2016)
   - Awarded the Wim van der Hoek prize 2015 and 2016
4. 3TU Master's in Systems & Control
   Results: The Master's in Systems & Control is running well.

[3] http://www.d-incert.nl/
[4] http://www.automotivenl.com/

Agenda for 2017

In 2017, 4TU.HTS will continue to focus on the following aspects:

- Further expanding robotics research in the Netherlands by supporting the RoboNED platform;
- Conducting research into e-mobility in the Netherlands, in particular investing approximately €40 million in setting up an innovation programme across various top sectors;
- Participating in the HTSM top sector;
- Raising the profile of the 4TU.Federation as a whole at high-tech trade fairs;
- Further expanding the Master's in Systems & Control.

12 Humans & Technology

4TU.H&T	People involved
Scientific Director	Professors Dirk Heylen (UT, Penvoerder), Mark Neerincx (TU Delft) and Wijnand IJsselsteijn (TU/e)
Secretary	Vacancy (formerly Wilma Hiddink, UT)
PI's	Khiet Truong/Gijs Huisman (UT), Marieke Peeters/Roel Boumans (TU Delft), Femke Beuts/Peter Ruijten (TU/e)
Advisory board	50l UD's/UHD's/HL/Postdocs/PhD students from TUD, TU/e and UT

The 4TU.H&T research centre's objectives are as follows:
To draw up roadmaps relating to research and research programmes that have received funding;
- To create a living eco-system of consultation and co-operation between the universities and industry;
- To raise the international profile of Dutch research in the field of human-technology interaction, which uniquely interweaves the technical and life sciences;
- To run shared teaching programmes at MSc and PhD level;

4TU.H&T has taken various steps in order to achieve these objectives.
- Workshops have been organised in order to draw up roadmaps and agendas for both Dutch and international research programmes;
- Visiting professors have been appointed to help bridge the gap between research and practical applications;
- A flagship programme has been created and implemented, and subsequently matched with suitable partners from industry;
- 4TU.H&T has also invested in developing and coaching talented individuals through exchange programmes and summer schools;
- Finally, various Master's and graduate programmes have been fine-tuned.

Results

In view of the fact that its flagship programme did not receive funding from the STW, in 2016 4TU.H&T focused on brokering agreement on specific subjects through a number of workshops in order to draw up project proposals.
A range of meetings were arranged in relation to the research centre's key areas of interest. Three workshops were held in the field of Affective Computing on the subject of tactile interaction; participants included various partners from academia and industry and representatives from civil-society organisations. In addition, a Lorentz workshop was organised in the field of Group Dynamics, to which a number of international guests were invited. In the domain of Supportive Technology, there was a workshop on technology to support dementia patients.
A smaller workshop involving various companies was held on the subject of Human-Agent Interaction – one of the centre's research priorities. Furthermore, TU Delft and UT jointly organised the most notable international conference in this field (IVA), with contributions from TU/e during the tutorial day. The living eco-system envisaged by 4TU.H&T is also blossoming.
In 2016, in collaboration with Paris 6, 4TU.H&T applied for and successfully obtained a Van Gogh grant in the field of Social Signal Processing and Virtual Humans. Instead of appointing visiting professors, however, the decision was taken to invite Dutch and

international researchers to participate in the workshops outlined above and to attend various PhD schools co-established by 4TU.H&T.
Following these workshops, a dozen project proposals were submitted within the Netherlands and Europe, a number of which successfully secured funding. The research centre is also working on several STW Perspective programmes and NWO Gravitation proposals.

Education

In addition to organising workshops and other roadmap-related activities, 4TU.H&T devoted considerable time to organising educational activities, primarily aimed at PhD candidates and post-doctoral researchers. Seventy researchers took part in eNTERFACE in Twente in 2016. A large number of seminars were held on significant topics, which were attended by researchers from the universities of technology and other interested parties. 4TU.H&T also took the decision to concentrate on PhD level education and this therefore became the focal point of the various seminars and PhD schools. Moreover, instead of establishing the joint MSc programme, the centre is working to facilitate more student exchanges.

