4U.Federation

Annual report 2020

April 2021



UNIVERSITY OF TWENTE.





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Foreword

The COVID-19 pandemic has shown very clearly that everything is connected to everything else, but also that existing trends are being accelerated. Measures intertwine with each other and call for new measures. There are no simple solutions to complex problems, because solutions also show that everything is related to everything else. Solutions must therefore also be made in relation to each other. Technology plays an essential role in this, from data management and logistics to the development of new apps and AI applications. But all these technological innovations should be ecologically, ethically and economically responsible, and socially acceptable. Connected solutions require collaborative teams. The 4TU.Federation encourages collaboration between the teams of the four universities of technology. It creates cross-pollination between disciplines and facilitates a transition to a new normal.

It is with great pride that I listened to the 4TU students who jointly presented the first *Techrede* speech. These young people are our creative thinkers of the future, multidisciplinary bridge builders, who are working together to find solutions for the challenges facing us today in respect of climate, energy, agriculture, food production and healthcare. Among the quests to have emphasised the essential role of technological innovation in all of this are Prince Constantijn of the Netherlands, Prime Minister Mark Rutte, Ineke Dezentjé of FME, and Hans de Jong of Philips.



These challenges facing society form the playing field for the activities of 4TU. Since the federation's founding in 2007, the playing field has evolved significantly. The intake of students and labour market demand for engineering graduates continue to be key factors. The new <u>Strategy 2020-2025</u> sets out in detail the research, teaching, and valorisation role of 4TU in the new playing field.

An important step has been taken with the presentation of the <u>Sector Plan for Science and Technology</u> <u>Education</u> to the Minister of Education, Culture and Science. In close consultation with the science faculties of the general universities, the technical universities of applied sciences, student organisations, and the business community, no fewer than seven projects have been launched with the aim of increasing teaching capacity and the number of graduates.

Despite the turbulent times we are living in, some excellent solutions have been presented - during the Dutch Design Week, for example, and in the 4TU Impact Challenge final. Many of these presentations can be read on the popular website and in the newsletter that was introduced in the past year. There is extensive coverage on what has so far been achieved, but also much to inspire you to look to the future.

Louise O. Fresco Chair 4TU.Federation President of the Executive Board of Wageningen University & Research

General Management Board & Executive Committee

General Management Board	Tim van der Hagen, Rob Mudde, <i>vacant</i> (Delft University of Technology (TU Delft))
	Robert-Jan Smits, Frank Baaijens, Nicole Ummelen (Eindhoven University of Technology (TU/e))
	Victor van der Chijs, Thom Palstra/Tom Veldkamp, Mirjam Bult (University of Twente (UT))
	Louise Fresco, Arthur Mol, Rens Buchwaldt (Wageningen University (WU))
Executive Committee	Louise Fresco (chair), Tim van der Hagen, Robert-Jan Smits, Victor van der Chijs
Support	Lotte Melenhorst (TU Delft), Renee Westenbrink (TU/e) Hanneke Bodewes (UT), Pieter Munster (WU)
4TU	IJsbrand Haagsma

The General Management Board met twice, and the Executive Committee five times. Because of the pandemic, the meeting of the Executive Committee with a delegation from the employee participation body was postponed.

Sector Plan for Science and Technology Education

A complex process was concluded in June with the adoption of the <u>Sector Plan for Science and Technology</u> <u>Education</u> and its presentation to the Ministry of Education, Culture and Science. The sector plan has been produced in close consultation with the science faculties of the general universities, the technical universities of applied sciences, student organisations, and the business community. Seven joint projects are being presented, aimed at increasing intake capacity and the number of science and technology graduates. The focus lies on computer sciences, mechanical engineering, and electrical engineering because the gap between the supply and demand in the labour market for these disciplines is the greatest.

Strategy for 2020-2025

Following a stakeholder survey, it was decided in 2019 not to make any major changes to the 4TU.Federation's strategy. <u>The Strategy 2020-2025</u>, which was approved and published in September, is the result of discussions in the Executive Committee and the three management committees. The strategy priorities include the aim to visibly contribute to the availability and use of technological developments that have an impact on society, and the wish for 4TU to help strengthen the field of technology in partnership with external parties.

Once the budgetary parameters for the years 2022-2025 had been set, the management committees involved were able to start work on the details of proposals for an activity plan.

Techrede speech and follow up

The General Management Board and the Executive Committee held extensive discussions on the content of <u>the Techrede speech</u> on 1 October 2020, which was organised by 4TU. The event saw students calling upon politicians and the business community to put technological innovations high up on their priority lists. At the request of the board, the students will also help with the follow-up to the Techrede speech, as 'drivers of technology'. In the run-up to the elections, close contact will be maintained with the members of the Knowledge Coalition in order to promote greater innovation on as broad a front as possible.

Departure of secretary

In November, the board said farewell to its secretary, IJsbrand Haagsma. The board is grateful for the work he has carried out on behalf of the federation since 2012. Following a recruitment procedure, a suitable candidate was introduced to the Executive Committee. Marjolein Dohmen-Janssen will take up her new position as secretary to the 4TU.Federation in March.

Key indicators

The number of assistant, associate, and full professors (in FTEs) between 2009 and 2019 is given in the tables below. The results of actively seeking to recruit female academic staff can be clearly seen - in each of these years, their number increased more quickly than that of their male counterparts.

Numbers of academic staff (assistant, associate, and full professors in FTEs), male and female, 2009-2019

MALE	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	19/18	19/09
TU Delft	747	751	754	734	726	731	735	744	757	775	787	1.5%	5.2%
TU/e	465	462	453	447	438	435	432	454	444	440	451	2.6%	-2.9%
UT	423	486	467	452	434	421	417	418	423	435	460	5.7%	8.7%
WU	404	398	397	408	408	405	405	390	391	385	387	0.5%	-4.2%
FEMALE	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	19/18	19/09
TU Delft	124	128	139	146	161	167	178	185	196	215	233	8.3%	87.5%
TU/e	59	62	65	58	73	81	98	108	114	120	132	10.3%	123.9%
UT	106	117	121	118	117	114	115	119	127	145	151	4.3%	42.4%
WU	104	106	115	121	123	132	144	152	162	170	189	11.2%	81.1%

Source: WOPI, reference date: 31 December

Research Management Committee

Board	Thom Palstra (UT, chair until Nov), thereafter Tom Veldkamp
	Arthur Mol (WU, chair from Nov)
	Tim van der Hagen (TU Delft), Frank Baaijens (TU/e)
Support	Hanneke Bodewes / Jasper van Alten (UT, secretary)
	Pieter Munster (WU), Lotte Melenhorst (TU Delft), Rianne Pas (TU/e)
4TU	IJsbrand Haagsma, Linda Baljeu

In 2020, the Research Management Committee consisted of the research portfolio holders of the Executive Boards of the four universities of technology. 4TU.Research is responsible for the realisation and supervision of the collaboration and planning by the universities with regard to research. A wide range of activities have taken place, despite the pandemic.

Strategy for 2020-2025

During the reporting year, the committee considered the research component of the draft version of the 4TU.Federation strategy. An important aspect was the focus on collaborating in socially relevant fields and the contribution that could be made towards the visibility and impact of technology. It was concluded that the current network organisations (the 4TU.Research Centres) are easily capable of putting technology in the spotlight and of representing the Dutch technology sector.

The activities and results of the High Tech for a Sustainable Future (HTSF) programme help raise the external profiles of the universities of technology and promote intensive collaboration between and among disciplines, especially through the appointment of tenure track candidates¹. Opportunities for this primarily lie in the appointment of the new academic staff that the four universities of technology will be recruiting in the coming years as part of the sector plans for education and research. The Research Management Committee will devise plans in 2021 for a successor to the HTSF programme and for the network organisations.

High Tech for a Sustainable Future

The 4TU talent stimulus 'High Tech for a Sustainable Future' is a research programme initiated by 4TU.Research. A total of \in 22 million has been set aside for five themed-programmes from the organisation's own resources: *DeSIRE, Plantenna, Precision Medicine, Pride & Prejudice* and *Soft Robotics*. The mid-term evaluations of the five programmes were completed in 2020, and appropriate actions arising from these evaluations are being taken. This includes further strengthening the impact and clarifying the role of tenure track candidates on the programmes. 'Team science' is a key term in this context.

Because of the pandemic, there have been delays in appointing temporary staff in some cases. The Research Management Committee has consequently decided to treat flexibly the deadline for appointing temporary staff.

An update for each programme is given in Chapter 17.

Research centres

In 2020, 4TU had nine research centres, which were visited (online) by the rectors during the reporting year. As well as producing some useful conversations, the visits afforded an interesting insight into all the activities being developed by the network organisations. Everything was covered - from involving consortia with major research proposals (4TU.Ethics and Technology) and developing a stakeholder network (4TU.Resilience Engineering), to securing a key position on the national building innovation agenda (4TU.Bouw). The conversations are also being used as input for determining the direction of the research part of the strategic plans for 2022-2025.

¹ Talented young academics with the prospect of a permanent appointment

Health@4TU

For a number of years now, 4TU has seen working partnerships in the field of health, under the banner of *Health@4TU*. This has created a central point of contact for medical technology at the universities of technology; its leaders have secured a place at the discussion table with the government, the Dutch Research Council and health funds. By working together, we can more effectively influence the implementation of the *National MedTech Agenda* and the *Health and Care Mission*², such as by helping draw up programmes and creating fit-for-purpose funding instruments for such programmes. Accordingly, the management committee has decided to back the plans of *Health@4TU* and to award the group an annual budget for coordination costs.

Key indicators

Number of 4TU doctorates, 2010-2020

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	20/19	20/10
4TU	915	917	973	1064	1145	1130	1182	1063	1161	1230	1083	-12.0%	18.4%
TU Delft	333	319	303	353	371	357	395	359	368	400	374	-6.5%	12.3%
TU/e	189	199	245	218	243	234	224	212	264	290	244	-15.9%	29.1%
UT	188	203	196	220	244	234	267	197	243	247	184	-25.5%	-2.1%
WU	205	196	229	273	287	305	296	295	286	293	281	-4.1%	37.1%

Number of 4TU doctoral candidates present, 2010-2020

М	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	20/19	20/10
TU Delft	1708	1835	1854	1871	1881	1913	1959	1995	2021	1983	2038	2.8%	19.3%
TU/e	849	893	851	886	925	969	1028	1072	1070	1063	1105	4.0%	30.2%
UT	850	839	831	784	784	783	756	751	699	648	798	23.1%	-6.1%
WU	907	929	994	963	962	953	938	933	912	922	1026	11.3%	13.1%
F													
TU Delft	613	681	713	730	744	739	751	771	795	828	890	7.5%	45.2%
TU/e	308	312	308	324	355	398	415	462	494	509	541	6.3%	75.6%
UT	411	445	421	409	420	452	436	442	429	383	456	19.1%	10.9%
WU	785	872	965	992	941	943	929	938	955	1014	1170	15.4%	45.0%
4TU	6431	6806	6937	6959	7012	7150	7212	7364	7375	7350	8018	9.1%	24.7%

Source: WOPI (reference date: 31 December)

² Key mission in the document by the Ministry of Health, Welfare and Sport, in the context of the cabinet's mission-driven top-sector and innovation policy

Prizes

The following prizes were awarded in the 2020 reporting year. The titles of the grants should not serve as a guide. For example, the Vici 2019 grant was awarded in February 2020, and is therefore included in this annual report.

