4TU.Federation

Annual Report

2023

May 2024

TU Delft Delft University of Technology | TU/e Eindhoven University of Technology | University of Twente. | Wageningen University & Research

4TU.

Foreword

Engineering talent is a driver of both societal improvement and economic progress. The talent we train today will play a key role tomorrow in solving complex challenges such as climate change, healthcare and urban development. These tech talents are developing sustainable energy sources, advanced medical treatments and smart cities that are more efficient and livable. And they are an important part of answering the question of where the Netherlands will make its money in 2050.

Practice shows that it is difficult to entice study seekers to choose our beautiful technical study programmes. In secondary education, fewer and fewer students choose a Natuur&Techniek profile, putting great pressure on intake. In the recent LANDSCAPE report, we outline what needs to be done to increase educational capacity and train more students in disciplines such as computer science, electrical engineering and mechanical engineering. In the coming period, we will continue along this path, in which the commitment from everyone is badly needed: from the knowledge institutions, but also from the government and industry.

As technical universities, we play our part in increasing the outflow of technically skilled talent for the labour market. Merely maintaining the current numbers of graduates is insufficient for the task we face: we want to achieve solid growth - or a jump in scale - in the coming years, especially in master's programmes. After all, the labour market is eager for new engineers.

Just as we are joining forces in the field of education, we are doing the same in our research and valorisation activities. The projects from the second phase of the capacity-building programme High Tech for a Sustainable Future (HTSF) are slowly taking shape. And we are closely involved in the further development of the Council for Technical Sciences and the establishment of the Netherlands Academy of Engineering, the latter of which saw the light of day in 2023, both of which will play an important role in connecting all these great initiatives at strategic level.

I would like to thank everyone for contributing to our joint efforts in 2023, and look forward to further pursuing our shared ambitions in the near future.

Vinod Subramaniam
Chairman 4TU.Federation
Chairman Executive Board University of Twente

1 General & Executive Board

General board	Tim van der Hagen, Rob Mudde, Marien van der Meer (TUD) Robert-Jan Smits, Frank Baaijens / Silvia Lenaerts, Nicole Ummelen (TU/e) Vinod Subramaniam (chairman), Tom Veldkamp, Machteld Roos (UT) Sjoukje Heimovaara, Arthur Mol, Rens Buchwaldt (WUR)
Executive Board	Vinod Subramaniam (chairman), Tim van der Hagen, Robert-Jan Smits, Sjoukje Heimovaara
Support	Birgit van Driel / Wijnie Prosman (TUD), Renee Westenbrink (TU/e), Dieuwertje ten Brinke / Linda te Winkel (UT), Pieter Munster / Marc-Jan Zeeman (WUR)
4TU	Marjolein Dohmen-Janssen, Linda Baljeu / Sandra Nienhuis

The General Board (AB) met twice, once online and once physically. The Executive Board (DB) met five times, once physically. The DB also had an online meeting with a delegation of the participation councils of the four TUs.

Political developments

In the meetings of the 4TU Board, the various political developments came up regularly. One of the main topics in these was the Internationalisation in Balance Act. Through internet consultation, 4TU provided input on this law, in addition to input from individual universities. In doing so, 4TU emphasised the importance of international engineering students for the Dutch knowledge economy and, together with the RUG, also drew attention to this via an opinion article in the Volkskrant. Meanwhile, the cabinet had fallen. 4TU sent all political groups input for their election programmes, calling for i) training more engineers to enable social transitions, ii) introducing future-proof funding in higher education, iii) investing at least 3% of GDP in research & development for a strong and innovative economy, and iv) investing in technological innovation ecosystems to increase the impact of science and innovation.

National Technology Strategy

In 2023, the Ministry of Economic Affairs and Climate (EZK) worked on the National Technology Strategy (NTS). The NTS provides building blocks for strategic technology policy by identifying key technologies where the Dutch knowledge field and Dutch business can make a positive impact and where a unique Dutch position is possible. 4TU was asked by EZK to provide feedback on the draft shortlist of priority key technologies.

Cooperation RUG

A formal collaboration between 4TU and the University of Groningen (RUG) was established on 1 January 2023. The reason was the fact that RUG is the only other university in the Netherlands to train engineers. Expansion of the 4TU.Federation was not an issue in this respect. v, however, is keen to enter into structural substantive research and education cooperation in areas where it is most obvious. This has led to formal cooperation within two 4TU centres, namely 4TU.HTM (High-Tech Materials) and 4TU.NIRICT (ICT). Further exploration of cooperation opportunities is taking place within four other centres (4TU.Applied Mathematics, 4TU.Centre for Engineering Education, 4TU.Energy, 4TU.Stan Ackermans Institute for EngD studies)

New 4TU.Centre

In 2023, 4TU decided to establish a new 4TU.Centre, namely the 4TU.Centre History of Technology (4TU.HoT). The centre aims to give new impetus to the field of engineering history, because historical awareness of technology and the role engineers have played in it over the past centuries is important and helps us think about solutions to the societal challenges we face now and in the future.

2 Research Board

Board	Arthur Mol (WUR, chairman) Tim van der Hagen (TUD), Frank Baaijens / Silvia Lenaerts (TU/e), Tom Veldkamp (UT)
Support	Pieter Munster (WUR, secretary), Birgit van Driel / Wijnie Prosman (TUD), Rianne Pas (TU/e), Dieuwertje ten Brinke / Linda te Winkel (UT)
4TU	Marjolein Dohmen-Janssen, Linda Baljeu / Sandra Nienhuis

In 2023, the Research Board consisted of the research portfolio holders from the Executive Boards of the four technical universities. 4TU.Research is responsible for shaping and overseeing the universities' research cooperation and planning.

HTSF programme

Within the 'High Tech for a Sustainable Future' (HTSF) theme, the 4TU.Federation is giving a strong impetus to sustainable technology research. It is a thematic capacity-building programme aimed at attracting new scientific talent and finding answers to major societal challenges.
In 2023, four new multi-million-dollar programmes on personalised healthcare (RECENTRE), reducing heat in cities (HERITAGE), developing green, biodegradable sensors (Green sensors) and a future-proof food system (REDESIGN) were launched. The programmes consist of tenure trackers complemented by support staff such as PhD candidates and postdocs.
In addition, by 2023, the programmes from the previous HTSF programme will also have finally settled in at the various institutions. A beautiful Crossover Event took place on Friday 9 June, saying goodbye to the old programmes and kickstarting the four new ones mentioned above.

4TU.Centres

In 2023, the 4TU.Centres each had a visit from one of the rectors, during which the rector in question entered into a conversation with the centre about the (substantive) state of affairs and possible bottlenecks or challenges.
For instance, the 4TU.Centres have been faced with high (staff) costs due to inflation. To maintain the same level of activity, it was therefore decided to give them 10% extra financial leeway where necessary.

4TU.History of Technology

The 4TU.Research Board has given the History of Technology Foundation the status of a 4TU.Centre in 2023. With this, the name has been changed to 4TU.History of Technology.

Netherlands Academy of Engineering

4TU.Research is delighted to have succeeded in establishing a Netherlands Academy of Engineering (NAE) and has made a positive contribution in the year 2023 through start-up funding, bringing together relevant parties and advising on the set-up of the NAE.