Agenda for 2017

4TU.H&T's more important general goal for 2017 is to expand and strengthen its community, and it will therefore dedicate more energy to increasing the centre's visibility. Furthermore, it will work to increase the number of PIs that coordinate activities across multiple faculties, hopefully including WUR, as one means of growing the H&T community.
Activities that proved a success in 2016 will be continued and expanded. Two workshops with industry and civil-society organisations have already been scheduled for the summer of 2017, as well as three seminars. The goal is to ultimately run six to eight seminars and four to six workshops, which will hopefully result in fresh research proposals.
Moreover, there are plans in place to establish a PhD School on the subject of Affective Computing in collaboration with the International Association for the Advancement of Affective Computing. There is growing interest in this area in the Netherlands, and it is strongly represented within the universities of technology; however, since the various researchers in the field are yet to be brought together, a national symposium will also be arranged.

13 Netherlands Institute on Research on ICT

4TU.NIRICT	People involved
Board	Prof.dr.ir. Inald Lagendijk, TUD (scientific director) Birna van Riemsdijk, prof.dr. Marieke Huisman, prof.dr.ir. Maarten van Steen, dr. S. Stuijk and prof.dr. Johan Lukkien
Programme Manager	Eveline Vreede
Research portfolio	prof.dr.ir. Maarten van Steen and dr. Birna van Riemsdijk
Young researchers network	dr. S. Stuijk
Coorperation in education	Prof.dr. Marieke Huisman and prof.dr. Johan Lukkien
BSR	Prof.dr.ir. Wil van der Aalst, prof.dr. Arie van Deursen en prof.dr. Jaco van de Pol

Information and communications technology (ICT) research at the universities of technology primarily concentrates on refreshing and prioritising individual subdisciplines. The 4TU.Netherlands Institute for Research on ICT (4TU.NIRICT) research centre focuses on integrating, positioning, and prioritising all aspects of ICT research, in both multidisciplinary and chain approaches in a rapidly digitising world. Since more than 50% of research conducted at universities of technology concerns ICT, the research centre can effectively devote itself to strengthening the national ICT research network. In doing so, the decision was made to focus on researchers who are at the start of their careers. Another objective is to encourage cooperation in emerging research and educational topics that will be of significance for ICT in the future.
4TU.NIRICT endeavours to achieve these goals using a three-pronged approach involving community building, educational collaboration, and research portfolio management. Its largest research programme is the Big Software on the Run (BSR) project. BSR is an independent research programme in which seven research groups from UT, TU Delft and TU/e are taking part.
Since WUR joined the federation, ongoing discussions are taking place with WUR's Professor of ICT Bedi Tekinerdogan regarding expanding 4TU.NIRICT's administration and activities.

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. The emphasis here is on researchers who are yet to build an extensive national network. In addition to the annual community meeting, a network of younger ICT faculties has been set up under the name of ICTng (ICT next generation). In doing so, close cooperation was sought with the FES COMMIT/ programme (coming to an end in 2017), which pursues similar objectives. Led by Assistant Professor Przemek Pawelczak, 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.

Educational collaboration

All of the universities of technology develop their own curricula and educational activities, the development and implementation of which can help to strengthen each other in some areas. Educational collaboration is particularly necessary to help

increase the efficiency of educational development and teaching (where possible). 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. One bottom-up educational initiative, which was (financially) supported by the research centre, was the best-practices workshop MOOC, which was created by colleagues for colleagues.
In 2015, 4TU.NIRICT sponsored the European School of Information Theory. In 2016, a joint contest was held whereby the four most enterprising ICT students from universities of technology could win the chance to take part in the European Innovation Academy summer school. As part of the 4TU.BSR programme, a winter school was organised in October 2016 entitled "Big software on the run: Where software meets data", which attracted more than 80 participants.
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 Director of Research represents the research centre on the EIR Digital General Assembly.