Innovative Research IncentivesERCSchemeVeni 2020: awarded in November
2020Starting 2020: awarded in November
2020Vidi 2019: awarded in November
2020Advanced 2019: awarded in April 2020
Consolidator 2020: awarded in DecemberVici 2019: awarded in February
20202020

TU Delft	Veni 2020 Abel-John Buchner Jesper Cockx Irene Dedoussi Dorine Duives Laura Ferranti Anahita Jamshidnejad Manon Kok Eline van der Kruk Filip Malinowski Matus Rybak Amy Thomas Deepesh Toshniwal Aikaterini Varveri Alexandros Vasileiadis Vidi 2019 Doris van Halem Toeno van der Sar Monique van der Veen Coen de Visser	Starting 2020 Peyman Mohajerin Esfahani Caroline Paul Advanced 2019 Jerry Westerweel Cees Dekker Lieven Vandersypen Consolidator 2020 Stan Brouns Kristof Cools Simon Gröblacher	WU	Veni 2020 Emmanuel Adu-Ampong Mohammad Alanjari Tim van Emmerik Daniel Gallardo Albarrán Esther Marijnen Deli Zhang Annah Zhu Ingrid de Zwarte Vidi 2019 Leontine Becking Wilma van Esse Wouter Kohlen Jose Lozano Torres Florian Muijres Elwira Smakowska Luzan Maarten Voors Vici 2019 Thijs Ettema Christa Testerink	Starting 2020 Marnix Medema Daan Swarts Tobias Zuest Advanced 2019 - Consolidator 2020 Rutgerd Boelens Joris Sprakel
TU/e	Veni 2020 Max Birk Sofie Haesaert Fatemeh Hashemi Loe Schlicher Emily Sullivan Roderick Tas Vidi 2019 Andreas Hülsing Liesbeth Janssen Adrie Mackus Laura Sanità Vici 2019 Ageeth Bol Jeroen van Oijen	Starting 2020 Ruth Cardinaels Alberto Curto Adrie Mackus Advanced 2019 Philip de Goey Consolidator 2020 Tom de Greef Ilja Voets	UT	Veni 2020 Pantelis Bampoulis Cristina Bayón Calderón Caroline Gevaert Erik Groot Jebbink Michael Lerch Giulio Ragazzon Clara Stegehuis Annemieke Witteveen Jelmer Wolterink Albert Wong Vidi 2019 Tatiana Filatova Rebecca Saive	Starting 2020 Dominik Krug Advanced 2019 - Consolidator 2020 Jan Klaers

B Education Management Committee

Board	Rob Mudde (TU Delft, chair), Frank Baaijens (TU/e), Thom Palstra/Tom Veldkamp (UT), Arthur Mol (WU)
Support	Hélène Bartelds (TU Delft, secretary), Lilian Halsema (TU/e), Lisette Woud (UT), Eva Verschoor (WU)
4TU	IJsbrand Haagsma, Linda Baljeu

In 2020, the Education Management Committee consisted of the Education portfolio holders of the Executive Boards of the universities of technology. The committee is responsible for the details and monitoring of the working partnership between the universities in relation to teaching. Various matters have been covered this year. For example, there was greater coordination regarding the third cycle at universities of applied sciences and a process of combined accreditation at *NVAO* and *EUR-ACE*, and discussions were held on the recommendations of the 4TU's *University Teaching Qualification (UTQ) Supervisory Committee*.

The effect of the pandemic

Teaching at the university has been very severely affected by the pandemic. The members of the board exchanged experiences and everyone learned something from everyone else. Experts at the 4TU.Centre for Engineering Education updated managers about the latest information on online and blended learning, and about the consequences and opportunities for the future.

Sector Plan for Science and Technology Education

Following the recommendations of the Van Rijn Committee, the Ministry of Education, Culture and Science asked 4TU to draft a *Sector Plan for Science and Technology Education* in collaboration with the science faculties of the general universities, universities of applied sciences, student organisations and the business community. The plan involved the setting up of the projects mentioned below, the specific details of which were developed after the summer of 2020.

- Joining forces to give scientists the opportunity to devote more time to teaching duties as well as to offer them more development and career opportunities in teaching, based on the 'Room for everyone's talent' position paper³;
- Working together to ensure that available teaching capacity is distributed evenly throughout the country and to come to agreements on increasing this capacity in the next few years;
- Jointly developing a *programme choice check* for degree programmes in the computer sciences, mechanical engineering and electrical engineering disciplines. This programme choice check will also actively suggest relevant science and technology study programmes offered at universities of applied sciences;
- Jointly making teaching materials available that can be used collectively on Bachelor's programmes and bridging education programmes, both traditional and online. Besides being efficient, joint teaching materials also facilitate mobility between higher education institutions;
- Joint development of *life-long development* programmes geared towards continued education and preventing the departure ('drain') of professionals into the business community and public sector bodies. It is clear that a regional approach for each discipline should be adopted in collaboration with the higher professional education sector;
- A joint campaign to raise the profile of electrical engineering, with a particular focus on female students;
- A joint promotional campaign to raise international awareness of the opportunities that await talented scientists in the Netherlands in the next few years.

³ A <u>publication</u> by the Association of Universities in the Netherlands, the Netherlands Federation of University Medical Centres, the Royal Netherlands Academy of Arts and Sciences, the Dutch Research Council, and the Netherlands Organisation for Health Research and Development

Foundation for the Promotion of Science and Technology

The 4TU.Education managers would like to see the foundation for the promotion of science and technology (Stichting Techniek Promotie, STP) embedded in the *Talent for Technology Platform*. The activities of the STP are very valuable, but should be organised either in a national body or more closely to the regular policies of educational institutions. Given that collaboration efforts in the national platform have not been a success, the 4TU.Education managers have decided to integrate the successful projects, including *FIRST*® *LEGO*® *League*, with the institutions' marketing activities.

Key indicators

The significant increase in the number of students in the period 2010 to 2020 is illustrated in the following figures. The year 2020 is also on course for an increase in student numbers, with an average rise of 5% compared to 2019.

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

4TU student population, 2010-2020, all students (primary enrolment as of 1 October)

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	20/19	20/10
TU												4%	50%
Delft	17329	17721	17874	19148	20034	21469	22199	23325	24507	24961	26028		
TU/e	7307	7519	7762	8377	9209	10116	10764	11372	11969	12237	12873	5%	76%
UT	8886	9398	9314	9315	9263	9082	9396	9921	10665	11404	12219	7%	38%
WU	6457	7071	7491	8302	9032	9720	10697	11446	11946	12280	12896	5%	100%
4TU	39979	41709	42441	45142	47538	50387	53056	56064	59087	60882	64016	5%	60%
М	28178	29022	29280	30967	32363	34025	35290	36983	38681	39529	41243	4%	46%
F	11801	12687	13161	14175	15175	16362	17766	19081	20406	21353	22773	7%	93%

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	20/19	20/10
INT	5658	6461	6839	7246	7688	8726	9895	10905	12209	13154	14191	8%	151%
NL	34321	35248	35602	37896	39850	41661	43161	45159	46878	47728	49825	4%	45%

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

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	20/19	20/10
TU									4094	3783		4%	44%
Delft	2730	2790	2756	3057	3125	3274	3353	3641			3943		
TU/e	1501	1591	1729	1967	2144	2276	2396	2616	2338	2296	2535	10%	69%
UT	1788	2000	1780	1792	1814	1691	2060	2113	2335	2631	2755	5%	54%
WU	1113	1102	1181	1457	1484	1521	1655	1713	1711	1620	1734	7%	56%
4TU	7132	7483	7446	8273	8567	8762	9459	10083	10478	10330	10967	6%	54%
М	4746	5116	5092	5657	5793	5956	6149	6725	6869	6664	7056	6%	49%
F	2386	2367	2354	2616	2774	2806	3310	3358	3609	3666	3911	7%	64%

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	20/19	20/10
INT	671	844	725	741	768	805	1158	1307	1875	2070	2269	10%	239%
NL	6461	6639	6721	7532	7799	7957	8301	8776	8603	8260	8698	5%	35%

Source: 1CHO

Centre for Engineering Education

The four universities of technology are collaborating to improve engineering education through the Centre for Engineering Education (CEE). The 4TU.CEE collects and develops evidence-based knowledge and informs and advises the 4TU.Education board on trends and innovations in education. CEE continuously monitors and analyses the effectiveness of innovations at the four institutions.

The four universities of technology exchange expertise and experiences, with the help of the <u>CEE</u> <u>Innovation map</u> for example, which since late 2020 has included information on 237 innovations and projects. During this year of crisis, the pages on projects that deal with online teaching were very popular; projects on <u>challenge-based learning</u> also generated much interest. With over 38,000 hits, the CEE's websites received almost twice as many visitors as it did in 2019. See Chapter 13, 4TU.CEE, for more information about this centre.

Key indicators

The following tables show that the number of Master's students at the four universities of technology has doubled over the past ten years. The number of Bachelor's degrees awarded to international students continued to rise in 2019 (figures for 2020 are not yet available), with an explosive growth of no less than 260% having been achieved over a period of ten years.

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

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	20/19	20/10
TU									3500	3459			
Delft	1156	1240	2089	2327	2519	2207	2882	3393			4107	19%	255%
TU/e	487	621	717	887	976	655	1117	1180	1264	1373	1633	19%	235%
UT	314	567	847	688	667	471	1072	1122	1117	1195	1284	7%	309%
WU	1095	992	1325	1310	1300	1228	1676	1750	1765	2035	2053	1%	87%
4TU	3052	3420	4978	5212	5462	4561	6747	7445	7622	8062	9077	13%	197%
М	1795	2098	3170	3243	3516	2893	4131	4577	4666	4858	5558	14%	210%
F	1257	1322	1808	1969	1946	1668	2616	2868	2956	3204	3519	10%	180%
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	20/19	20/10
INT	1637	1711	1858	1867	2219	2773	2889	3117	3114	3098	2918	-6%	78%
NL	1415	1709	3120	3345	3243	1788	3858	4328	4532	4964	6159	24%	335%

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

4TU BSc degree certificates, 2009-2019

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	19/18	19/09
4TU	3493	4338	5542	4875	4955	5565	5175	5617	5962	6440	6685	4%	91%
М	2393	2996	3863	3166	3205	3651	3284	3608	3854	4011	4244	6%	77%
F	1100	1342	1679	1709	1750	1914	1891	2009	2108	2429	2441	0%	122%
INT	201	312	335	399	480	483	541	470	450	649	723	11%	260%
NL	3292	4026	5207	4476	4475	5082	4634	5147	5512	5791	5962	3%	81%

4TU MSc degree certificates, 2009-2019 (including graduate degrees)

			-		,		•				·			
		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	19/18	19/09
	4TU	4861	5054	5892	5556	5987	6416	6960	7540	8045	8448	8434	0%	76%
	М	3259	3373	3805	3643	3845	4080	4366	4701	4846	5195	5156	-1%	62%
	F	1602	1681	2087	1913	2142	2336	2594	2839	3199	3253	3278	1%	105%
	INT	1247	1398	1649	1674	1845	1967	2164	2643	2926	3058	2986	-2%	139%
	NL	3614	3656	4243	3882	4142	4449	4796	4897	5119	5390	5448	1%	54%
1														

Source: 1CHO



Director	Paul Althuis (TU Delft)
Programme manager	Roelyn van der Hoek (UT)
Management team	Paul Althuis (TU Delft), Robert Al (TU/e)
Management team	Jaap Beernink (UT), Sebastiaan Berendse (WU)

The joint valorisation efforts are based within the 4TU.IMPACT centre. It reports to the Valorisation Management Committee, consisting of the Valorisation portfolio holders of the four universities of technology. In 2020, these were Robert-Jan Smits (TU/e, chair), Nicoly Vermeulen (TU Delft), Victor van der Chijs (UT), and Rens Buchwaldt (WU).