Council for Technical Sciences

The Board of 4TU.Research facilitated the creation of a Council for Technical Sciences in 2023. This meets the broad desire from ministries, sector planning committee(s) and NWO, among others, to achieve self-direction, representation and strategic cooperation within the technical sciences (TW).

Exchange consequences national elections

In FY2023, the 4TU.Research Board has been a place to discuss, align and take action on the run-up to and impact of the national elections on research at the technical universities. Topics that have been of interest are including sector plans, the National Growth Fund and start-up and incentive grants.

Visit Swedish University of Agricultural Science - Chalmers - Kungliga Tekniska hogskolan

On 19 & 20 April 2023, a delegation of Scandinavian technical universities visited the Netherlands (location Eindhoven) to exchange knowledge and explore cooperation opportunities. Special attention was paid to the higher e d u c a t i o n funding system.

Key figures

Number of PhDs 4TU, 2013-2023

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
4TU	1.064	1.145	1.130	1.182	1.063	1.161	1.230	1.083	1.200	1.132	1.285
TUD	353	371	357	395	359	368	400	374	432	394	408
TUE	218	243	234	224	212	264	290	244	268	225	309
UT	220	244	234	267	197	243	247	184	206	193	209
WU	273	287	305	296	295	286	293	281	294	320	359

Number of PhD students present 4TU, 2013-2023

M	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
TUD	1871	1881	1913	1959	1995	2021	1983	2038	2067	2140	2248
TUE	886	925	969	1028	1072	1070	1063	1105	1130	1336	1321
UT	784	784	783	756	751	699	648	798	843	834	898
WU	963	962	953	938	933	912	922	1026	1073	1097	1097
V											
TUD	730	744	739	751	771	795	828	890	936	1006	1074
TUE	324	355	398	415	462	494	509	541	557	660*	683
UT	409	420	452	436	442	429	383	456	499	512	542
WU	992	941	943	929	938	955	1014	1170	1224	1292	1336
Neutral/Unknown											
TUD											0
TUE											1
UT											8
WU											7
4TU	6.959	7.012	7.150	7.212	7.364	7.375	7.350	8.018	8.329	8.877	9.215

Source: WOPI (Reference date 31 Dec)

3 Education Board

Board	Tom Veldkamp (UT, chairman), Frank Baaijens / Silvia Lenaerts (TU/e), Rob Mudde (TUD), Arthur Mol (WUR)
Support	Chris Rouwenhorst (UT, secretary), Barbara Marx, Ottelien Rikhof (TUD), Lilian Halsema (TU/e), Marc-Jan Zeeman (WUR)
4TU	Marjolein Dohmen-Janssen, Linda Baljeu / Sandra Nienhuis

In 2023, the Education Board Committee consisted of the education portfolio holders of the Boards of the technical universities. This committee is responsible for shaping and overseeing planning and cooperation between the universities in the field of education. There were some changes in the composition of the board committee this year, for example, the chairmanship shifted from Rob Mudde (TUD) to Tom Veldkamp (UT) and Frank Baaijens (TU/e) was succeeded by Silvia Lenaerts (TU/e).

Enrolment in technical education - Internationalisation - 4TU.VO

The topic of 'intake in technical education' featured prominently in 2023. Several studies show that there is a lagging observed in intake in technical courses compared to the overall intake.
For the large and structural labour market shortages within the disciplines of computer science, electrical engineering and mechanical engineering, the LANDSCAPE advisory report has been delivered and submitted to OCW. This report contains many measures that can be jointly taken up in the coming years. The measures range from appealing to other target groups, better technology education in primary education to proper labour market entry.
The Research Board of 4TU.Research has asked the four Pre-University programmes of the TUs to come up with a coherent plan to strengthen engineering education in secondary education and to make a structural contribution to a proposal to counter the declining trend in the choice of vwo students for the N&T and N&G profiles. With this, the 4TUs have expressed their ambition to establish one (inter)nationally well recognisable and organised 4TU Pre-University programme.
Current political developments around internationalisation are putting additional pressure on intake, while studies show that international students are badly needed to cope with labour market shortages. Within the Education Committee, the TUs keep each other informed and respond together if necessary.

Quality assurance EngD courses

In 2022, the quality assurance of EngD courses was scrutinised. To this end, advice was sought from an EngD Quality Assurance Committee. The committee concluded that quality assurance of programmes is increasingly taking place at the institution level. In response, a transition to a new EngD quality assurance system was initiated. A draft protocol was drawn up in 2023, which is currently being coordinated with many parties (including KIVI, CCTO and SAI). The executive committee is closely monitoring this.

Progress of 4TU projects Education Sector Plan Science Technology

In addition, 2023 was marked by the completion of some of the sector plan projects from the Science and Technology Education Sector Plan. For instance, the LANDSCAPE report was delivered and the LLO project led to numerous (national and regional) initiatives and to more alignment between educational institutions and the labour market. The educational institutions involved have also all made strides in their own organisation for LLO, LLO policy and interpretation around all those national and regional initiatives. The project is now merging further into the other national and regional developments.

Centre for Engineering Education

The four technical universities work together to improve engineering education through the 4TU.Centres CEE. The centre collects and develops evidence-based knowledge and regularly informs and advises the 4TU.Education Board on educational trends and innovations. By 2023, the CEE will have

delivered the advisory report 'Room for Everyone's Teaching Talent' to the Education Board. This report contains several recommendations for recognising and valuing University Teaching, teacher quality and teaching careers within the 4TUs.

Population of 4TU, all students*

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	23/22	23/10
TUD	19.148	20.034	21.475	22.216	23.310	24.505	24.959	26.027	26.672	26.591	25.998	-2%	50%
TUE	8.377	9.209	10.116	10.759	11.371	11.969	12.232	12.870	12.788	12.815	13.037	2%	78%
UT	9.315	9.263	9.082	9.391	9.919	10.665	11.402	12.220	12.609	12.188	11.814	-3%	33%
WU	8.302	9.032	9.720	10.696	11.446	11.946	12.279	12.897	13.057	12.992	12.968	-0%	101%
Population 4TU	**45.142**	**47.538**	**50.393**	**53.062**	**56.046**	**59.085**	**60.872**	**64.014**	**65.126**	**64.586**	**63.817**	**-1%**	**60%**

Population WO

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	23/22	23/10
Bachelor	156.755	159.163	159.283	163.221	171.568	182.423	191.450	205.300	212.448	215.521	217.693	1%	38%
Master	88.042	91.538	96.306	99.253	102.812	106.430	109.439	119.344	125.214	121.920	119.937	-2%	59%
Postmaster	1.833	1.806	1.765	1.645	1.540	1.540	1.433	1.519	1.464	1.346	1.197	-11%	-23%
Undivided	1.394	622	289	50									-100%
Total WO	**248.024**	**253.129**	**257.643**	**264.169**	**275.920**	**290.393**	**302.322**	**326.163**	**339.126**	**338.787**	**338.827**	**0%**	**41%**

Population WO minus 4TU

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	23/22	23/10
Total	**202.882**	**205.591**	**207.250**	**211.107**	**219.874**	**231.308**	**241.450**	**262.149**	**274.000**	**274.201**	**275.010**	**0%**	**37%**