Research collaboration

The research centre promotes and provides funding to stimulate bottom-up initiatives for collaboration on thematic research projects. It thereby develops and maintains a research portfolio, of promising issues that ultimately have a reasonable chance of receiving external funding. From 2014 to 2017, the universities of technology collaborated on the following topics: Data Science, Cyber Security, Antenna Research, Empathic Lighting, Wirelessly-Powered Autonomous Systems, Smart Industry/IoT, Green ICT, Human Computation and Crowdsourcing, and GPGPU. Various activities were developed as part of these partnerships, such as joint workshops, seminars and representation in the Dutch ICT landscape. The universities also collaborated on (successful) joint project applications. There were a number of exchanges between young researchers and fact-finding investigations were also carried out at various companies.

Big Software on the Run

4TU.NIRICT's largest research programme is the Big Software on the Run (BSR) project. BSR arose from a national Gravitation proposal which was submitted (and rejected) in 2013 by 4TU.NIRICT, RUN and VU Amsterdam. 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 requires 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, and in Enschede the focus is on distributed computing. This efficient use of resources has also been organised with an eye on 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, creativity and healthy friction. Unexpected new developments have also arisen, such as the collaboration with security groups in the area of privacy in software analysis. External funding is essential for some sub-activities within BSR so as to maintain the network of collaboration which has been built up.

Agenda for 2017

In 2017, 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 offer various awards. In addition, it will organise another Community Day. ICTng is also organising a series of meetings, the first of which will be hosted by the University of Amsterdam and VU Amsterdam in March. Thematic workshops and substantive networking events will be organised by some of the researchers who are working together within smaller research partnerships. Finally, BSR will run various national consultations and a final winter school.

14 Centre for Research Data

4TU.Centre for Research Data	People involved
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) and Robin Duinker (Communication Officer)
TU/e	Leon Osinki (Data Librarian), Sjef Öllers (Specialist Scientific Information)
UT	Maarten van Bentum (Data Librarian)

The 4TU.Centre for Research Data (4TU.ResearchData, formerly the 3TU.Datacentrum) offers services and advice for archiving research data in a secure, standardised 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 reusing research data
- advice and support on data management
- a voice advocating good data management, both nationally and internationally

When the 3TU.Federation became the 4TU.Federation in May 2016, the centre announced its new name at the same time.

Growth

4TU.ResearchData reports that the data archive continued to grow in 2016, with 335 new datasets added to the archive. A total of 7,042 datasets are now deposited with the centre.

In 2016, the centre internationally promoted its RDNL (Research Data Netherlands) Essentials 4 Data Support course with a presentation at the Knowledge Exchange workshop on RDM Training & Skills in London, and a two-day company training session in Denmark on behalf of the Danish Data Management Forum. The course was one of three finalists for the 'Teaching and Communication' category of the Digital Preservation Awards.

Finally, the centre's IFLA paper entitled "*Essentials 4 Data Support: Five years' experience with data management training* has been peer reviewed and accepted for publication.

Awards

The 4TU.ResearchData archive was awarded the Data Seal of Approval (DSA) for 2014-2017. The validation period for the next DSA will be 2017-2019. The centre will apply for the new DSA at the end of 2017.

As part of its RDNL efforts, the centre organised the '*Data Prijs 2016*' (Data Prize 2016). This year's prizes were awarded in three categories and the centre planned a broad data management-related programme, including three break-out sessions. The centre received 56 nominations (compared to 48 in 2014) and nearly 100 people attended the Data Prize Day.

The centre's showcases highlight engaging stories related to data sharing. The most successful showcase in 2016 was Bas Hensen's Disentangling Data: Disproving Einstein's Theory of Locality. This focused on illustrating the importance of data in countering Einstein's claims concerning the entanglement of electrons.

Picture: Bas Hensen, interviewed as part of the Research Data Showcase on Disentangling
Photo: Annemiek van der Kuil, PhotoA.nl

Agenda for 2017

In 2017, 4TU.ResearchData will focus on the following four topics:

1. Developing the Archive
   - Set up a closed archive to preserve data that cannot be shared
   - Implement Restricted Access to preserve data that can only be shared at the owner's discretion
   - Implement API to enable specific tools and services to be built into the archive
   - Have the Technical Infrastructure Group explore new solutions for the technical development of the archive in the long term
2. Advice and Communication
   - Conduct research into the applicability of new FAIR guidelines to research data
   - Review advice relating to data management and funding providers' policies on research data
   - Produce new promotional materials
3. Data Management
   - Implement the new Preservation Policy (review and update obsolete data formats)
   - Review current metadata schema and update these where necessary
4. Training
   - Run the Essentials for Data Support and related workshops four times a year
   - Work with individual 4TU members to help embed good research data management within their university.