For the Dutch knowledge economy, a sufficient level of innovation is essential for keeping the economy going and for keeping the population of the Netherlands prosperous and happy. In this regard it is important to generate enough ideas and successful results that can ultimately be sold on the market. The four universities of technology have an active role to play in improving the Dutch knowledge system, for which 4TU has drawn up the 4TU.IMPACT plan for 2018-2021. The plan contains various modules that external parties are welcome to join.

Module 1 - 4TU4Industry

In 2020, the 4TU4Industry working group formulated its tasks for the next few years. The working group not only coordinates participation at the Hannover Messe for the four universities of technology, it also represents their interests in the area of valorisation:

- on matters that involve funding by both the private and public sectors;
- on matters that are relevant to valorisation and the results of research;
- on matters involving the Ministry of Economic Affairs and Climate Policy, top sectors and missions, the National Growth Fund, the Confederation of Netherlands Industry and Employers (VNO-NCW), FME, etc.;
- in the context of current and future national and European innovation policies.

In 2020, the working group was actively involved with multiple proposals for the Dutch government's National Growth Fund. The first step was also taken towards representing the joint interests in framework agreements. The chair of the working group represents 4TU in the High Tech Systems and Materials top sector, while the working group itself ensures that information from the universities of technology is conveyed to the right people. Against the background of the elections for the House of Representatives in 2021, efforts were made to harmonise activities with the VNO-NCW employers' organisation, and it was agreed immediately after the election that an activity for members of the House of Representatives should be jointly set up. The knowledge coalition also supports the wish to see an allocation of at least 3% of GDP to R&D as part of the government coalition agreement.

Module 2 - Living labs

On 19 November 2020 young, highly talented students in the Netherlands competed against each other during the final of the second online edition of the <u>4TU Impact Challenge</u>, the innovation competition organised by the four universities of technology. The winner will accompany the Dutch trade delegation to the World Expo in Dubai in 2022. More than 1,000 students, around 80 teams per university, participated in the local preliminaries of the 4TU Impact Challenge that took place earlier this year at each of the four universities of technology. The candidates worked on their idea or prototype with the help of coaches from companies that are pioneers in their field. Chat sessions, training sessions, and workshops helped the eight finalists prepare for their pitches and questions from the jury. And it was not just the winners who were in the spotlight - other teams made outstanding contributions too. 4TU Impact will continue to follow the finalists' progress.

Techrede speech

With a nod to the Kings' Speech to Parliament, 4TU organised the <u>Techrede speech</u> on 1 October 2020. It included an appeal for innovation, action, and collaboration. The four students who delivered the *Techrede* speech talked about the importance of committing now to a Delta Plan in order to create a resilient, safe, and sustainable future. Among the guests to have emphasised the essential role of technological innovation in all of this are Prince Constantijn of the Netherlands, Prime Minister Mark Rutte, Ineke Dezentjé of FME, and Hans de



Jong of Philips. In the run-up to the *Techrede* speech, 4TU innovators used a series of vlogs to give viewers a guided tour of the world of innovation and its importance for society. The 'tech files' - a series of reports about the 'tech route' to the future - were also produced. Presenter Harry Piekema took viewers on a journey into the past, present, and future of technological innovations. The *Techrede* speech students were also asked to follow up on their speech, and the results of their work will be shown in 2021 in a public appearance during the *Innovation Expo* on 8 April.

Module 3A - Entrepreneurship education

The working group has completed its research into activities based on the 'snowflake game'. The game involves analysing different ways of learning to think as an entrepreneur. The publication about the research is ready. Another research activity has been started, following the inspiring example of WU – the 'entrepreneurial mindset monitor'. This is a mobile apps-based monitor that identifies the attitudinal developments of students during courses on entrepreneurship.

Module 3B - Screening & scouting

The Screening and Scouting working group and the Coalition of the Willing⁴ have identified the problem areas in the valorisation process and produced a timetable for jointly tackling them in the next few years. During the final quarter of 2020, work was carried out on a series of articles entitled 'The spin-off of the spin-off' with the intention of showing the scientific benefits that can be gained from this. This helped create awareness of entrepreneurship among scientists. Articles will be published almost weekly from the first week of January 2021, in collaboration with Innovation Origins.

Because of the pandemic, the pilot of the minor 4TU.Entrepreneurship Course on one of the two Technology Tech Transfer themes (TTT) has been deferred for a year.

Module 4 - Finance

The Smart Systems and Circular Technologies TTT programmes were successfully launched this year. Five spin-offs have already received funding and supervision through the programme. This year, too, an application has been submitted in the area of medical technology, the result of which will be known in 2021.

Module 5 - Events

The annual participation at the Hannover Messe was cancelled this year because of the pandemic. Contributions to the Dutch Design Week and the VSNU Impact Festival were organised online. Among the items to feature were clips from and vlogs on the *Techrede* speech. The Innovation Expo has been put back to April 2021.

Commercial activity

This annual report covers business activity, an indicator of valorisation. Business activity is measured in terms of the number of spin-offs and start-ups. The international definitions of these terms, which are also used by the Association of Universities in the Netherlands, have been adopted for the purpose of this report.

	Spin-offs	Start-ups
TU Delft	10	3
TU/e	7	15
UT	2	unknown
WU	4	6

⁴ Initiative by eight European countries to jointly achieve results and to learn from each other in the area of government digitalisation.

Applied Mathematics Institute

Scientific director	Johann Hurink (University of Twente)
Coordinator	Laurie Baggen (TU/e)
Management team	Richard Boucherie (UT), Luc Florack (TU/e) Arnold Heemink (TU Delft), Peter van Heijster (WUR)
Board	Joost Kok (dean, UT), Johan Lukkien (dean, TU/e) John Schmitz/Lucas van Vliet (dean, TU Delft), Peter van Heijster (WUR)

More and more technology sectors are in great need of advanced and application-oriented mathematics knowledge and expertise. The overall aim of the 4TU Applied Mathematics Institute (4TU.AMI) is to encourage collaboration between mathematics groups and researchers at the four universities of technology, and thereby to jointly promote the role of mathematics in fields of application.

Fresh insights

In 2020, director of research Kees Vuik (TU Delft) handed over his duties to Johann Hurink (University of Twente). Hurink has made an introductory digital knowledge tour to visit everyone involved with 4TU.AMI - from the board and management team to researchers, directors of studies, and coordinators of service teaching of mathematics. This meant, in 2020, a moment of reflection, which led to new initiatives at 4TU.AMI.

"Issues are becoming more and more complex. Mathematicians will increasingly be called upon to provide answers"

Johann Hurink – director of research, AMI 4TU interview

Strategic Research Initiatives

Work involving strategic research orientations (SROs) on five long-term themes has been taking place within the 4TU.AMI programme. These themes are Big Data, Energy, Health, Resilience and Water. However, most of the SROs no longer had any specific objectives: the research network had acquired a sound basis for collaboration with excellent contacts between the universities in question. Discussions with the SRO coordinators revealed changing needs – smaller-scale initiatives that occur bottom-up, with a specific short-term objective. It was therefore decided, in consultation with the SRO coordinators, to change the SRO concept to SRIs: Strategic Research Initiatives. SRIs offer a platform for focused initiatives in a particular field of research and are ideal ways of giving young researchers the opportunity to build up inter-university networks.

Educational projects

During discussions with directors of studies and with coordinators of service teaching of mathematics, it became clear that there is scope for greater depth of the research into mathematics teaching. The Research on Education in Mathematical Sciences taskforce was set up for this purpose. With representatives from each of the four universities, this group will identify in 2021 what is needed to meet this need.

The Blended Learning teaching project was concluded in 2020. As part of the project, research was conducted into how blended learning can be applied to the teaching of mathematics. Work was also carried out on online teaching materials, online testing, and the development of ICT tools for teaching mathematics. In this 'COVID-19 year', the importance of a clear understanding of blended learning for the application of new teaching methods was reaffirmed. During conversations with relevant parties, 4TU.AMI detected in particular a strong need for practical advice, especially in service teaching. The mutual sharing of best practices and videos about basic terms would be particularly useful. This forms the basis for a new teaching project, the details of which will be worked out in 2021.

Built Environment

Scientific director	Maarten Hornikx (TU/e)
Coordinator	Maaike Riemersma (TU/e)
Management team	Frank van der Hoeven (TU Delft), Erik Schlangen (TU Delft) André Dorée (UT), Sanda Lenzholzer (WUR)

From 2018-2021, the activities of 4TU.Built Environment (4TU.BE) were aimed at alignment with the National Construction Agenda, at making theme-based choices in relation to government ambitions (with a view to funding), and at looking for options in addition to regular research programmes such as those of the Dutch Research Council. In 2020, a great deal of time was spent on developing close ties to the <u>Building and Technology Innovation Centre</u> (BTIC). The BTIC's objective is to set the innovation agenda for construction and to provide a platform and act as a driving force for creating research agendas, as well as to respond to calls. At the heart of the BTIC is the management team, consisting of a member representing TNO, one representing the building federations, and one (Henk Visscher) representing 4TU.BE. 4TU.BE also has a delegate in the BTIC working group (Maarten Hornikx, TU/e) and on the BTIC Council (Jan Dirk Jansen, TU Delft). In addition, the 4TU.BE coordinates the delegations of its faculties on the <u>BTIC writing teams</u> for the – now five – knowledge and innovation programmes.

Social and Economic Council of the Netherlands (SER)

When it comes to innovation themes in the built environment (such as the energy transition), it is important to ensure sound connections between senior secondary vocational education (MBO), higher professional education (HBO) and universities. These connections cover degree programmes, practical contexts and research. The intention is to set up field labs where these connections can be created in the degree programmes at the institutions in question. The involvement of government ministries is important in this regard. The Social and Economic Council (SER) has a Labour Market and Education core team that is concerned with this area; its number includes 4TU.BE delegate André Dorée (UT).

Joint calls are pursued via the BTIC. This has resulted in, among other things, various awards from the <u>Mission-Driven Research, Development and Innovation scheme</u>, in which employees of the faculties involved with 4TU.BE work together. It is through the BTIC, in which knowledge institutions (HBO, TNO), industry, and ministries are represented, that 4TU.BE achieves greater prominence. Agenda for 2021

> "I see 4TU.Bouw as the watchdog for R&D and technological innovations. They require structural investment in order to safeguard the future of our sector"

> > Maarten Hornikx – director of research, 4TU.Bouw

The autumn saw the start in the centre of an exploratory search for the approach post-2021. It has been decided, for example, that participation in the SER Labour Market and Education core team will continue, as will involvement with the BTIC. The preparatory phase will be completed there and a search made for a suitable construction for the design, building, and technology sector, obviously in collaboration with other knowledge institutions, building federations and ministries.

4TU.BE performs a coordinating role in the increasingly urgent social themes of the energy transition, construction, circularity, digitalisation, infrastructure and area development, and climate adaptation. Connections will be made between new knowledge and technology at the universities and various links in the research, development, and teaching innovation chain. In 2021, 4TU.BE will be setting up 'development teams'. These are communities based around the above themes that 4TU.BE will be actively supporting, and which will offer a platform for conveying a joint long-term vision. The extent to which PDEng degree programmes can increase the appeal to those in industry of taking part in research and innovation will also be examined.

7 Design United

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

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

The activities of the research centre have the following objectives: 'to connect, to communicate, to coordinate and to create'. DU enhances its strength through its role in national discussions as a platform/point of entry for design research, in order to put design as a discipline on the map, and by helping set the agenda in the Creative Industry top sector.