Population 4TU and wo, female students

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	23/22	23/10
WO, woman	127.065	129.776	131.429	135.141	141.867	150.603	158.545	172.611	181.609	181.835	182.657	0%	47%
4TU, woman	14.187	15.187	16.376	17.797	19.101	20.430	21.364	22.784	23.403	23.345	23.134	-1%	96%
WO minus 4TU,	112.878	114.589	115.053	117.344	122.766	130.173	137.181	149.827	158.206	158.490	159.523	**1%**	**42%**
% women WO	51%	51%	51%	51%	51%	52%	52%	53%	54%	54%	54%		
% female 4TU	31%	32%	32%	34%	34%	35%	35%	36%	36%	36%	36%		
% women WO mi	56%	56%	56%	56%	56%	56%	57%	57%	58%	58%	58%		

Population 4TU and wo, international students

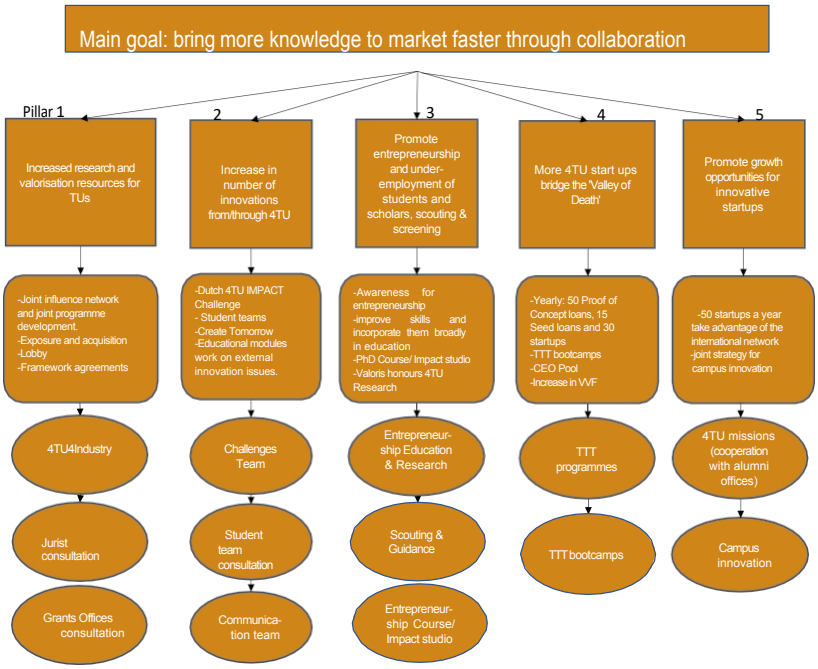
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	23/22	23/10
All uni	248.288	253.465	258.041	264.681	276.598	291.205	303.291	327.217	340.245	340.032	340.160	0%	41%
4TU	45.142	47.538	50.393	53.062	56.046	59.085	60.872	64.014	65.126	64.586	63.817	-1%	60%
All uni's - 4TU	203.146	205.927	207.648	211.619	220.552	232.120	242.419	263.203	275.119	275.446	276.343	**0%**	**38%**

*source ICHO

4 IMPACT

Director	Jeroen van Woerden (TU/e)
Programme manager	Roelyn van der Hoek (UT)
Management team	Jeroen van Woerden (TU/e), Sebastiaan Berendse (WUR) Bas Kerkwijk (UT), Kemo Agović (TUD)

4TU's joint valorisation efforts are housed at the 4TU.IMPACT centre. Below is an overview of the goals and sub-goals of the 2022-2026 multi-year plan. Some 2023 highlights are described below by pillar.



Pillar 1 Lobbying at the national level

4TU.Impact remains committed to lobbying for structural funding for valorisation activities. Meanwhile, 4TU.Impact has made tremendous efforts to submit a Growth Fund application for valorisation jointly with universities, universities of applied sciences and TO2 institutions to make the next leap of scale. As such, the need for structural funding of valorisation activities remains. The 4TU directors and various staff from the TUs have held the pen and provided much of the input.

In addition to this Growth Fund application, a contribution was also made to the Biotech Booster. The other Growth Fund applications were always coordinated for the four TUs in the 4TU.4Industries consultation.

A lot of energy was also put into bringing about the national *deal terms* launched in February 2023 from 4TU.Impact. These are uniform provisions on how intellectual property is transferred from knowledge institutions to spin-offs. It has been a difficult process to arrive at these uniform provisions. The UT had the lead and the other TUs rallied behind the UT with active contributions. The TUs are still working closely together on this issue. For instance, they are jointly working on standard agreements in line with this *deal terms* such as a term sheet, an IP agreement and a shareholders' agreement. The whole thing is not yet finalised and will also require the necessary efforts next year. Because we are ahead internationally with these concrete *deal terms*, there is interest in them from abroad. TU employees are therefore regularly invited abroad to give explanations.

Following a joint online training for *grants offices* and the consultation during the 4TU.Impact Support Day on 12 October, the grants offices consultation was launched.

Pillar 2

The 4TU.Impact Challenge was organised for the fifth time. This year, the final took place during the annual 4TU.Impact Support Day at TU/e. In 2024, the final will take place at TU Delft.

The Challenge team organised a 4TU. *honours league* during and in collaboration with Create Tomorrow. The students were offered various workshops on the first day, to work in groups on various issues from companies and civil society organisations the next day, well prepared. The winning team was allowed to accompany 4TU startups to the mission in Düsseldorf. They gained many entrepreneurial skills here.
This year also saw the launch of the communications team. The team, consisting of communication officers from the four TUs, works together to make innovations and startups more visible to the outside world.
A joint day was organised by the student team consultations at TU/e for all student teams from the four TUs. Mutual acquaintance and a comprehensive workshop on how to do acquisition and relationship management was the main focus. In addition, a number of teams were given a good picture for the Building the Future programme.

Pillar 3

In the Insightful Innovators series, you will read the stories behind enterprising students and their ambition to make the world a better place. They are a driving force behind innovation in the Netherlands.
The *business developers* piloted the AI platform ScoutinScience, which helps to scout research with high tech transfer potential. This provides leads to enter into conversations with the scientists, whose publications are hereby highlighted
The first activities regarding a pilot to link entrepreneurial students to 4TU scientists with an interesting invention have started. In 2024, the Impact study pilot will take place. The students will then, among other things, be trained in doing extensive market research.

Pillar 4

The TTT (Thematic Technology Transfer) programmes are running well, with 76 cases discussed, 41 vouchers awarded and nine CLAs signed by 2023. A curriculum of eight workshops and trainings was organised. A Team Up Day was also organised. A co-production of the TTT programmes Smart Industry, MedTech and Circular Technology. This day was dedicated to team building, both internally and with investors. By itself, the StartupRoulette resulted in 60 conversations between investors and the attending teams. With 160 participants and an average rating of 8.6, the first TTT Team Up Day can be called a great success.