15 Centre for Engineering Education

4TU.CEE	People involved
TU Delft	ir. Aldert Kamp (Leader), dr. Renate Klaassen (coordinator)
TU/e	prof.dr. Perry den Brok (leader), Chantal Brans Msc (coordinator)
UT	dr. Jan van der Veen (Leader, Chair), Lisa Gommer MSc (coordinator)
WUR	ir. Emiel van Puffelen (leader), drs. Marijke van Oppen (coordinator)
Advisory Board	Kristina Edström (KTH, Stockholm), prof. dr. Marc de Vries (TUD), prof. dr. ir. Lex Lemmens (TU/e), prof. dr. Rikus Eising (UT), vacancy (WUR) and Christiaan Meijer (Student TUD)

The 4TU.Centre for Engineering Education (4TU.CEE) is the place to be for teachers and scientists who have questions and ambitions in the domain of engineering education. Its mission is to inspire, stimulate, support and disseminate effective and high quality engineering education through research and the application of evidence-based innovations within engineering education.

Results

In 2016, a European Conference on Engineering Education[5] was jointly organised in Delft, at which 160 participants from 18 countries discussed the engineering education of the future, including international keynote speakers and numerous workshops. Three work packages on the subjects of 'Comparing Bachelor's curriculum innovations at the universities of technology', 'Investigating successful educational innovations in engineering education' and 'Interdisciplinary engineering education' resulted in a variety of reports, conference papers and presentations at international conferences and educational events at each of the universities of technology. The CEE also organised inspirational tours featuring international visitors to inspire teaching staff with fresh ideas and findings. Prof. Kristina Edstrom and Prof. Jacob Kuttenkeuler (KTH, Sweden) were invited to discuss strategies to help teaching staff to obtain better learning results with comparative or even less strenuous teaching investment. Furthermore, Donald Carpenter and Andrew Gerhart (DTU, Denmark) ran a workshop on active learning in engineering education.
A number of new projects were initiated at each of the universities of technology. TU/e launched projects relating to blended learning, efficient thesis supervision and active learning formats. In Twente, projects commenced on digital testing, teacher teams and academic skills for engineers.
Pilots seeking to support teaching staff to go beyond simply obtaining the basic university teaching qualification started at TU/e and UT. TU Delft has produced a vision document[6] on the future of engineering education, which contains input from large numbers of staff members and students. Collaboration with 16 other universities of technology on rewarding teaching excellence[7] and career progression is underway – an initiative of the Royal Academy of Engineering (UK).

Organisation

4TU.CEE is a small, flexible organisation with a broad network of allied researchers,

[5] https://www.4tu.nl/cee/en/events/cdio_conference/
[6] https://www.4tu.nl/cee/en/publications/vision-engineering-education
[7] http://www.evaluatingteaching.com/