Strategic contributions

In 2020, DU researchers actively contributed towards the development of visions and strategies for the Dutch creative sector. They did so via *CLICKNL* (the top consortium for knowledge and innovation of the Creative Industry top sector), but also by making a start, with the help of deans, in creating an overview of the Design Engineering sector. The sector plan will be presented in 2021.

DRIVE in hybrid form

Together with CLICKNL, DU organised the annual Design Research and Innovation Festival (DRIVE) during the Dutch Design Week in Eindhoven, this time in a hybrid form. Members of the public and speakers took part - live and online - in <u>inspiring sessions</u> that dealt with five socially relevant themes: Mobility, Circular and Biobased Building, Water, Health and Safety. For each theme, DU researchers carried out <u>exploratory research projects</u> for five *World Design Embassies*.

The annual exhibition during the Dutch Design Week (DDW) was replaced in 2020 by the online `Up Close & Personal' event. There was a daily livestream talk show with varying current design research themes. The talk shows were held on social media, the DDW TV channel, and the DU website, and were supported by an <u>e-Magazine</u>. The five themes - Hybrids, Eco-Logica, Living Matter(s), Silent Power, and Crisis! - put 33 of the most thought-provoking yet accessible research projects at the four universities of technology in the spotlight. The columns by 4TU experts and the critical perspectives of the external guests also prompted much reflection and in-depth analysis. The event not only reached a wide design audience, it also made clear that the contributions by the 4TU design researchers reach beyond the boundaries of the faculties and that it is in fact their teamwork and complementarity that demonstrate the unique impact of the design sciences on the challenges facing society.

Design perspectives

In 2020, the contours were laid for a new DU event that is due to take place in 2021 for the first time: 'Design Perspectives'. It will bring different disciplines, researchers, students, and professionals together in theme-based meetings to find the best ways of generating impact through 4TU research into solutions to complex societal challenges.

The purpose, for DU, is to help create a future-oriented sector perspective for the design engineering sciences and to focus on strengthening the discipline in 4TU and in the Netherlands. A strong discipline is needed to be able to create a robust link with the other 4TU disciplines and to show what the integrating role of the design engineering discipline can mean for 4TU and how it can be realised in concrete joint research projects.



Scientific director	Paulien Herder (TU Delft) until June, thereafter David Smeulders (TU/e)
Managing director	Yvonne Schavemaker (TU Delft) until June, vacant thereafter
Management team	Gerrit Brem (UT), Harry Bitter (WU), Kornelis Blok (TU Delft)

To facilitate and accelerate the energy transition, the four universities of technology are combining their forces in 4TU.Energy. The mission is to bring researchers and students from the four universities closer together and thus strengthen ties in teaching and research. This way, the people required for the transition can be trained together and essential scientific knowledge and new technologies can be developed in order to facilitate progress towards a sustainable, CO2-neutral – or, preferably, a CO2-negative – energy system in the coming decades.

NWO Crossover

The NWO Crossover project entitled 'New Energy and Mobility Outlook for the Netherlands' is the joint creation of the 4TU.Energy partners. The proposal was accepted in the same tranche as the 'Reversible Large-Scale Energy Storage' project. The €8.5 million project deals with more than just technology and economic profits. It is run along multidisciplinary lines, with a strong focus on the role of institutions, knowledge networks and human actors such as consumers and businesses. The researchers are looking to develop new methods and techniques for this purpose and thereby help bring about the necessary shift in our energy supplies and mobility.

"Each solution in the field of energy has consequences that we all need to discuss with each other. The strength of 4TU lies in identifying the advantages and disadvantages of every option." David Smeulders – director of research, 4TU.Energy interview with 4TU

Long-Term Mission-Driven Innovation Programme

As part of the mission of the top-sector Energy's Long-Term Mission-Driven Innovation Programme's 'Sustainable heat and cooling in the built environment', 4TU researchers are taking part in the 'WarmingUP' programme, which is being coordinated by TNO. This €9.3 million programme deals with heat networks, thermal energy, geothermal energy, underground high-temperature heat storage, and the suitability of their integration in society. In the WarmingUp collective, 38 participants and 17 partners from the whole of the heat chain are working on the development of sustainable and collective heating systems. The starting point is that they should be affordable, reliable, feasible, and socially acceptable. System and process innovations are needed for a more efficient design, construction and control, and a good working relationship between the parties. WarmingUP seeks to develop these innovations on an integral basis and at a more rapid pace than previously.

Visibility

4TU.Energy is also contributing to the visibility of scientific work on the energy transition in society. Two short videos have therefore been produced giving an accessible account of the joint contribution being made by the universities of technology towards the energy transition. They can also be used to highlight particular studies and aspects of infrastructure. <u>'Towards a digital twin of our power grid'</u> and <u>'Wind energy challenges''</u> are now online; there are also plans for follow-up themes.

Together, with 4TU.Impact, Energy is supporting the teams of students wishing to sign up for the 'Xprize Gigaton Scale Carbon Removal'. In this worldwide competition, funded by the Musk Foundation, teams will have to demonstrate a validated scale model of their solution for removing CO2 and be able to show that the scaling up of their model to gigaton level can be achieved in a way that is economically viable.

Agenda for 2021

- Graduate school system integration
- Sponsorship events
- 4TU.Ethics and Technology 4TU.Energy 4TU.High-Tech Materials joint workshop
- Collaboration with 4TU.AMI

Ethics and Technology

Scientific director	Anthonie Meijers (TU/e)
Managing director	Tijn Borghuis (TU/e)
Assistant director	Karen Buchanan (TU/e)
Management Team	Philip Brey (UT), Patrick Smith (UT), Vincent Müller (TU/e)
	Sabine Roeser (TU Delft), Filippo Santoni de Sio (TU Delft)
	Marcel Verweij (WUR), Zoë Robaey (WUR)

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

At the end of 2020, 4TU.Ethics had a total of 14 professors, 26 senior researchers, 23 postdocs and junior researchers, and 53 doctoral candidates, as well as 80 affiliated members, which represents an increase of 36 members.

New researchers

The Centre has been able to implement the Strategy for 2018-2021, subject to a few modifications necessitated by the pandemic.

Because of the launch of the ten-year NWO 'Ethics of Socially Disruptive Technologies' Gravitation programme, submitted by 4TU.Ethics in collaboration with the Ethics Institute of Utrecht University, there was a fresh intake of new researchers in 2020. They have been included in the activities of the centre and the doctoral candidates - plus those from Utrecht University - are taking part in the 4TU.Ethics Graduate Course programme.

The 4TU.Ethics Annual Research Day was held online on 4 November. Among the items on the programme were a panel on synthetic biology and biotechnology and a keynote speech by Pak-Hang Wong (University of Hamburg) entitled 'Artificial Intelligence, Personal Decisions, Consent, and the Confucian Idea of Oneness'.

COVID-19 crisis working group

The outbreak of COVID-19 created a wide range of ethical, social, and political challenges relating to the research work of the 4TU.Ethics community. They include value conflicts, data and privacy issues, online welfare, civic responsibility, transfer of knowledge and risk reduction. To coordinate a response to these aspects, 4TU.Ethics and the Delft Design for Values Institute set up the Working Group on COVID-19 Crisis (WGCV-19). The working group focuses on the ethical challenges raised by pandemics and emergency measures, and how they can be addressed by emerging technologies. As well as pooling and encouraging research in this area, they are keen to share the knowledge they acquire with policymakers, epidemiologists, medical professionals and the public at large, doing so through a series of podcasts⁵.

Well-being of doctoral candidates

In response to the results of national surveys into the well-being of doctoral candidates⁶ and the effect of the pandemic on their working and living conditions, a programme has been launched for improving their well-being in 4TU.Ethics. In a series of systematic dialogues with doctoral candidates, supervisors and the management team, the most important factors in relation to well-being have been identified, with a particular focus on which of these factors can be positively influenced within the community. The strengthened PhD Council has devised new online activities for this purpose.

Teaching

In the 'Ethics Education for Engineers' project (led by Lavinia Marin, TU Delft), case-based exercises for ethics in engineering teaching are being collected and published as openly accessible teaching material. The first collection was published on the 4TU.Ethics community page on the SURF <u>edusources platform</u>. Work on the development of a MOOC has recently been carried out for engineers in the Royal Institute of Engineers in the Netherlands (KIVI), for those seeking to become a KIVI chartered engineer. The

⁵ For an overview of their activities, go to <u>https://www.delftdesignforvalues.nl/covid-19/</u>

⁶ RuG 2019, Promovendi Netwerk Nederland 2020

course is being offered via Coursera and has an open-access section that attracts thousands of students every year, with the number peaking at 7487 during this pandemic year. A project has also been launched to develop a module on ethics and technology for secondary school pupils. The project will be completed in 2021.

Funds

In 2020, members of 4TU. Ethics acquired funds for 16 new projects:

NWO	K€ 772
EU/ERC	K€ 303
EU/H2020	K€1408
Other	K€ 862
Total	K€3346

Agenda for 2021

Thanks to new projects and the further implementation of the NWO Gravitation Programme, research activities will be expanded and the 4TU.Ethics community will continue to grow.

In October, the biennial 4TU.Ethics conference will be held in Wageningen (both physically and online), the theme being 'It's alive' - concerning the increasingly indistinctive boundary between technological artefacts and living creatures. The conference will be dedicated to the conceptual, ethical and political issues relating to the way in which humanity is able to manipulate living systems and nature and how technologies are changing humanity.

The 4TU.Ethics Graduate Course programme will go ahead, physically if possible. New elements will be added to the programme, as part of the well-being initiative. The PhD Council will continue the linking activities it developed last year and help with organising the annual PhD Day.

In the Ethics Education for Engineers project, the collection of case-based exercises will be completed, tested, and finally published via the edusources platform. Teaching materials on philosophy and the ethics of technology will be devised for secondary schools, in the context of the new 'online literacy' element of the curriculum.

10 High-Tech Materials

Scientific director	Jilt Sietsma
Coordinator	Reina Boerrigter
Management team	Bernard Dam (TU Delft), Rint Sijbesma, Marc Geers (TU/e)
Management team	Remko Akkerman, Gertjan Koster (UT), Karin Schroën, Joris Sprakel (WU)

The primary objective of the 4TU.High-Tech Materials Research Centre (4TU.HTM) is to stimulate and take a fresh approach to outstanding materials science research at the four universities of technology through collaboration and new initiatives relating to both research and teaching. The researchers involved represent many aspects of materials science, ranging from fundamental to applied research and from nanotechnology to constructions. Since 2015, 4TU.HTM has been able to bring together materials research in the Netherlands in this way. The priorities for the years 2019-2021 are teaching, the materials infrastructure and the relationship with industry, e.g. via a strategic partnership with the Materials Innovation Institute (M2i).

Working partnerships

4TU.HTM continued to create links in 2020 between the approximately 150 principal investigators who are involved. By encouraging joint activities at the four universities of technology and by helping formulate policies, 4TU.HTM has fostered new working partnerships.

For example, a consortium led by Sissi de Beer (UT) consisting of colleagues from Twente, Wageningen, Eindhoven, and Delft, started the <u>Recovery and Circularity of Valuable Resources</u> (ReCoVR) project. A financial contribution from 4TU.HTM in 2020 made possible proof-of-concept experiments for the project proposal in the laboratories at Twente and Wageningen. The proposal was ultimately accepted as an NWO/TTW Perspective Programme.

A few of the partnerships that were supported by 4TU.HTM in 2020, such as those involving research into smart materials and coatings, and mechanical metamaterials, will be continued in 2021. They have not yet run to completion because of the coronavirus restrictions.