Pillar 5

Due to the successful missions last year and the good cooperation with both RFO and the embassy and alumni offices, it has been decided to again jointly visit a number of fairs in 2023, namely London Tech Week, Collision, Future Tech Fest and Slush. From the 4TUs, 60 startups attended for this purpose. In addition, the events F&A Next, Slush'D, Level Up and Up Rotterdam took place in the Netherlands, to which 4TU startups were invited (organised by or in cooperation with one of the TUs in each case). For the missions, bootcamps were organised in cooperation with RVO. Participants were trained and prepared to get the most impact out of participating in the mission. And this had an effect. All startups indicated that they would like to join future missions. They gain many contacts, establish relationships with investors and thus increase their growth opportunities. It also contributes to a huge increase in (social) media posts.

5 Applied Mathematics Institute

Scientific director	Johann Hurink (UT)
Coordinator	Ellen van den Bos (UT)
Management team	Kees Vuik (TUD), Luc Florack (TU/e until October 2023), Alberto Ravagnani (TU/e from November 2023, Richard Boucherie (UT), Peter van Heijster (WUR), Roel Verstappen (RUG)
Board	Joost Kok (dean UT), Edwin van den Heuvel (dean TU/e) Lucas van Vliet (dean TUD), Peter van Heijster (WUR)

The overarching goal of the 4TU.Applied Mathematics Institute (4TU.AMI) is to foster cooperation between mathematics groups/researchers from the four TUs and the RUG in order to jointly increase the participation of mathematics in application fields. In 2023, cooperation with the mathematics groups of the University of Groningen was further shaped. By having RUG be full members of the MT, they can actively participate in AMI's activities in all processes.

Networking event

At the end of June, 4TU.AMI organised a networking event in Delft to give recently started 4TU.AMI members the opportunity to introduce themselves to the 4TU.AMI community and build new contacts. The day was also dedicated to getting further acquainted with RUG mathematicians. Twenty-two short presentations were given and there was plenty of room for meeting and exchanging. The whole event was completed with two invited speakers, one in the field of research and one in the field of education. The day ended with discussion tables and drinks and BBQ. The day was very successful and will be repeated in 2024.

The two 'Strategic Research Initiatives' (SRIs) launched in 2022 continued to work towards achieving their goals. Furthermore, a project group was started in the second half of 2023 from all five universities with the aim of setting up an SRI in the area of 'research to education'. Given the importance of the topic for 4TU.AMI, this SRI will have a larger scope than previous SRIs. In addition, there are two more initiatives to start a new SRI.

Activities

In addition to these activities, AMI also supports the organisation of a number of conferences and workshops organised by and for the 4TU.AMI community. Furthermore, 4TU.AMI provided financial support for the writing of a Gravity proposal, partly because of the face-lifting effect of such a programme on the entire research field. In addition, 4TU.AMI mathematicians once again provided a number of tasks for the annual MATH+ Advent Calendar.

In 2024, 4TU.AMI will continue to build on the lines set out. The aim is to launch two new SRIs per year. Another networking event will be organised in the summer, this time in Twente. Furthermore, the cooperation with the RUG will be evaluated in the second half of 2024. In case of a positive outcome, a final organisational structure for the cooperation will be set up.

6 Built Environment

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

Main activities and impact

The activities of 4TU.Built Environment (4TU.BE) in 2023 focused on facilitating the Domain Booster Teams (DATs) in drafting Strategic, Long-term Research & Innovation Agendas, deepening cooperation with key stakeholders such as the Directorate-General for Public Works and Water Management (RWS), TKI Bouw en Techniek (TKIBT), the Social and Economic Council (SER) and People Make the Transition (MMT), the Association of Universities of Applied Sciences (VH) and specifically Domain Built Environment (DBE) and the National Lecturers' Platform Built Environment (NL-GO). Further efforts were made to increase the name recognition of 4TU.BE, nationally and internationally. Articles are regularly published on the website via Innovation Origins and shared on our new LinkedIn page. Contact with the European Construction and Technology Platform (ECTP) has been established and they are willing to post news and events on their website. The 4TU.BE website has been thoroughly updated to include news articles and events.

The MT's meeting frequency has been increased to a monthly, shorter online consultation from September 2022, with regular input from one of the DATs. Each DAT has its own webpage on the 4TU.BE website. A total of four deans' meetings were held in 2023, including one physically in Wageningen, one meeting with RWS and one meeting with the 4TU.BE-MT. Subjects discussed there included input into the Engineering Sector Plans (together with RUG), positioning in the broader context of 4TU.BE (TKI Bouw en Techniek, RWS, Civil Engineering Council, etc.). The MT of 4TU.BE further held one physical meeting in 2023 in addition to the monthly online meetings.

Domain Booster Teams

At the 4TU.BE meeting on 11 October, five Domain Driving Teams (DATs) started working on their long-term research and innovation visions. The DATs see these long-term visions as input into the national and international strategic knowledge and innovation agendas. Further coordination within and between DATs and the MT has been facilitated.

Networking & Communications

On the 4TU.BE website, the DATs each have their own page, the content of which is coordinated with the DATs. In 2023, nine articles were posted on the website, written by Innovation Origins (in NL and Eng). An article from 4TU.BE is shared on a regular basis in the 4TU.Federation's newsletter among others on Houses of the assembly line, Student Teams and Healthy Environments (DAT HitBE). 4TU.BE now also has a LinkedIn page.

TKI Construction and Engineering

4TU.BE had a two-person delegation (Anita Baas and Maaike Riemersma) on the MT of the BTIC (from 1 July TKI Bouw en Techniek) in 2023. This 4TU.BE-funded deployment ended at the end of 2023. Several faculties of 4TU.BE participated in the (re)submission of the now-started NGF proposal 'Future-proof Living Environment'.

SER Labour Market and Training

4TU.BE-MT member Prof André Doree continues to represent **4TU**.BE/U-NL in the SER core team Labour Market and Schooling. Alignment has taken place with the Growth Fund application LLO Catalyst. This has given energy transition and co-creation labs a prominent role in the honoured LLO proposal. In parallel with the roll-out, a model has been developed that facilitates quadruple-helix collaboration of MBO, HBO, WO and practitioners. This model is before branches of network operators, builders and installation companies for ratification. It allows LLO initiatives from the WO to be linked to transition paths in terms of content and financing, starting with energy transition.

Sector plans

The chairman of the Deans' Consultation **4TU**.BE, Theo Salet, had a coordinating role in the submission Sector Plan Civil Engineering and Design of the Built Environment. This led to a supported and successful submission by **4TU**.BE in cooperation with the University of Groningen.

Agenda for 2024

At the end of 2023, the terms for the current scientific director and coordinator expire. Advice to the successors is to continue and expand the line of work with the DATs and expand contacts with the other 4TU.Centres. At national level, cooperation with RWS TKI Bouw en Techniek, the universities of applied sciences (DBE and NL-GO) will be continued. Efforts will be made to cooperate at European and international level.