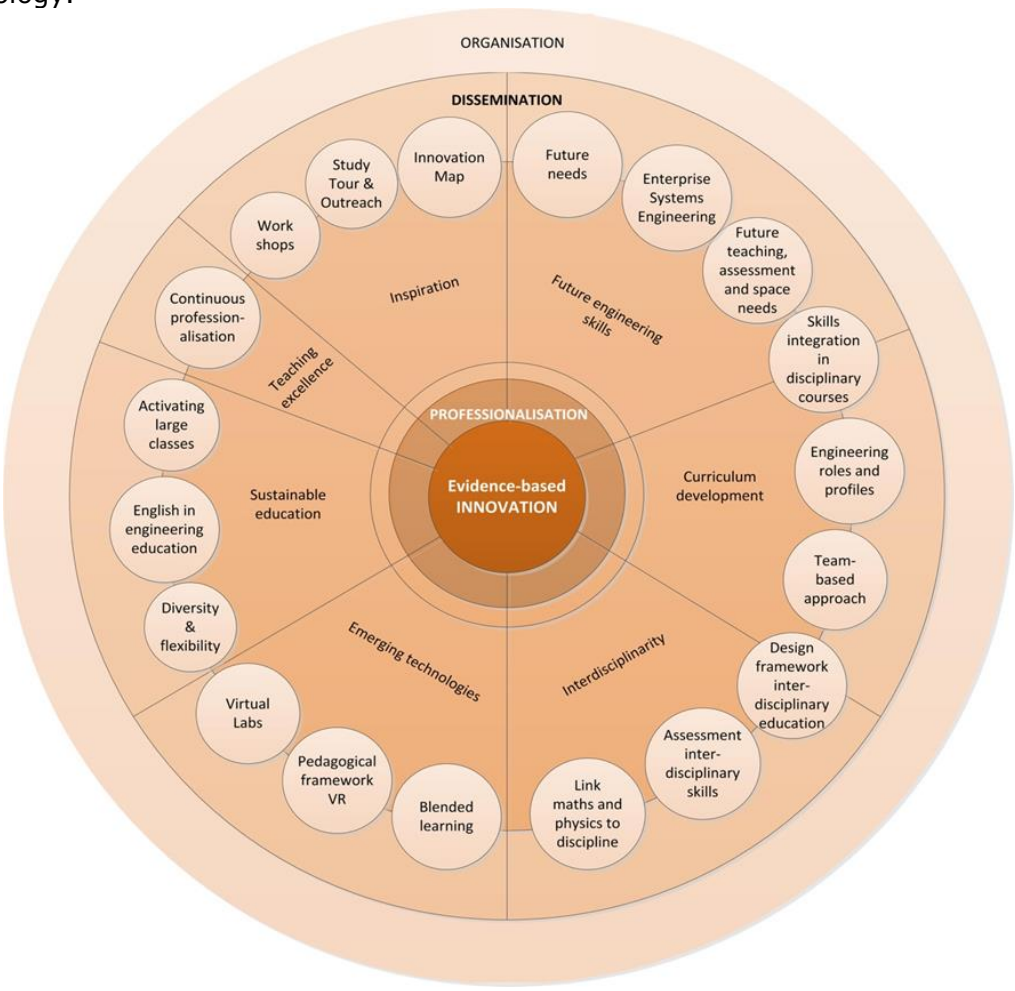
teaching staff and ambassadors. Its board consists of four leaders, each supported by a coordinator. Suitable teaching staff, educational researchers and support staff are identified and recruited for each project.

Agenda for 2017

The figure on the following page illustrates the various topics on which 4TU.CEE is actively working. Staff members from two, three or all four technical universities collaborate and share expertise on each theme, consulting international experts where necessary.

Wageningen University had joined 4TU.CEE by the end of 2016. Results of education innovation projects at Wageningen in past years will also be disseminated via the 4TU.CEE innovation map[8]. WUR's course and programme of innovation projects for 2017 are currently under development, for which the project teams may avail themselves of 4TU.CEE's innovation results. Stijn Heukels, Meike Sauter, Ellen Torfs and Harm Biemans will actively encourage lecturers involved with the new WUR innovation projects to use the options available within 4TU.CEE. Over the period of 2017-2019, WUR will contribute to the majority of 4TU.CEE's activities and will coordinate those relating to the theme of "diversity".

Various publications are available online at www.4tu.nl/cee/en, including the Progress Report 2014-2016[9] and the 4TU.CEE Strategic Plan for 2017-2019[10]. The site also features a map of a wide variety of educational innovations at the four universities of technology.