Elsewhere, 4TU.HTM held an online Surfaces, Interfaces and Coatings workshop for academic and industrial scientists. The annual Meeting Materials conference was organised in conjunction with M2i and featured a specific Materials for Energy 4TU.HTM session.

In the *MaterialenNL Platform*, a national initiative of the Chemistry, High Tech Systems and Materials, and Energy top sectors, the aim of which is to promote research into materials, the 4TU.HTM director of research, as a member of the sounding board group, co-wrote the recently published *National Materials Agenda*. In 2021, 4TU.HTM will help organise the national materials conference.

"Materials now are where energy and oil were 40 years ago - we see the challenges and are we are slowly starting to move in new directions."

Jilt Sietsma – director of research, 4TU.HTM. in 'Stretching the boundaries of materials'

Visibility

The 4TU.HTM 'New Horizons in Designer Materials' research programme that finished in 2019 has been summarised in a book, entitled '*Stretching the boundaries of materials*'.

Activities and news items relating to materials science at the four universities of technology are announced on the 4TU.HTM website and on <u>LinkedIn</u> and Twitter. The work of Danqing Liu (TU/e), one of the researchers on the 4TU.HTM research programme, received considerable attention in 2020, on <u>BNR Nieuwsradio</u>, for example. Meanwhile, <u>the series of articles on the 4TU.HTM research programme</u> in the bilingual Innovative Materials publication was completed. 4TU.HTM <u>also published an interview</u> with a talented materials researcher, on collaboration, diversity, and her research at WUR.

Materials infrastructure

The availability, accessibility and quality of research equipment is essential for materials science research, for which 4TU.HTM is seeking a joint approach. To that end, the centre has developed web applications with an overview of <u>the materials science infrastructure</u> at the four universities of technology and of <u>expertise of materials scientists</u>.

Teaching

activities

During the reporting year, an overview aimed at doctoral candidates was made of the post-graduate courses on offer in materials science. It will be available online in 2021. Where necessary, 4TU.HTM will encourage lecturers and provide organisational support for setting up new courses and making them accessible. Since 2020, 4TU.HTM has been in discussions with the publisher of Innovative Materials about the development of a materials showcase for teaching and presentation purposes, in collaboration with materials scientists from the TU Delft Faculty of Industrial Design Engineering. Several scheduled teaching activities, such as courses for doctoral candidates, were postponed until 2021.

Looking ahead to the coming years

During the next few years, the development of technology will be governed more strongly by sustainability criteria. This will make materials and materials science more important, because the sustainable production, use, and recycling of materials are at the heart of every technological design. Many of the current activities at the centre will be continued, but given the emphasis on sustainability, collaborative partnerships will be sought with 4TU.Research Centres like 4TU.Energy, 4TU.Ethics and Technology, and 4TU.Resilience Engineering.

11 Humans & Technology

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

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

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

Activities

Although some scheduled activities were unable to take place, a number of conferences were held online instead. A large number of the H&T members were actively involved with the organisation of the ACM International Conference on Multimodal Interaction (ICMI2020), from 25 to 29 October. They sat on the General, Virtual, Local, and Doctoral Consortium chairs. As well as organising the conference, H&T was also responsible for the Insights on Group and Team Dynamics workshop. More than 400 people took part in ICMI2020 - twice as many as would have been able to attend the originally scheduled physical event.

The global pandemic has underlined the importance of several existing H&T research fields, such as that of mediated touch. No longer being able to hug family members and friends has certainly made clear the importance of touch. An online or 'mediated' touch could be a solution in circumstances where skin-to-skin contact is not possible. The research project attracted a great deal of attention in the media during the first lockdown in 2020. It was discussed in <u>De Kennis van Nu</u> (NPO1), 'Knuffelen in de anderhalvemetersamenleving' (Hugging in times of social distancing), Focus (Radio1), Eén Vandaag (NPO1), on EO Radio, and elsewhere. The coronavirus-related <u>We\Visit project</u> also enjoyed extensive media coverage. The project worked full steam ahead on a tool to make it easier to plan video calling in intensive care departments, and thereby ease the problems of loneliness.

Agenda for 2021

Ethics, artificial intelligence, and mental health continue to be important themes. Various small-scale events are planned involving inspiring speakers on subjects of interest, such as values in AI, social AI, trust and calibration.

The year 2021 will also see four PhD candidates in the network gain their PhDs. For each of their defences, a small symposium will be organised. The year will be concluded with a PhD winter school in the first week of November, around the theme of human centred AI. It is hoped that the deferred symposium, with academics, businesses and social organisations, will be able to take place then as well.

12 Netherlands Institute on Research on ICT

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

The 4TU.NIRICT research centre concentrates on bringing together, positioning and prioritising all aspects of ICT research. ICT is a very broad field, in which 4TU.NIRICT focuses on the interface between electrical engineering and computer science. This is why NIRICT encourages and facilitates interaction and collaboration in these areas, as well as in other disciplines. NIRICT aims to unite the ICT community and recognises and values the role of young scientists in the institutions.

2020 brought many challenges, as well as fresh opportunities. During the year, management considered the options for the future. The result is a new vision and mission, together with a number of exciting ambitions for the years ahead.

Vision and mission

Vision: Creating collaboration in the 4TU ICT community by bringing ICT research disciplines together, thereby ensuring that Dutch society and industry can thrive.

The mission of NIRICT is to tackle ICT challenges in the context of a connected world. 4TU.NIRICT helps promote ICT in engineering and technological development, better work methods in these areas, and innovation in the teaching of ICT. We achieve this by bringing together relevant stakeholders such as ICT researchers, teachers, and people from the professional field for activities aimed at community building.

Connecting electrical engineering and computer science

ICT is a very broad field, in which 4TU.NIRICT focuses on the interface between electrical engineering and computer science. In order to exploit the full potential of ICT for society and the business sector, it is important to bring ICT researchers from the fields of electrical engineering and computer science together and to strengthen the community. NIRICT has been doing this since 2018 - through the call for community funding, for example. In 2020, the right balance between electrical engineering and computer science as a requirement for funding was added, in addition to working partnerships between multiple universities. Four projects were approved in the reporting year. They focus on intelligent long-range Wi-Fi, hardware acceleration, self-sustainable computing, and multi-paradigm modelling and management of software-intensive systems.

> "The new generation of ICT specialists is more diverse in every respect. They are more international, some are returning to university from industry, and they are also trying to make their mark outside the traditional scientific paths."

> > Cynthia Liem - chair, ICTng in interview with 4TU

Helping the next generation

As in previous years, helping the next generation was high on NIRICT's list of priorities. They are the future and it is important to be aware of their wishes, their needs, and their fears, and what obstacles they are likely to come up against. To that end, a survey was sent out in the summer of 2020, in collaboration with *ICTng* (a NIRICT initiative), on the subject of perceptions of academic leadership among the Dutch academic ICT community. A total of 121 people completed the survey, which produced valuable information for NIRICT about universal problems, challenges and wishes. The annual NIRICT Community Day (an online version this year) was also mainly about the next generation and the results of the survey. The participants were divided into theme-based groups and some very useful discussions took place.

DEI fund

NIRICT aims to create a united ICT community that can help tackle the social challenges facing Dutch society. That is why, in June, NIRICT opened the *DEI fund* (diversity, equity, inclusion), aimed at creating these values in the community. 4TU.NIRICT uses the DEI fund to support projects that promote a culture and environment in which all members of the 4TU.NIRICT community can take part and develop their talents to the full. Three projects were approved in 2020. The first is aimed at best practices in the area of gender and nationality composition of student teams. The second project involves supporting participation of researchers from under-represented groups in the Lorentz 'Beyond the Mobile-Cloud Computing Paradigm' workshop. The third emphasises the inspiring work of women in computer science.

Agenda for 2021

NIRICT is currently working on an ambitious plan to give a boost to the new generation of ICT researchers as well as to ICT research itself. It is therefore seeking to use 2021 primarily for raising the profile of its new vision, mission, plans and ambitions. The call for community and DEI funding will continue, as will the ICT.OPEN partnership. The results of the survey of the new generation of ICT scientists will be used to improve their professional well-being. To increase their mutual awareness, a member of ICTng will be joining the NIRICT board.

13 4TU.ResearchData

TU Delft	Marta Teperek (Director)
	Madeleine de Smaele (Repository Manager), Paula Martinez Lavanchy (Research Data
	Officer), Egbert Gramsbergen (Data Engineer), Arie Braat (Data Engineer), Ardi
	Nonhebel (ICT Specialist), Jan van der Heul (Data Librarian), Eric Rumondor (Data
	Librarian), Connie Clare (Community Manager), Eirini Zormpa (Trainer on RDM & Open
	Science), Deirdre Casella (Communications Advisor)
	Merle Rodenburg (Director TU/e Library), Iza Witkowska-de Koeijer (Team Lead
TU/e	Research Data Management), Sjef Öllers (Specialist Scientific Information),
	Sil van Lieshout (Data Steward)
UT	Marjolein Drenthe (Director, UT Library), Maarten van Bentum (Data Librarian)

Originally a data collection of hydrological measurements, 4TU.ResearchData has evolved into the largest data archive of its kind in the Netherlands. 4TU.ResearchData was established in 2010 as an initiative of three universities of technology (Delft, Eindhoven and Twente). Its mission is to guarantee accessibility of science and technology research data during and after completion of research, thus spurring on the quality of the research.

Renewal

For 4TU.ResearchData, 2020 was a year of change, renewal and growth. The heart of its range of services - the <u>data repository</u> - was updated. 4TU.ResearchData celebrated its tenth anniversary and the <u>4TU.ResearchData Community</u> was launched. These milestones provided the opportunity to freshen up the brand identity and the website. The driving force behind these activities is the aim to further increase the number of researchers using the repository. This aim is shared by the data stewards and other staff at the universities, who support researchers on their way to FAIR data.

In June 2020, there was a change to the composition of the management of 4TU.ResearchData, with the departure of Alastair Dunning and the appointment of Marta Teperek.



Increase in number of datasets

The year 2020 showed an increase in the number of datasets published by the four universities of technology. There was also a considerable rise in the number of datasets published by other institutions.

The forecasts for 2021 are based on the first two months of the year.

4TU.ResearchData Community

The <u>4TU.ResearchData Community</u> was founded in 2020, and is led by a community manager. The community links data stewards and researchers from the four universities of technology and elsewhere. The initial steps involved the creation of an <u>online platform</u> as an interactive room for networking and for building the community. Three discipline-specific working groups have been set up to promote FAIR data practices, to learn about the evolving range of services available, and to establish contacts between data stewards and researchers.

The Monthly Round-Up newsletter provides the latest news, opportunities and events involving 4TU.ResearchData, partner institutes and the wider FAIR data community. The newsletter now has almost 100 subscribers.

"I believe in the capital of the data behind the research. There is much more than the publication of that one article."

Marta Teperek – director, 4TU.ResearchData in an interview with 4TU

Training courses

Despite the challenge of having interactive and practice-based workshops online, three Software Carpentry workshops were held at TU Delft in 2020, plus one at TU/e, with a total of 97 participants. The waiting list grew to almost 100 researchers by the end of 2020, all of whom were keen to learn more about the basic skills needed to work reproductively with code.

The partnership with SURF and DANS in the <u>Research Data Netherlands</u> alliance (RDNL) continued, with a well-attended *Dutch Data Prize 2020*, training courses, <u>'Essentials 4 Data Support</u>, and the <u>'Delivering</u> <u>Research Data Management Services''</u> MOOC, which was given in collaboration with the Digital Curation Centre and the University of Edinburgh.