7 Design United

Scientific director	Daniel Saakes (UT)
Management team / Scientific co-directors	Marco Rozendaal (TUD), Stephan Wensveen (TU/e), , Dieuwertje de Wagenaar, Lenora Ditzler, Gert Jan Veldwich (WUR)
Board	Caspar Chorus (TUD), Lin-Lin Chen (TU/e), Mascha van der Voort (UT), Karin Schroën (WUR)

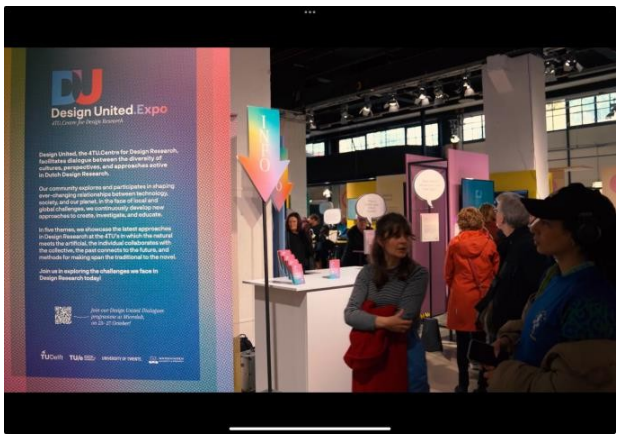
4TU.Design United (4TU.DU) contributes to the field of design professionals by developing new knowledge and unlocking existing knowledge. This improves the innovative power of industry, realises economic growth and contributes to solving societal problems. 4TU.DU forms a community for Dutch design research and focuses on designers and researchers, as well as on applying organisations.

The centre's activities aim: 'to connect, communicate, coordinate and create, and educate'. 4TU.DU increases clout by playing a role in national discussions as a platform/front door for design research, to put design on the map as a discipline, and to help set the agenda in the *Top Sector Creative Industry*.
4TU.DU researchers have actively contributed to vision and strategy development of the creative sector in the Netherlands by 2023. The Design Engineering Sector Assessment has been integrated into the Engineering Sector Plan.

Together with CLICKNL, 4TU.DU organised the annual ***Design Research & Innovation Festival*** **(DRIVE)** during Dutch Design Week (DDW) in Eindhoven, this year's 10th edition. Audiences and speakers came together for four mornings in inspiring sessions and workshops within the themes: Systems and Societal Innovation, Future Living Environments, Designing the Circular Economy, Digital Society.

The **Dutch Design Week** contribution was dominated by five provocative yet accessible themes: Politics of Design, Climate Futures Now!, More than Human Design, Disentangling AI, Design and Society and Making Matters.

The 4TU.**DU-Expo** in the well-attended Klokgebouw gave a stage to research projects of the four TUs and allowed a wide audience to try out research and prototypes. In the afternoons, researchers, experts and interested parties met for debate, reflection and deepening in the **Dialogues meetings**.



Both the exhibition and the *dialogues* were developed and curated by teams of 4TU researchers, thus transcending institutional boundaries and showing precisely the collectivity and complementarity that show the unique impact of design sciences on societal challenges.

This year, we started to diversify activities throughout the year and organised two **perspectives** meetings: in Wageningen and in Delft. In a workshop format, 4TU design researchers reflected on new trends in the field and took the first steps towards concrete joint activities and research projects.

Probes funding enables researchers to take the first steps towards a joint grant application. Four *probes funding* were awarded in 2023, which together show the diversity of design research. The results of the probes were presented at Dutch Design Week.

8 Energy

Scientific director	David Smeulders (TU/e)
Coordinator	Lou Sha
Management team	Gerrit Brem (UT), Harry Bitter (WUR), Peter Palensky (TUD)

4TU.Energy aims to accelerate society's transition to a carbon-neutral future by connecting and leveraging the energy community and through centralised support for energy research and education. The main activities and results in 2023 were as follows.

Building the community Energy Community Day 2023 (click here for more information, including video). The annual 4TU.Energy Community Day serves as a platform for researchers to make contacts, expand their professional network and find inspiration at their peers. The pilot edition in 2023 was successful: more than 50 attendees (PhD students and research staff). The feedback received showed the added value of 4TU.Energy.

Interview series - "Meet Our Energizer" (click here for more information). The quarterly interview invites affiliated researchers to introduce themselves to the 4TU.Energy community, with the aim of fostering new connections within the community for collaboration.

Research support

Research map (current version see here). Energy is a broad research topic, and 4TU.Energy scientists can be found in a variety of scientific disciplines. To give an overview of who is working on what, a "Research Map" has been presented to the community. There are 13 main research topics, about 50 sub-topics and 80 researchers (research groups) listed in the current Research Map. The Research Map is open on our website for feedback.

Research videos (click here to watch the video series). The video series shows concrete examples of 4TU.Energy research. The low-threshold description of research has increased 4TU.Energy's visibility and recognition among the public (e.g. via website, LinkedIn page and YouTube).

Educational support

PhD course 2023 (click here to watch this event back). The annual PhD course aims to enable knowledge transfer and build the capacity of young researchers. The 2023 pilot edition focused on "Sustainability, systems and societal aspects in the energy transition" and also offered pitch training prior to the course. There were 40 participants for the 2-day course, incl. three PhD students from the RUG. We also included presentations from the Province of North Brabant and TNO in the programme.

4TU.Responsible Sustainability Challenge (full programme info see here). An initiative of the 4TU.Centres High-Tech Materials, Energy and Ethics & Technology, 4TU.RSC offers online mentoring and live events to enrolled honours master's students working on business challenges.

In 2023, 4TU.Energy hosted one live workshop at TU/e and co-hosted the final live event in Utrecht; two of the three challenges were brought in by 4TU.Energy.

Funding (funding schedule and funded projects can be found here)
4TU.Energy has opened the call for funding since April 2023, aiming to lower the threshold for 4TU researchers to start collaborative research within the Energy domain and/or join the community. In 2023, four of the six proposals submitted were honoured, with a total amount awarded of €75k.

In 2024, we aim to continue our work in community building, research and educational support. A new initiative is the launch of the Curriculum Overview to help students and teachers with an overview of energy courses and programmes. With regard to outreach, a joint call for funding will be launched with 4TU.NIRICT in 2024; cooperation with NERA, for example, will be further explored; and we will continue our efforts with the 4TU Alliance on Energy Access in building a platform to engage with the Dutch energy access sector.

9 Ethics and Technology

Scientific director	Vincent Blok (WUR)
Managing director	Jochem Zwier (WUR)
Coordinator	Mariska Bosschaert-Bakhuizen
Management team	Vincent Blok (WUR), Jochem Zwier (WUR), Philip Brey (UT), Yashar Saghai (UT), Sabine Roeser (TUD), Udo Pesch (TUD), Wybo Houkes (TU/e), Andreas Spahn (TU/e)

4TU.Ethics is a community of researchers promoting and conducting both fundamental and applied research in ethics and technology. The centre aims to address social and technological challenges in the context of a globalised and connected world. The aim is to promote understanding of ethical issues around developments in engineering and technology. An important part of the centre is the *graduate school*, in which PhD candidates study engineering philosophy and engineering ethics under the guidance of senior members.

Membership 2023: 26 full professors, 16 associate professors, 46 assistant professors, 14 lecturers, 25 postdocs, 58 PhD students, eight researchers with other positions at universities and 11 members working outside the academy.

Activities

Vincent Blok - Research day

Research day: The biennial *research day* took place in 2023 and facilitated the meeting of researchers and their research in the heart of Utrecht. This year, the research day focused on sharing the research of several members. 22 members presented their research. There was also time for informal discussions between members. The day ended with a dinner. There were +/- 60 members who participated in the day.