[8] https://www.4tu.nl/cee/en/research-innovation/
[9] https://www.4tu.nl/cee/en/publications/3tu.cee-progress-report-final
[10] https://www.4tu.nl/cee/en/publications/4tu.cee-strategic-plan

16 Stan Ackermans Institute

4TU.SAI	People involved
Director/chairman	prof.dr.ir. Jan Fransoo (TU/e)
Coordinator/secretary	mr.drs. Ben Donders (TU/e)
Board	Fransoo, Donders, prof.dr. Geert Dewulf (UT) and prof.dr.ir. André de Haan (TUD)
Coordinator TUD	ir. Pieter Swinkels
Coordinator UT	dr.ir. Timo Meinders

The various designer programmes offered by universities of technology in the Netherlands are presented to both prospective students and the business community under the banner of the Stan Ackermans Institute (SAI), supported by the website, brochures and videos. Graduates receive the degree of Professional Doctorate in Engineering (PDEng). Representatives of the SAI attended the '*bedrijvendagen*' (technical career fairs) hosted by the four universities of the federation, as well as elsewhere in the country.

Over the past few years, several new programmes have been launched at TU Delft, UT and TU/e, while others have been discontinued. The total number of programmes has grown from 11 in 2010 to 19 in 2016, the intake has increased from 125 to 198 students, and the number of graduates from 93 to 166. The designer programmes have produced more than 3,900 graduates since their introduction.

A brochure was published in 2016 on the occasion of the designer programmes' thirtieth anniversary, which featured a selection of industry-commissioned design assignments completed by SAI students and accompanied by a foreword by the Rector Magnifici of the 4TU universities. This brochure was distributed as a supplement to the monthly journal *De Ingenieur* published by the Royal Netherlands Society of Engineers (KIVI) in a run of approximately 25,000 copies.

This year, the SAI Board also issued a memorandum entitled "*Key Features Designer Programs*", which outlines the key quality assurance requirements to which all programmes should adhere. This memorandum was used to initiate a debate with the Dutch Certification Committee for Courses to become a Technological Designer (Nederlandse Certificatie Commissie voor Opleidingen tot Technologisch Ontwerper, CCTO), which is currently in charge of certifying the programmes, concerning the current assessment process.

Representatives of all designer programmes and the CCTO gather on an annual basis. In 2016, the meeting was held in December at TU Delft. On this occasion, the plenary debate focused on developments at the three universities of the federation and on issues relating to the status of Chartered Engineer.

TU/e, TU Delft and UT are currently contemplating how to integrate the designer programmes into their respective Graduate Schools. The Deans of the Graduate Schools are currently holding general meetings, which include the designer programmes on the agenda.

All of the 4TU universities have now entered into talks with the KIVI, which is seeking to promote the Chartered Engineer qualification that can be attained by engineers who have four years of work experience. During these talks, it was noted that this qualification is a desirable goal for PDEng graduates. At present, the final criteria of the designer programmes in Process Technology are being reviewed to compare how they relate to the criteria for the Chartered Engineer qualification.

Overview of intake and degree certificates issued for designer programmes 2013-2016

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

17 Master Programmes

Construction Management & Engineering

The Master's in Construction Management and Engineering (CME) is a two-year English language degree programme. It addresses the growing need for reform within the building and construction industry and prepares students for dealing with present and future transitions. This industry is currently under considerable pressure due to an increasing need for greater transparency, client orientation and innovation. Furthermore, society is now demanding a shift towards more sustainable solutions.

Education directors:
TU Delft: Ir. Jules Verlaan
TU/e: Prof. Harry Timmermans
UT: Dr. Andreas Hartmann

Jaar	Instroom (TUD+TUe+UT)	Diploma's (TUD+TUe+UT)	Totaal aantal studenten (TUD+TUe+UT)
2013/2014	55+49+25= 129	54+17+24= 95	
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	53+14+13= 80		216+97+65= 378

Embedded Systems

Embedded systems are hardware-software systems that are embedded into a larger product. The Master's in Embedded Systems degree programme focuses on how to design good quality embedded systems that are both efficient and reliable.