Looking ahead to the coming years

In 2021, the focus will be on strengthening the partnerships with the universities of technology and on expanding membership. There will also be various technical improvements, such as the integration of software and tools for data management in the repository of 4TU.ResearchData. These new functions will make data management easier for researchers. Efforts will also be made at further expansion of the community, with the aim of gaining a greater understanding of the discipline-specific needs of researchers and to keep up to date with evolving FAIR data practices. Finally, a campaign will be run to ensure that the number of datasets deposited with the universities of technology continue to rise.

14 Centre for Engineering Education

Director	Perry den Brok (WU)
TU Delft	Marcus Specht (leader), Remon Rooij (leader), Renate Klaassen (coordinator)
TU/e	Antoine van den Beemt (temporary leader), Alexander Schuler-Meyer (temporary leader), Caroline Vonk (coordinator)
UT	Jan van der Veen (leader), Ineke ten Dam (temporary coordinator)
WU	Emiel van Puffelen (leader), Nicolette Tauecchio (coordinator)
Advisory	Kristina Edström (KTH Stockholm, chair), Marc de Vries (TU Delft),
Board	Ines Lopez (TU/e), Nieck Benes (UT),
	Erik Heijmans (WU), Ellen Siebers (Student UT)

The 4TU.Centre for Engineering Education (CEE) encourages innovations and research in engineering education. It does this by linking innovation in teaching to research, strategy development, and international cooperation. For each activity, the centre seeks to bring together lecturers and researchers from each participating university. The spectrum of projects and activities runs from a range of short innovation projects to doctoral programmes of longer duration. Connecting to international experts and relevant literature is part and parcel of the CEE approach. The centre regularly presents its results at conferences, during workshops and its own events, and in academic and other journals.

During the <u>2018-2021 strategic period</u>, CEE has been focusing on (1) teaching the engineers of the future, (2) interdisciplinary engineering teaching, (3) the creation of education ecosystems for modern engineering teaching, and (4) excellent professors in engineering teaching.

Departure

In 2020 CEE said goodbye to Aldert Kamp, who was involved at its founding and who played a leading international role in the CDIO, and who for a long time acted as a local leader in Delft. In Eindhoven, Birgit Pepin stepped down as the leader of CEE. Those leaving the advisory council were Lex Lemmens (TU/e), Rikus Eising (UT), and Christiaan Meijer (TU Delft student member).

Visibility

The impact of the CEE continued to grow during the reporting year. The <u>CEE innovation map</u> was updated and the number of innovations/projects about which information is available rose to 237. In these coronavirus times, the pages on projects that deal with online teaching were very popular; projects on <u>challenge-based learning</u> also generated much interest. With over 38,000 hits, the CEE's websites received almost twice as many visitors as it had in 2019, with the number of unique visitors doubling too. The CEE also published six newsletters, each for more than 3,000 subscribers, and reported on activities via a <u>blog</u> and on <u>LinkedIn</u>.

> "We do ask engineers to constantly innovate their profession, because society demands it. Then why not ask the same from the teaching staff? We do have to support them properly, though."

> > Perry den Brok – director, 4TU.CEE in <u>4TU Tech Talk</u>

European conference

A major milestone in 2020 was the organisation of the <u>SEFI conference (European Society for Engineering</u> <u>Education</u>) at UT, with considerable help in the organisation and substantial contributions from CEE. The conference was held online because of the coronavirus restrictions. 365 participants, 60 contributions from 4TU colleagues about CEE projects and other topics, and four keynote speeches about climate change, professional roles for engineers, appreciating education, and augmented reality.

Publications

Various publications appeared in 2020 based on the work of the CEE. Aldert Kamp wrote a book about modern engineering teaching, entitled <u>'Navigating the landscape of higher engineering education'</u> and a <u>dissertation</u> (Vaessen, TU/e) was published about perceptions among students on tests and examinations

in higher engineering education. There were 47 publications on the conferences of the SEFI and CDIO international networks, as well as some ten other publications. CEE director Perry den Brok delivered the keynote speech at the ICAB conference, about innovation in teaching during the era of coronavirus. Both <u>WUR</u> and <u>TU Delft</u> created useful overviews of their projects and the results they yielded.

Highlights at the four universities of technology

Some interesting projects and activities were also held at the various universities. Below are some highlights for each university, which make up just a selection of the overall range of the CEE activities.

Publications appeared at WUR, and there were results from projects about <u>intercultural education</u>, <u>boundary crossing</u>, <u>blended learning</u> and <u>teaching large groups</u>. Projects on the learning pathways, challenge-based learning, and entrepreneurial learning made good progress this year at WUR. Presentations about projects were given at the SEFI and CDIO conferences, as well as at the annual WUR Teachers' Day.

At TU/e, CEE organised several <u>workshops</u> for and by teachers for the purpose of sharing knowledge about innovations in education resulting from projects funded by 4TU.CEE. These workshops - initially physical, later online - were even busier than in previous years, with dozens more people in attendance. The workshops also received positive reviews. TU/e received a Comenius Leadership grant for research and innovation into challenge-based learning. The CEE also played an important role in obtaining a grant from the Dutch Research Council for carrying out practical research into higher education; the project is aimed at <u>learning from teachers in the context of innovations</u> and is being led by Jan Vermunt (TU/e) and Perry den Brok (WUR).

In Delft, Aldert Kamp gave a <u>keynote speech</u>, under the auspices of the CEE, at the virtual conference of the American Society of Engineering Education. TU Delft was also involved with the development and implementation of the 15 ECTS <u>Joint Interdisciplinary Project</u>, in which dozens of student teams consisting of members from a range of disciplines worked *for* and *with* stakeholders from the field. The project has successfully evolved, and has now been transformed from the 'experimental' stage into an integral part of the range of TU Delft Master's subjects in the first quarter of the second Master's year.

New research projects have got underway at UT, into interdisciplinary project work (Xin Ming), for example, and model-based reasoning (Kishore Sivakumar). Together with TU/e, Twente is part of an international research project by Ruth Graham, in response to the transition to online learning. In 2021, UT will be launching a Teaching and Learning Fellows pilot. The learning assistant training course, which was introduced at UT in 2020 following a CEE pilot in 2020, is in line with this greater appreciation of education.

Looking ahead to 2021

In 2021, 4TU.CEE will make a new strategic plan for the years 2022-2025. The main themes of the plan will be: (1) the entrepreneurial engineer/academic entrepreneurship in engineering teaching, (2) the ethical and responsible engineer/ethics and sustainability in engineering teaching, (3) challenge-based learning, (4) teaching excellence in engineering teaching, and (5) the role of information technology in engineering teaching/the information-driven engineer.

4TU.CEE will be organising a five-part series of webinars during the first six months of 2021. During the webinars, each of the universities of technology will explain several cases in relation to challenge-based learning in action. The series will be concluded with an international webinar on the subject later in the year.

15 Centre for Resilience Engineering

Scientific director	David Smeulders (TU/e) until 1 Sep, thereafter Tina Comes (TU Delft)
Managing director	Marjolein Dohmen-Janssen (UT)
Management team	Bas Jonkman (TU Delft), Geert Jan van Houtum (TU/e), Tatiana Filatova (UT), Miranda Meuwissen (WUR)

The 4TU.Centre for Resilience Engineering (4TU.RE) is the knowledge centre that develops, applies and disseminates knowledge, methods, and techniques in order to make societies more resilient. 4TU.RE focuses on technical solutions and system designs in interaction with social-ecological systems.

Tina Comes, who has been actively involved from the start, was appointed director of research in September 2020.

She succeeded David Smeulders, who became director of research at 4TU.Energy.

Visibility

The website has been completely revamped this year, while an open resources section on resilience at 4TU has been added that can be used for reference. The resources section was expanded during the course of the year with teaching and research material, and the range of information continues to grow. 4TU.RE is active on Twitter and LinkedIn and every three months issues a newsletter which is read by more than 1,200 people. To ensure that results are published as widely as possible, the centre publishes in media outlets like <u>AD</u>, <u>Signaal</u>, and Process and contributes to events such as the Week of Resilience (Dies Natalis, TU Delft).

Growing community

During the year, the knowledge centre community was joined by new and talented scientists at the four universities of technology, bringing the total number of affiliated scientists to 15. As part of the community, they are working with DeSIRE⁷ tenure track candidates and post-doctoral researchers, and they are also involved with the other activities.

Fellowships awarded

During the past years, various grants were awarded for the projects of senior employees at the centre (DeSIRE tenure track candidates' projects are mentioned there), including no fewer than two *Vidis*: Tatiana Filatova for 'Een sociaal kantelpunt: klimaatbestendige toekomst door transformationele aanpassing' (A social tipping point: climate-proof future through transformational adjustment) and Neelke Doorn for 'Verantwoordelijkheid voor veerkracht bij klimaatadaptatie' (Responsibility for climate adaptation resilience).

The Netherlands Organisation for Health Research and Development (ZonMw) supports the *Smart dashboard for regional COVID-19 outbreaks* (Nelly Litvak), while at *EUH2020, Health Emergency Response in interconnected Systems* (HERoS) received an award (Tina Comes and Harith Alani). The Dutch Research Council awarded a grant to the 'Grenzen verleggen bij Grensmaas' (Pushing boundaries on the Grensmaas) living lab (Andries Richter and Tatiana Filatova).

RE Academy

Work continued in 2020 on the development of 4TU.RE's ambitious open educational resources (OER) for urban resilience, co-financed by SURF. This is a new tool for publishing and sharing education results, and as such it helps build a strong community of Resilience researchers and teachers. It is serving as a pilot for TU Delft Library Services for developing new OER services; the opportunities for teaching professionals are also being examined.

⁷ An important programme that the centre is working on is called Designing Systems for Informed Resilience Engineering (DeSIRE), from the 4TU call for proposals for High Tech for a Sustainable Future.

Joint International Conference on Resilience (JIRC 2020)

The JIRC2020 was organised this year in partnership with the Future Resilient Systems programme of the Singapore ETH Centre. Because of the pandemic, it was held entirely online and was free of charge. It featured four international keynote speeches (by John Andrews, Nottingham University; Garry Peterson, Stockholm Resilience Centre; Niki Frantzeskaki, Swinburne University of Technology and Arno Bonte, deputy mayor of Rotterdam), 20 parallel sessions and workshops, and plenty of online interaction and discussions. More than 800 (!) participants from Asia, Australia, Europe, Africa and America shared their ideas for designing, measuring, modelling, and governing resilience. Because of this event, the resilience community has grown enormously, and new working partnerships are in the pipeline.

Matchmaking and collaboration

Two matchmaking events were organised for promoting collaboration with professional partners - one with the Utrecht Security Region (with the cities of Utrecht and Amersfoort, and Stichtse Rijnlanden Water Authority) and one with Rotterdam and The Hague. The purpose of these events was to learn of the challenges and knowledge-related questions in the field of resilience that professionals face in day-to-day practice. 4TU.RE also presented the research and teaching activities, and collaboration opportunities were explored too.

Looking ahead to 2021

DeSIRE tenure track candidates are encouraged to submit applications for personal grants or larger research projects with consortia (such as NWO Perspective), which are directed or co-directed by senior 4TU.RE scientists.

The <u>SURF educational platform</u> will be launched in 2021 during an opening event with more than 70 teachers and colleagues from the professional field; work will also continue on the SURF project with open and online educational sources for urban resilience in the RE.Academy.

Various network events are planned, both externally and with the internal community. Examples include an in-depth meeting about the collaboration programme with the Rotterdam and The Hague local authorities and the Amsterdam Institute for Advanced Metropolitan Solutions (AMS), and a matchmaking event with Royal Haskoning/DHV, the Institute for Safety, AMS, and others.

The next international Resilience conference is scheduled for November, together with the ETH-Singapore Centre's Future Resilient Systems programme, this year under the directorship of ETH.