Education: By 2022, the 4TU. Centre Ethics & Technology had already put more emphasis on strengthening its own *graduate school*. In 2023, this was followed up by organising an education day. During this education day, coordinators of the various PhD courses exchanged information about their courses, followed by a fruitful discussion about further developments and possible improvements in education and the interrelationship between the courses. In addition, 4TU.Ethics in 2023 developed and offered two new courses 'Empirical methods for Philosophers of Technology' and 'Continental Philosophy of TechnoScience'. These courses were well attended and positively assessed.

PhD council: This year's PhD council consisted of Bouke van Balen (TU/e), Maaike van der Horst (UT), Karen Moesker (TUD), Anna van Oosterzee (UU) and Luuk Stellinga (WUR). They organised two *writing reteats* and social events for PhD students. They also worked to involve the PhD student community in the centre's work.

PhD day: Every year, the centre organises a day for all PhD students who are members. As several PhD students indicated that they wanted to orientate on their career after completing their PhD, the 2023 PhD day focused on the career theme. Members with a variety of different (non-academic) careers engaged in discussions with the PhDs about their chosen career paths. There was also room for social interaction.

Blog: The team that publishes the blogs on the 4TU.Ethics website started several new blog series in 2023. For two of these series, the team collaborated with the *graduate school*. From this, the Design for Justice 2023 and Responsible innovation 2023 series were born. The team also started a series in which alumni of the centre talk about their passion for research. There has been a demand from members to also look at ethics outside the university. This is done in the blog series Ethics beyond academia. The team consists of: Anne Marte Gardenier (TU/e), Anna Melnyk (TUD), Karen Moesker (TUD), Isaac Oluoch (UT) and Leon Rossmaier (UT).

Agenda 2024

In 2024, the centre will continue to implement the strategic plan as adopted in 2023. All courses, social events, etc. will continue to be organised in 2024. A new course on Philosophy and Ethics of Artificial Intelligence will start in cooperation with OZSW. In addition, the 4TU.Centre Ethics & Technology will organise a conference in collaboration with the gravity programme on *Ethics of Socially Disruptive Technologies (*ESDiT). Furthermore, in consultation with the members, we will investigate which theme is suitable for the PhD day 2024.

10 Health

Scientific Director	Richard Goossens (TUD)
Coordinator	Hanneke Bodewes (UT)
Team	Maroeska Rovers, Mariska van den Berg (UT), Noortje Bax (TU/e), Agnes Berendsen (WUR), Emelie van Bentum, Jaga Schreiber (TUD)

Throughout 2023, 4TU.Health renewed its efforts on many fronts to unite and raise the profile of health-related activities within the Universities of Technology. Technology is becoming increasingly important in addressing major societal challenges in health and care.

Research

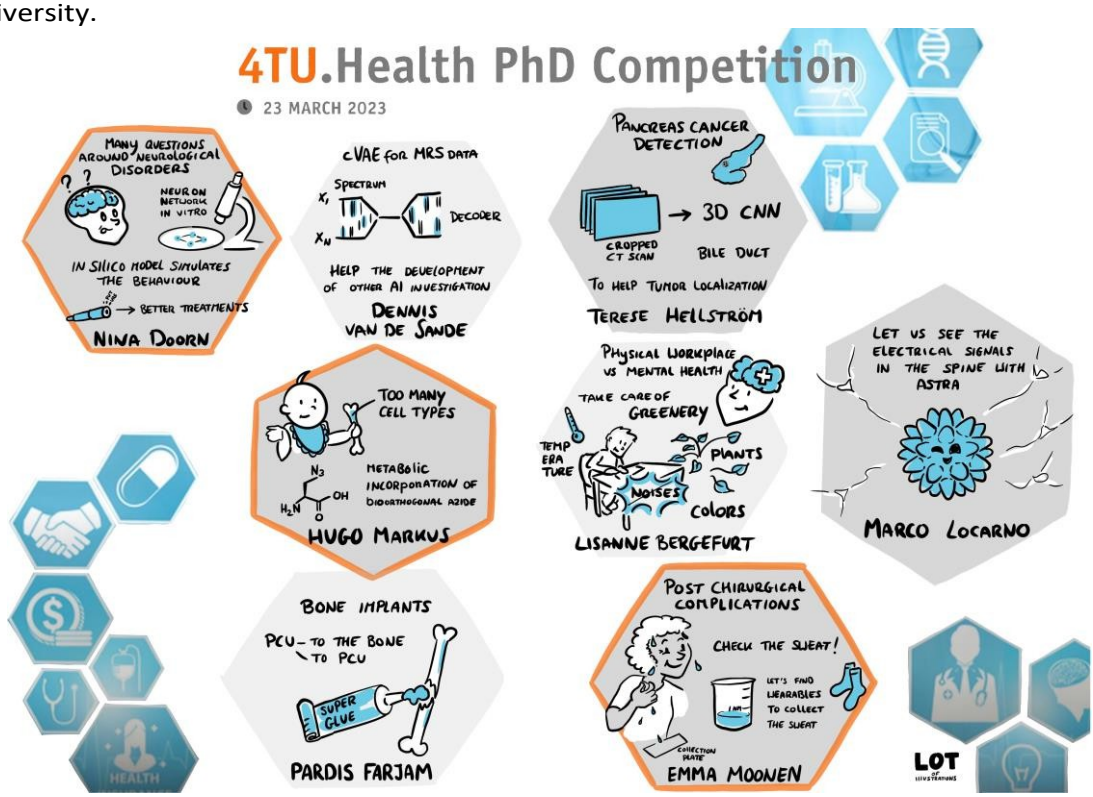
In this context, 4TU.Health contributed to the renewal of the Knowledge and Innovation Agenda (KIA) Health & Care in 2023. From 2024, 4TU.Health will also represent the universities in the governance of this KIA. In addition, in late 2023, 4TU.Health published the Cardiovascular Technology Research Agenda, in collaboration with the DCVA. This exploration identified the potential of eight technology domains for the cardiovascular field. In collaboration with the KWF, a follow-up to the Smart Measurement Technology call was realised. A new round is open in early 2024 and offers excellent opportunities for researchers from universities of technology.

Information

Awareness of funding opportunities by health funds and ZonMw among researchers at universities of technology is still limited. For this reason, 4TU.Health organised successful information meetings with ZonMw and the KWF in 2023.

Visibility

To increase the visibility of 4TU.Health within technical universities and strengthen its own community, a PhD poster competition was held in March 2023. Almost 50 PhD students presented their posters to each other, with three winners receiving a budget of 5,000 euros to start a project together with a PhD from another university.



Drawing of Lot

New teams

In terms of organisation, 4TU.Health started two working groups in 2023: one focused on Human Capital for healthcare and life sciences, in which people from relevant training programmes of the technical universities work together, and one on MDR (the laws and regulations concerning medical devices). With a limited budget, these working groups facilitate exchanges between the universities and represent them in consultations with external parties.

In 2024, 4TU.Health will launch several booster teams focusing on key themes in the healthcare sector, including the deployment of AI, sustainability, workforce in healthcare and design. In launching these initiatives, cooperation will also be sought with other 4TU.Centres that prioritise the health domain, such as 4TU.Construction and 4TU.NIRICT.