Opleidingsdirecteuren:
TU Delft: Dr. Hans Tonino
TU/e: Dr. Bas Luttik
UT: Dr. André Kokkeler

Jaar	Instroom (TUD+TUe+UT)	Diploma's (TUD+TUe+UT)	Totaal aantal studenten (TUD+TUe+UT)
2013/2014	30+41+14= 85	22+32+16= 70	
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	59+54+18= 131		164+153+60= 377

Science Education & Communication

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

Opleidingsdirecteuren:
TU Delft: Prof. Marc de Vries
TU/e: Dr. Ruurd Taconis
UT: Dr. Jan van der Meij

Jaar	Instroom (TUD+TUe+UT)	Diploma's (TUD+TUe+UT)	Totaal studenten (TUD+TUe+UT)
2013/2014	34+16+25= 75	19+24+21= 64	
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	36+18+ 7= 61		92+67+48= 207

Sustainable Energy Technology

The Master's in Sustainable Energy Technology (SET) degree programme trains engineers in broad-based energy technology competencies. Graduates can apply their knowledge and skills in projects using a system-based and interdisciplinary approach. They can also apply SET fundamentals to identify technical solutions for problems relating to sustainable energy, taking account of economic, social, environmental and ethical factors. Graduates have developed expert knowledge in at least one of the sub-areas of the field and are able to participate in relevant ongoing research.

Opleidingsdirecteuren:
TUD: Dr. Rene van Swaaij
TU/e: Dr. Camilo Rindt
UT: Dr. Jim Kok

Jaar	Instroom (TUD+TUe+UT)	Diploma's (TUD+TUe+UT)	Totaal aantal studenten (TUD+TUe+UT)
2013/2014	77+41+15= 133	83+65+12= 160	
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	100+42+14= 156		273+118+48= 439

Systems & Control

The Master's in Systems & Control degree programme is aimed at Bachelor's graudates with a technical background who are interested in the analysis and control of dynamic systems in their widest sense. The programme addresses both fundamental and application-specific features, emphasising the multidisciplinary character of the field. It covers applications in mechanical engineering, electrical engineering, applied physics, chemical and aerospace engineering.

Opleidingsdirecteuren:
TUD: Prof. Hans Hellendoorn
TU/e: Dr. Camilo Rindt
UT: Dr. Jan Willem Polderman

Jaar	Instroom (TUD+TUe+UT)	Diploma's (TUD+TUe+UT)	Totaal aantal studenten (TUD+TUe+UT)
2013/2014	43+31+ 8= 82	29+ 7+ 1= 37	
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	86+46+17= 149		239+112+37= 388

Specialisation: Cyber Security

The 4TU.CybSec Master's specialisation programme provides Computer Science students with deep technical knowledge and a good understanding of all relevant socio-technical issues. Cyber security is a multidisciplinary field based on a Computer Science core (e.g. cryptography, formal methods, secure software engineering, and

machine learning) and a broad range of supporting disciplines (e.g. law, economics, criminology, management, and psychology).

Programm coördinator:
UT: Prof. Pieter Hartel
TUD: Prof. Jan van den Berg

Jaar	Instroom	Diploma's	Totaal aantal studenten
2015/2016	11	10	11
2016/2017	11		37

18 External relationships

The 4TU.Federation has entered into agreements with several external parties. This section reports on the results of these agreements in 2016.

Nemo Kennislink

The Nemo Kennislink.nl[11] website reports on the great quest that is science. The site's editors follow researchers and their progress, present significant new scientific developments and expose the research behind current events. The 4TU.Federation has been supporting Kennislink since 2011.
In 2016, 375,000 visitors viewed more than 600,000 pages of news relating to science and technology.
The federation's support is also reflected in Kennislink's production figures: around 75 new articles were written for the science and technology section. The extra hours devoted to science and technology were shared between editors Robert Visscher and Roel van der Heijen, who had regular contact with public relations officers from the universities of technology and collected news from other sources.
The Faces of Science project continued in 2016 in collaboration with the Jonge Akademie of the Royal Netherlands Academy of Arts and Sciences (KNAW), for which researchers blogged about their work in order to create a lively and realistic picture of how scientific research is conducted for school pupils and university students. The line-up in 2016 featured the following 'faces' from the universities of technology: Life Science & Technology PhD candidate Gerben Stouten (TU Delft), Microbiology PhD candidate Nico Claasen (WUR), and Dr Julia Cramer (TU Delft) in Quantum Mechanics.