The internal community will be meeting on various occasions, including for one and two-day strategy discussions.

16 Stan Ackermans Institute

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

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

The SAI uses its website, brochures, and social media posts to promote itself. To recruit potential trainees, the SAI also attends business days at the four universities of technology and elsewhere in the country and in Germany (Hannover Messe). In 2020, a brochure was published containing a selection of design assignments completed by trainees.

TU Delft has four active study programmes, Twente has five and TU/e ten, following the phasing out of the 11th variant in 2020. The intake in the programmes has declined slightly from 168 to 162, and the number of graduates has declined from 158 to 146. An overview of intake and graduation figures by programme and institution is provided by the table in this section.

The SAI board has issued a recommendation on the future of the degree programmes following a discussion between 4TU.Education and CCTO about the new programme at UT and the plans of the universities of applied sciences for a third cycle (working title 'professional doctorates'). The recommendation followed from of consultations with CCTO and the deans of the Graduate Schools of the four universities of technology.

In 2020, 4TU.Education approved the recommendation to continue the current structure and focus of the programmes for technological designers, in which emphasis is placed on the academic level of the programmes. Other universities wishing to start design study programmes may join the SAI, subject to certain conditions. The SAI board was asked to monitor the plans of the universities of applied sciences for a third cycle. The board will also coordinate the start of the new programmes with CCTO, which will concentrate on quality control. CCTO has agreed to this arrangement.

New regulations for the SAI were agreed in 2020 - they entered into force on 1 January 2021. Since that date, the board has been made up of the deans of the Graduate Schools of the four universities of technology, with the chair being the dean of the Eindhoven Graduate School, until agreed otherwise.

The 4500th PDEng diploma in the Netherlands was awarded in October to Hossain Muhammad Muctadir of the software technology programme at TU/e.

Overview of intake and degree certificates issued for design programmes 2015-2020

	2015		2016		2017		2018		2019		2020	
	D	Ι	D	Ι	D	Ι	D	Ι	D	Ι	D	Ι
Eindhoven University of Technology												
Process and Product Design (PPD)	22	24	19	28	23	28	30	21	26	22	19	22
Information and Communication Technology (ICT) ⁸	11	6	14	10	3	12	10	5	8	5	8	6
Logistics Management Systems (LMS) ⁹	12	4	7	10	4	0	8	0	1	0	0	0
Mathematics for Industry (MI)	15	6	14	0	5	0	0	0	0	0	0	0
Software Technology (ST)	20	17	15	20	16	17	20	18	15	19	16	17
Design and Technology of Instrumentation (DTI)	7	7	10	9	6	9	9	0	6	0	1	0
Architectural Design Management Systems (ADMS)	1	0	1	0	0	0	0	0	0	0	0	0
User-System Interaction (USI)	15	17	14	13	18	0	10	1	2	1	1	1
Automotive Systems Design (ASD)	12	14	11	15	14	14	14	14	13	15	13	16
Smart Energy Buildings & Cities (SEBC) ¹⁰	10	8	8	6	8	13	1	12	15	9	10	23
Clinical Informatics (CI)	9	13	11	13	10	13	12	13	10	14	12	14
Qualified Medical Engineer	3	1	6	7	0	5	6	7	5	4	7	7
Data Science (DS)		0		11		20	9	20	16	25	19	12
Total	137	117	130	142	107	131	129	111	117	114	106	118
TU Delft												
Process and Equipment Design (PED)	10	9	9	9	8	13	10	10	12	13	7	9
Bioprocess Engineering (BPE)	12	7	10	8	7	7	8	7	7	7	6	7
Comprehensive Design in Civil Engineering (CDCE)	0	0	1	0	0	0	0	0	0	0	0	0
Chemical Product Design (CPD)	1	7	6	7	7	6	9	8	6	8	6	6
Civil & Environmental Engineering							0	5	0	6	2	5
Total	23	23	26	24	22	26	27	30	25	34	21	27
Twente												
Energy and Process Technology (EPT)	2	4	3	11	4	6	9	12	6	10	7	5
Robotics	1	2	4	5	2	4	4	3	2	1	4	1
Civil Engineering (CE)	6	6	3	7	4	2	4	7	6	7	5	6
Healthcare Logistics	0	0	0	0	0	0	0	0	0	0	0	0
Maintenance	0	2	0	9	1	4	8	7	2	2	3	4
Business and IT (new)										0	0	1
Total	9	14	10	32	11	16	25	29	16	20	19	17
Total, 4TU	169	154	166	198	140	173	181	170	158	168	146	162

 ⁸ New name: Design of Electrical Engineering Systems
⁹ New name: Industrial Engineering
¹⁰ New name: Smart Buildings & Cities

17 High Tech for a Sustainable Future

With the award of a total of 22 million euros to five research programmes on the theme of High Tech for a Sustainable Future, the 4TU.Federation is giving a huge boost to research on sustainable technology. This enables the four universities of technology to take the lead in creating significant impact on challenges facing society in the long term. The four universities of technology have made this sum available in the context of the profiling budget intended for research that contributes to the Dutch National Research Agenda (NWA). The research proposals fit the focus areas of the government's Top Sector policy, the NWA and the UN's Sustainable Development Goals.

17.1 DeSIRE

Programme coordinator: Tatiana Filatova, UT

The purpose of the Designing Systems for Informed Resilience Engineering (DeSIRE) programme is to build up a flourishing resilience engineering community. In that capacity, DeSIRE serves as the initiating basic concept of the 4TU.Centre for Resilience Engineering. To develop solutions in complex sociotechnical environment systems, different fields and disciplines should be interconnected, both inside and outside the academic world. DeSIRE is funding 16 new tenure track candidates and 12 post-docs across 14 faculties with applications in the water, energy, cities, agriculture, and transport networks sectors.

Core activities

In 2020, the DeSIRE tenure track candidates have published extensively about various aspects of resilience (35 articles in journals, three book chapters, and 16 conference papers), and one tenure track candidate has joined the editorial board of the Journal of Infrastructure Systems. Sessions have been organised at international conferences, including the Joint International Resilience Conference 2020, while two tenure trackers sat on scientific committees for international conferences and various colleagues were invited to speak at international events. Two articles were published in journals with the aim of putting the topic of resilience in the spotlight outside the academic world.

The tenure track candidates submitted multiple grant proposals. In 2020, a VENI and an ERC Starting Grant were submitted. Various other proposals aimed at sectoral applications are in the pipeline, including one H2020, two NWA proposals, and two proposals that have been developed jointly by teams of DeSIRE tenure track candidates. DeSIRE members, both as individuals and as part of a consortium, were successful in funding rounds, including NWO Accelerator, NWO-IDG (Idea Generator), the Netherlands Organisation for Health Research and Development (ZonMw) (mobility and COVID-19) and a large-scale National Research Agenda project. In addition, four regular PhD positions were gained, as were two industrial PDEngs, in 2020.

"We cannot prevent natural disasters, but we can reduce the consequences in our complex sociotechnical environment to a minimum."

Tatiana Filatova – DeSIRE programme manager

Teaching

Tenure track candidates and senior members of staff have invested a great deal of time in the SURF Open Educational Resources for Urban Resilience, with the objective of setting up a Resilience Academy. This has laid the foundation for the planned resilience educational platform for professionals and policymakers. All tenure track candidates have integrated resilience thinking into 15 regular modules offered by the four universities of technology. They have also given guest lectures about the subject at the Singapore-ETH Centre and at Leiden University. The tenure track candidates have further extended their impact by giving a lecture at the <u>Polder 2C's Winter School</u> and by supervising Master's projects with professionals who operate in the field.

Growing external network

In 2020, DeSIRE members expanded their academic network through partnerships with existing 4TU centres (including Ethics), excellent international research groups in resilience engineering, and through joint initiatives such as JIRC2020. Obviously, this also happens at an individual level via international academic and industry-based partnerships, including new partnerships with the *European Supply Chain Forum*, the Alan Turing Institute, and by taking on leadership roles, such as the secretaryship of the Working Group on Cyber Security in Power Systems at IEEE. The DeSIRE *Resilience Fellowship programme* has appointed 30 Fellows (Dutch and international), from both the professional field and from the academic world. The Fellowship programme enables 4TU researchers with an interest in the resilience of socio-environmental-technical systems to invite junior and senior researchers or colleagues from the field from all over the world. This leads to working partnerships and the first successes have involved not just knowledge sharing but also joint publications and proposals. To promote the vision at an international level, a *Special Issue in Socio-Environmental Systems Modelling Journal* has been initiated.

Community

To strengthen the ties inside the programme itself, the tenure track candidates organised online themebased events almost every month in 2020, sometimes with external professionals (NGInfra, local authorities). Meanwhile, the annual two-day DeSIRE meeting was held online in June 2020, also organised by the tenure track candidates. They organised other sessions too, thereby gaining valuable experience as young academics - this included interaction with external speakers like Arnoud Molenaar, Chief Resilience Officer of Rotterdam. The tenure track candidates jointly developed a <u>mission statement</u> for the team and organised sessions at *JIRC2020*. In 2020, DeSIRE launched and funded ten extra postdoctoral positions to support further cohesion and collaboration among the tenure track candidates.

17.2 Plantenna

Programme coordinator: Peter Steeneken, TU Delft

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

Teaching

Plantenna bridges the gap between students at universities of technology and precision farming. In 2020, for example, TU Delft students worked alongside horticultural companies on the precision monitoring of water absorption in crops and the application of ultrasound in order to gain accurate information about the local climate in greenhouses in three dimensions. Students at TU/e carried out research into how plants can be used as antennae. Projects of this kind not only lay the foundation for future partnerships with businesses, but generate interest in precision farming among the students themselves. Given that this sector is crying out for highly qualified people, this is a significant development for the future. This way, we can help the Netherlands remain at the head of the field in precision farming.

Highly encouraging results

The multidisciplinary aspect of Plantenna – developing sensor technology to derive information from plants – is leading to close working partnerships in 4TU. The combination of different areas of expertise resulted in 2020 in a variety of highly encouraging results that may be published in 2021 in leading trade journals. Promising technologies are being developed that can measure plant conditions without harming the plants - examples include a new ultrasound technology that can monitor plants' vascular systems in a non-destructive manner, a proof-of-principle for a leaf sensor that can be mass produced, and progress in the non-destructive measuring of stomata on leaves.

Last year, the FruitFrost project, which is being funded by the NWO, was launched. As part of this project, three doctoral candidates are working on a solution to damage caused by night frosts in orchards, with the help of the new sensor technology. The relationship between the researchers at the four universities of technology is strengthened through regular meetings and webinars, which enable them to explore new opportunities for working together more readily.

Interest among businesses

The Plantenna programme is attracting much interest from industry. Various projects involving industry are currently being prepared, or have already been submitted. The largest project, on which all the young assistant professors in Plantenna are working, is the PlantSense NWO Perspective proposal. The high level of interest among businesses (more than fifty of them) has resulted in upwards of thirty letters of support. Regardless of whether the proposal is accepted, Plantenna is succeeding in creating an industrial network for the valorisation and dissemination of research results.

In the media, too, Plantenna has come under the spotlight during the past year. The FruitFrost project was featured on <u>BNR Nieuwsradio</u>, while in the <u>'4TU-techtalk'</u>, researcher Gerard Verbiest (TU Delft) talked with Priva research director Jan Westra about precision farming. A <u>Plantenna blog</u> was also set up, in order to focus interest on the various lines of research. In this way Plantenna is raising awareness among the public of the challenges that we as a society are facing regarding the provision of food and how technology can help in the search for solutions.