11 High-tech materials

Scientific director	Arjan Mol (TUD)
Coordinator	Reina Boerrigter
Management team	Ferdinand Grozema (TUD), Marc Geers, Rint Sijbesma (TU/e), Remko Akkerman, Gertjan Koster (UT), Karin Schroën, Louis de Smet (WUR), Francesco Maresca, Moniek Tromp (RUG)

4TU.HTM is a networking centre that encourages researchers to collaborate and develop new initiatives; activities that benefit materials science research and education for the development of sustainable technologies. This involves the entire academic materials community in collaboration with external parties and industrial partners, and materials science research from fundamental to applied, and from nanotechnology to structures. In addition, 4TU.HTM aims to create awareness of the social importance of (sustainable production, use and recycling of) materials and of materials research with a view to applications for the energy transition. A trans-disciplinary approach is essential here, and the visibility and availability of experimental facilities an ongoing concern.

Collaboration & visibility

Since January 2023, 4TU.HTM has collaborated with the RUG, both at the policy level and within the materials science community; Advanced Materials researchers (RUG) are part of 4TU.HTM's board and network, and are involved in all activities.

4TU.HTM sets aside an annual budget to fund joint activities. As a result of a Lorentz Centre Workshop sponsored in 2022, a *Soft Matter* article by 29 international experts involved was published in 2023. In 2023, contributions were made to two meetings and a small-scale research project:

- The *Symposium Additive Manufacturing of Energy Materials* (M2i, UT, RUG);
- the *3rd ECCM Graduate School - powered by GroenvermogenNL*, with the theme 'Electrochemistry
  For green energy and material transition';
- The development of *Miniature actuator mechanism for aerospace application using shape memory material* (UT, TUD).

4TU.HTM was in charge of organising the *Soft Matter & Self-Assembly* joint workshop (January 2023). In December 2023, the first national *MaterialenNL Conference* was organised in collaboration with M2i and the MaterialsNL Platform. 4TU.HTM contributed to this both financially and in the organisation, with delegates in the steering committee and the programme committee.

4TU.HTM's X-profile has grown to over 700 followers by 2023, and, in addition to the website and LinkedIn group, contributes to the online visibility of the network's materials science activities.

Educational activities

The 4TU.*Responsible Sustainability Challenge*, a joint initiative with **4TU**.Energy, **4TU**.Ethics & Technology and the local Honours Offices, finished well in June, and was followed up in November. In addition, a physical series of *Presenting Materials Science Skills Courses* for PhD students started in 2023, with sessions at RUG, UT, and WUR. The *M2i & 4TU.HTM Business Awareness Course* for materials science PhD students and postdocs, with a view to future careers in industry or science, took place in February.

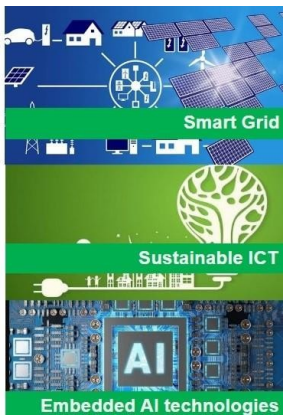
Looking ahead to

In 2024, **4TU**.HTM will further focus on the expansion and visibility of the materials science research community, including by contributing to a project within the framework of the NWA route Materials: Made in Holland with the aim of making an inventory of materials science knowledge and expertise. New policy on *funding* for *joint materials science activities* will also promote applications for *seed funding*, and more concrete joint activities with RUG will be defined. April 2024 will see the *kick-off* of the **next4TU**.HTM Committee. Two candidates per university were selected for this at the end of 2023. **4TU**.HTM will give this committee the initiative to organise activities specifically relevant to the target group, with *community building being* the main focus, and diversity and inclusiveness will be important starting points.

12 NIRICT

Scientific director	Mark van den Brand (TU/e)
Co-Scientific director	Suzan Bayhan (UT
Programme manager	Margje Mommers (TU/e)
Board	Marc Geilen (TU/e), Alan Hanjalic / Alle-Jan van der Veen / Justin Dauwels (TU Delft), André Kokkeler (UT), Bedir Tekinerdogan / Tarek Alskaif (WUR), Vasilios Andrikopoulos (RUG)

4TU.NIRICT encompasses all ICT research at the technical universities in the Netherlands and focuses on the interface between Electrical Engineering and Computer Science. The mission of 4TU.NIRICT is to increase the impact of ICT research in the Netherlands by bringing together EE and CS researchers, recognising, valuing and facilitating young scientists and promoting diversity, equality and inclusion (DEI) of the Dutch ICT community. All this is done through community-building activities such as the annual Community Day and various calls, among others.



Cooperation with the University of Groningen

From 1 January 2023, the Bernouilli Institute will be a full partner of 4TU.NIRICT. From Groningen, Vasilios Andrikopoulos joined the MT and Bayu Jayawardhana expanded the board. With RUG joining 4TU.NIRICT, the opportunities for collaboration, knowledge sharing and community building have multiplied for both parties.

Community Day

On 13 December 2023, our annual Community Day took place with the participation of some 50 researchers. The day focused on four themes: Energy and ICT, Health and ICT, Agriculture and ICT and Sustainable ICT. Several pitches were given during the first breakout sessions and the second breakout sessions identified the most pressing issues and research areas per theme. We look back on a very successful Community Day, with enthusiastic participants and good substantive discussions. The input gathered will be developed and followed up in the coming months.

Community activities

To support ICT-related activities that help strengthen the 4TU.NIRICT community, NIRICT has funded five projects through the Community Funding call. All honoured projects have a good balance between the contribution of Computer Science and Electrical Engineering, are related to the four themes and/or the ICT next generation (ICTng). Topics include; Cyber Security, electric vehicles, touch research, programming education, and FPGA technology for HPCDA. As in previous years, 4TU.NIRICT was again a partner of ICT.OPEN. Among other things, we organised a successful NIRICT session related to the themes of energy, agriculture and health. There were also three poster presentations of NIRICT projects.

Agenda 2024

In 2024, 4TU.NIRICT will continue the calls in terms of Community and DEI funding. A Community Day will also be organised again and will focus on the four themes; health, energy, agriculture and sustainable ICT. NIRICT would also like to cooperate with ICT.OPEN again and promote the next generation. In addition to the cooperation with the various faculties, we will also further expand cooperation with other 4TU.Centres such as 4TU.Energy and 4TU.Health. In 2024, we would also like to take a first step to better inform and encourage secondary school students to choose a technical further education.

13 ResearchData

Director	Daniel Bangert Madeleine de Smaele (Repository Manager)
TUD	Irene Haslinger (Director, TUD Library)), Iulia Popescu (Communications Advisor) Alastair Dunning (Head of Research Services)
TU/e	Floor Luub (Data Steward)
UT	Maarten van Bentum (Data Librarian)
WUR	Laura Zeeman (Data Librarian)

In spring 2023, 4TU.ResearchData launched its very own in-house developed free and open source repository software, called Djehuty. With this launch, we are proud to move to a free and open-source software, in support of our open science efforts and overall vision.