KIVI

All full-time professors with a permanent appointment are offered a collective KIVI membership, unless they raise an objection.
In 2016, the Stan Ackermans Institute and KIVI discussed the matter of whether to allow PDEng graduates to also qualify as Chartered Engineers.

AgriFoodTech Platform

The AgriFoodTech Platform[12] is an initiative launched by the Southern Agriculture and Horticulture Organization (*Zuidelijke Land- en Tuinbouworganisatie*, ZLTO), FME, the Dutch Food and Grocery Federation (*Federatie Nederlandse Levensmiddelen Industrie*, FNLI), WUR, and the 4TU.Federation with the objective of solving issues of social importance through technology and other forms of innovation. The AgriFoodTech Platform enters into dialogue with society with the aim of devising solutions to social problems together with civil society organisations, farmers, entrepreneurs, designers, government knowledge institutes and industry.

Science and Technology Registration Authority

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

[11] https://www.nemokennislink.nl
[12] http://agrifoodtechplatform.nl

Foundation for the Promotion of Science and Technology

The Foundation for the Promotion of Science and Technology (*Stichting Techniekpromotie*, STP) runs various nationwide programmes such as the Eureka!Cup, the Technology Tournament (*Techniek Toernooi*) and the FIRST® LEGO® League. These events are organised regionally by local partners and at national level by the STP. The STP's objective is to ensure that, from the age of four, every child comes into contact with the world of science and technology in order to optimise their development. Along with its partners, industry and its wider network, the STP reaches 100,000 children every year.

Regional co-operation was strengthened in 2016 and will be further developed by increasing the number of regional partners. Collaboration with educational institutions and the business community was also expanded, with increasing numbers of companies becoming actively involved in the Eureka!Cup as paying clients. In fact, in 2016, the number of paying clients reached 100% for the first time. The STP is seeking to secure more general sponsorship from industry. Furthermore, in 2016 the STP took on a liaison role in the Success Technology Pact (*Techniekpact*).
In 2017, the STP will continue to organise and coordinate the various national tournaments above and anticipates further growth in the number of participants. Finally, the STP will concentrate on reducing the fragmentation of its activities by increasingly syncing with those of the four universities of the federation.

RAI Amsterdam

In 2015, the 4TU.Federation entered into a partnership with RAI Amsterdam. Within the framework of this partnership, the federation offers its assistance by securing projects and contacts for the Innovation LAB, which forms part of several trade fairs at RAI Amsterdam. The LAB hosts state-of-the-art technology to inspire visitors and challenge them to converse with each other.
It was set up for a range of fairs that took place in 2016. 4TU nominated potentially interesting contacts from the four universities who were knowledgeable about the subject of each fair.
In the lead up to the HISWA Amsterdam Boat Show 2017, the secretary of 4TU has been invited to sit on the jury for the HISWA Product of the Year, a contest which pits the most innovative water sports products against each other.

Composition 4TU.Federation

The General Management Board consists of all members of the Executive Boards of the universities of technology.

The Executive Committee consists of the four presidents of the Executive Boards of the universities of technology:

- mr. Victor van der Chijs (UT, chairman)
- prof.dr.ir. Tim van der Hagen (TU Delft)
- ir. Jan Mengelers (TU/e)
- prof.dr.ir. Louise Fresco (WUR)
- Secretary: ir. IJsbrand Haagsma

The Research Management Committee consists of the research portfolio holders of the Executive Boards of the universities of technology:

- prof.dr.ir. Arthur Mol (WUR, chairman)
- prof.ir. Karel Luyben (TU Delft)
- prof.dr.ir. Frank Baaijens (TU/e)
- prof.dr. Thom Palstra (UT)
- Secretary: Drs. Meike Sauter (WUR)

The Education Management Committee consists of the education portfolio holders of the Executive Boards of the universities of technology:

- prof.dr.ir. Frank Baaijens (TU/e, chairman)
- Drs. Anka Mulder (TU Delft)
- prof.dr. Thom Palstra (UT)
- prof.dr.ir. Arthur (WUR)
- Secretary: Dr. Lilian Halsema (TU/e)

4TU Secretary general: ir. IJsbrand Haagsma
4TU Project manager: Linda Baljeu