17.3 Precision Medicine

Programme coordinator: Michel Versluis, UT

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

Young academics

Seven tenure track candidates - young and highly talented researchers - are working alongside twelve post-docs on this multidisciplinary programme. As well as having unique and independent academic profiles, the tenure track candidates are directly involved with improving and renewing teaching across the universities. They are teaching the academics of the future - physicists and mathematicians, biomedical engineers, and technical physicians.

"I've worked in Sweden, France and in the UK, but have never experienced this degree of connection."

Camilla Terenzi – precision medicine tenure track candidate in an <u>interview</u> with 4TU

Direct link with clinicians

Technology and data in precision medicine are based around the most important research themes on both Dutch and European agendas. In 2020, for example, a number of joint proposals by the programme were very highly rated in the submission round in the National Research Agenda.

Many activities are aimed at the regional flagship programmes of the EU, which in turn are strongly anchored at university hospitals and other leading hospitals. This means they can rely on the direct involvement of policymakers, healthcare insurers, and medical equipment manufacturers.

Many researchers in the 4TU consortium, including some tenure track candidates, have part-time positions at university hospitals. Conversely, the clinicians on the programme have part-time positions at the universities of technology. The unifying element is the existing partnerships at the centres for medical imaging of the Innovative Medical Devices Initiative (IMDI) in the Netherlands. There are also many kinds of new initiatives for the pooling of science, education, and healthcare, such as *e/MTIC* in the Eindhoven region, the *TOPFIT open innovation programme* run by Radboud University, Radboudmc, WUR, and UT, and the *Convergence for Health and Technology initiative* of Medical Delta. The precision medicine programme will also be closely associated with a number of new initiatives such as the National Growth Fund and Large-Scale Scientific Infrastructure.

Cross-fertilisation

In 2020, the programme purchased a superfast GPU computing cluster for the complex calculations for deep learning in medical imaging. New research lines were also set up in the same year – between TU/e and WUR for flow-MRI of nano and micro-bubbles that are used for contrast echocardiography, and between TU Delft and WUR into factor analysis of medical MRI data.

Three tenure track candidates from UT and TU/e, and their doctoral candidates and post-docs, are actively involved with the ultra-X-treme NWO Perspective programme for 3D echography in vascular surgery.

In 2020, TU Delft and WUR investigated the continued use of the open architecture MRI machine made by Siemens, which is an integrated part of the infrastructure of the UT TechMed Centre.

17.4 Pride and Prejudice

Programme coordinator: Aarnout Brombacher, TU/e

The aim of Pride and Prejudice (P&P) is to gather new scientific knowledge and innovative technology that can be used to persuade people to adopt healthier lifestyles.

In this HTSF programme, real-life monitoring via sensors (food consumption, physical activity and health parameters) is combined with the development of design interventions at different levels of the system (person, group, society) and with the evaluation of the effectiveness of these combined interventions.

Although the consortium, like the world at large, became entangled in the coronavirus pandemic, its teaching, research, and valorisation activities continued, and a great deal of production was generated. The most important contributions and activities are described below.

Setting up of Tenure Core Team

The halfway point of the Pride and Prejudice programme was reached this year. To encourage greater bottom-up collaboration in the consortium and to ensure a sustainable continuation of the research and teaching activities after the conclusion of the P&P programme, the Tenure Core Team (TCT) was set up. An interdisciplinary group of assistant professors and post-docs from all four universities of technology are represented in the team.

The main aim of the TCT is to support and facilitate collaboration in teaching, research and dissemination activities in the P&P consortium. TCT is seeking to identify champions with a strong research and teaching vision who will continue to aim to reach the P&P objectives even after the programme has come to an end. At present, the TCT activities are contributing to both the development of productive collaborative partnerships for the next two years and the exploration of the opportunities for building on P&P results for future working relationships.

Publications

The articles shown below have been published.

- Regina Morán Reséndiz and Marina Bos-de Vos (2020) *Collaboration in open innovation health initiatives: Working towards a sustainable healthcare system.* In Christer, K., C. Craig and P. Chamberlain, eds. Vol. 2 of Proceedings of the 6th International Conference on Design4Health, Amsterdam, 2020. Sheffield: Sheffield Hallam University.
- Lemke, M., Boon, M.J.B., Schifferstein, H.N.J. (2021) *Between Attraction and Aversion: How Designers Can Use the Concept of Disgust to Influence Food Consumption.* International Journal of Food Design, 6(1).
- Brouwer-Brolsma, E., et al. (expected 2021) A collaborative white paper: Dietary assessment and coaching: short and long-term innovations. Present efforts by the Pride and Prejudice consortium. (collaboration between all 4TU: WUR, UT, TU Delft and TU/e)

Teaching

Most teaching activities on the P&P programme involve the supervision of students about to graduate. This type of teaching offers an excellent opportunity to bridge any gaps between P&P research and teaching. Besides the supervision of students, a number of courses are being developed at the cutting edge of the nutrition and exercise fields. For example, students investigate the options for designing a toolbox that supports self-experimentation when encouraging behavioural changes. All TU Delft P&P staff are involved with this. Marina Bos-de Vos (TU Delft) and Bas de Boer (UT) are also joint supervisors of a Master's graduation project on 'Digital Twins and the Values of Users'. Bachelor's and Master's students are supervised in the context of 'nutrition intake assessment technology development' (using chatbots, avatars, etc.). Jos Kraal (TU Delft) teaches a Master's elective subject on Health Psychology. Rick Schifferstein, Mailin Lemke, Boudewijn Boon (TU Delft) teach 'Food and Eating Design'.

Valorisation

The National Research Agenda proposal 'Turn the healthy option into a happy option' is taking up the challenge of designing nutrition and the nutritional environment in such a way that people will eat less and yet still feel satisfied. All the P&P partners are involved with this.

17.5 Soft Robotics

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

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

Academics

Good candidates have been found for five of the six tenure track positions. In 2020, several post-docs (Mahboubeh Keyvanara, Femke van Beek (both TU/e), Laurence Willemet and Alberico Sabbadini (both TU Delft)), and PhDs (Mostafa Atalla (TU Delft) and Nick Willemstein (UT)) started on the Soft Robotics programme.

Within the consortium, strong ties have been forged with academic hospitals and industrial partners. Collaborative partnerships were also set up in 2020, with Cosimo Della Santina (TU Delft), Jovana Jovanova (TU Delft), and Bas Overvelde (AMOLF).

First symposium

In June, the consortium organised an online symposium on soft robotics. Researchers from all over the Netherlands were invited to the meeting, at which the SR research was discussed. Monthly colloquium meetings were also held.

Published articles

- Langowski, J.K.A., Sharma, P., Leylavi Shoushtari, A. (2020) *In the soft grip of nature.* Science Robotics, Vol. 5, eabd9120.10.1126/ scirobotics.abd9120.
- Langowski, J.K.A., Dodou, D., van Assenbergh, P. & van Leeuwen, J.L. (2020) *Design of tree-frog-inspired adhesives*. Integrative and Comparative Biology, Vol. 60, 906–918. 10.1093/icb/icaa037.
- Sakes, A., van de Steeg, I., de Kater, E.P., Posthoorn, P., Scali, M., and Breedveld P. (2020) <u>Development of a Novel Wasp-Inspired Friction-Based Tissue Transportation Device</u>. Frontiers in Bioengineering and Biotechnology.
- Di Natali, Christian, Ali Sadeghi, Alessio Mondini, Eliza Bottenberg, Bernard Hartigan, Adam De Eyto, Leonard O'Sullivan et al. (2020) *Pneumatic quasi-passive actuation for soft assistive lower limbs exoskeleton*. Frontiers in Neurorobotics 14. 10.3389/fnbot.2020.00031.
- Lin, X., Willemet, L., Bailleul, A., & Wiertlewski, M. (2020) *Curvature sensing with a spherical tactile sensor using the color-interference of a marker array.* In 2020 IEEE International Conference on Robotics and Automation (ICRA) (pp. 603-609). IEEE.

Milestones

Newspaper NRC called attention to this still relatively unknown area of research in an article about medical equipment inspired by octopus tentacles ('*Medische Instrumenten geïnspireerd op de inktvis'*). Tenure track candidate Ali Sadeghi was awarded a TURBO Grant (\in 80K) for the development of a single-foot orthosis based on soft robotics. Michael Wiertlewski and Aimée Sakes received a Cohesion grant (\notin 250K) for the development of a catheter capable of modifying its friction properties.

18 External relationships

As well as its many external relationships, the 4TU.Federation has specific agreements with several external parties. This section reports on the results of these agreements in 2020.

NEMO Kennislink

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

A total of 89 articles were published in the area of Technology in 2020, just one more than in 2019, but the proportion of readers of the articles aged between 18 and 24 was much higher. The number of subscribers to the newsletter increased by more than 20%.

In 2020, readers were obviously particularly interested in the coronavirus-related items, and some used the information given to contact the four universities of technology. Kennislink <u>interviewed Kenny</u> <u>Meesters</u> (TU Delft) on several occasions about his knowledge of communication when disasters occur. The items received extensive coverage, leading to an editorial in De Volkskrant. There was also much interest in the interview with professor of logistics, Jan Fransoo (TU/e), about <u>the enormous logistical operation that coronavirus vaccine represents</u>.

DCVA

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

Science and Technology Registration Authority

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

Foundation for the Promotion of Science and Technology

With a financial contribution from the universities of technology, the Foundation for the Promotion of Science and Technology (STP) has implemented its programme in the context of the science and technology tournament OO Techniek, the Eureka Cup, the First Lego League Jr and the First Lego League. The funding was gradually decreased in 2020 and further steps were taken for relocating some of the activities elsewhere.

RAI Amsterdam

Secretary IJsbrand Haagsma was unable to sit on the jury to select the HISWA Product of the Year for 2020, as the event was cancelled.

History of Technology Foundation

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

19 visibility

In 2020, the 4TU.Federation placed extra emphasis on its visibility. To that end, a communications advisor was appointed to focus on internal and external communications. The *Techrede* speech and the Dutch 4TU Impact Challenge attracted widespread attention, with new communications channels being used.

Communication activities

Since March 2020, 4TU has been communicating via its own channel on LinkedIn and Twitter. The LinkedIn channel in particular became very popular, with 1,000 followers in the first year. The messages were shared extensively, both inside the university network and by businesses and government bodies. Since June, 4TU has been sending a <u>4TU newsletter</u> every two months, readership of which now amounts to almost 2000 people who are interested to learn about the federation's latest developments. To show what the various working partnerships between the four universities of technology are producing, and how they are working alongside businesses, citizens and government bodies, a new series of accounts has been launched, known as <u>4TU.techtalks</u>, in which someone from 4TU discusses a societal challenge with a member of society that both are dedicated to overcoming and for which each has their own vision. The articles are very highly rated and are extensively shared in the networks of the external discussion partners.

In the media

BNR Wetenschap Vandaag has made accessible podcasts about two 4TU topics. One was about a new research project by the 4TU.High-Tech Materials Research Centre about smart materials, <u>'Robots met kippenvel en braille op je telefoon'</u> and the other dealt with the FruitFrost project of the HTSF Plantenna programme, <u>'Planten die zelf aangeven of ze last van nachtvorst hebben'</u>.

The *Techrede* speech was available on 4TU's own social media channels and, thanks to vlogs and the 'Tech Files', created a continuous flow of news. The four universities of technology, <u>Radio 1</u>, several <u>newspapers</u>, and numerous online channels of external parties gave it widespread coverage. The winners of the Dutch 4TU Impact Challenge were also much in the spotlight. Articles on the subject appeared in Innovation Origins, De Ingenieur, De Telegraaf, and elsewhere.