Another big achievement of 2023 is our continuous involvement in the Skills4EOSC project. 4TU.ResearchData has been contributing to the project by creating a curriculum for data stewards as well as building data stewards communities in Europe and connecting to the wide European Open Science Cloud (EOSC). We also participated in the 1st fellowship programme of the p r o j e c t .

Next to this, 4TU.ResearchData is housing TDCC NES, the Thematic Digital Competence Center for the Natural & Engineering Sciences (TDCC NES). TDCC NES aims at facilitating the implementation of FAIR data and software by mitigating a multitude of challenges currently faced by the NES researchers. Among others, the key achievements during the first year of TDCC-NES were: appointment of a Network Manager and Community Coordinator; establishment of a (joint) TDCC website, blog and newsletter; contact with all key LDCC stakeholders; recommendation of two bottleneck project proposals by the leads and submission to NWO.

In November 2023, 4TU.ResearchData welcomed Daniel Bangert, our new Director. Daniel Bangert previously held the position of National Open Research Coordinator at the Digital Repository of Ireland, where he worked extensively on supporting and advancing open science across Ireland. We look forward to working together with him in the coming period.

14 Engineering Education

Director	Perry den Brok (WUR, until June) / Remon Rooij (TUD, from June)
TU Delft	Marcus Specht (leader), Remon Rooij (co-leader), Renate Klaassen (programme coordinator until September), Vera Scheepers (programme coordinator, from September), Noortje van der Kraan (support)
TU/e	Esther Ventura-Medina (leader), Caroline Vonk (programme coordinator)
UT	Cindy Poortman (leader), Luuk Bunk (programme coordinator)
WUR	Emiel van Puffelen (leader and programme coordinator), Judith Gulikers (leader, joining in September 2023)
Advisory Board	Kristina Edström (KTH Stockholm, chair), Marc de Vries (TUD), Ines Lopez (TU/e), Nieck Benes (UT), Erik Heijmans (WU), Ellen Siebers (Student UT)

The 4TU.Centre for Engineering Education (CEE) initiates and stimulates innovations in and research into engineering education. It does this with educational innovation, linked to research, strategy development, policy advice and international cooperation. The range of projects and activities includes a range from short innovation projects to longer-term postdoc and PhD projects. Liaison with international experts and relevant literature are part of CEE's approach. The Centre regularly presents its results on its own Innovation Map, with almost 300 projects, and in its own Newsletter, sent four times in 2023. We also present results at conferences, including SEFI and CDIO, during workshops and our own events, in scientific journals and in the media.

The board saw the transfer of chairmanship this year and bid farewell to Delft's programme coordinator of the first hour Renate Klaassen in 2023, who has been succeeded by Vera Scheepers. From January '24, in Wageningen, Judith Gulikers (leader) and Stijn Heukels (programme coordinator) will take over from Emiel van Puffelen and Perry den Brok. In Twente, Priyanka Pereira will start in 2024, succeeding programme coordinator Luuk Buunk. T h e r e have also been quite a few changes within the advisory board. Besides some changes from the 4TUs, it now also consists of two international colleagues, two student members and one RUG member.

Collaboration

In 2023, cooperation with the RUG has been further shaped. Our CEE.RUG contact Gerald Jonker regularly attends CEE board meetings; an *advisory board* member has been installed on behalf of the RUG; and the RUG has become involved in several CEE projects.
Together with KU Leuven and the University of Melbourne, CEE organises the *PRACtESE* symposia for PhD students in the field of Engineering Education Research. Our CEE PhD students, 16 in total, and their supervisors and promoters actively contribute to the sessions.

A sizeable group of 4TU colleagues is very active within the international CDIO and SEFI *communities*, both as conference delegates and *liasion officers*, but also in working groups, as reviewers and/or as editorial board members of the *European Journal of Engineering Education* (SEFI). Our international cooperation on interdisciplinary engineering education with Aalborg University (Prof. Anette Kolmos et al.) is also intensive.

Themes

Last year, the themes of the 2022-2025 strategic plan continued to take centre stage. The 4TU.CEE '22/'23 midterm progress report reports extensively on our results and impact. For instance, there were several 4TU events around *Challenge Based Learning* including the first national CBL congress in Eindhoven and a series of CBL webinars. The SEFI deans convention '*Leadership for Digitalisation in Higher Engineering Education*' held in Twente was largely dedicated to the *Digitally Literate Engineer*. Within the ICT-Enhanced Engineering Education theme, an active community on 4TU Learning Analytics has emerged. And in the Responsible Engineer area, a new 4TU-wide study on 'Teaching for Sustainability' was approved, which addresses the teacher professionalisation needed to integrate this topic into engineering education. The 4TU Entrepreneurial Engineering Education group, including the CEE postdoc and PhD, remain active and work closely with local entrepreneurship centres.

Within the *Teaching Excellence* theme, several major projects are underway including '*Teacher professional learning in the context of innovations in higher education*' (Teachers2Learn project). As a follow-up to the *Teaching Culture Survey* 2022 and the 4TU.CEE-led Sector Plan project 'Teaching Excellence and Teaching Careers', the 4TU.CEE was asked by the rectors to make concrete suggestions on how to accelerate success with the Recognition and Appreciation-with-accent-on-education policy. This resulted in the recommendation *Room for everyone's educational talent*, which is now being widely disseminated and discussed in the institutions.
Besides all these collaborative projects, the 4TU.CEE also supports a range of local initiatives and projects around the themes of our strategic agenda that can be found in the '22-'23 progress report and our regular communication channels.

Looking ahead to 2024

In March, CEE leaders and coordinators will go on a working visit to Groningen. In May, the Teachers2Learn project will have its closing event. On 9 October, the 4TU.CEE will organise the sector plan closing event 'Educational Quality and Educational Careers' in Utrecht where Ruth Graham and one or more rectors will also attend. And 2024 will also mark the launch of the Strategic Agenda CEE 2026-2029 to be developed.

CBL Conference Ines Lopez Arteaga

15 Resilience Engineering

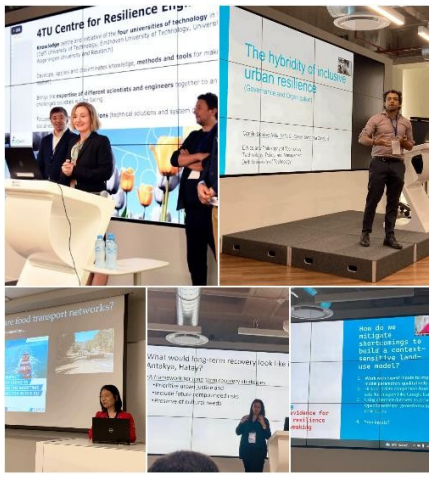
Scientific director	Tina Comes (TUD)
Managing director	Stephanie Hessing (UT)
Management team	Maria Pregnolato (TUD), Geert Jan van Houtum (TU/e), Ahmadreza Marandi (TU/e), Joanne Vinke-de Kruijf (UT), Andy Nelson (UT), Maximilian Koppenberg, Miranda Meuwissen (WUR)

Introduction

The 4TU_.Centre for Resilience Engineering (4TU.RE) develops, implements and disseminates knowledge, methods and techniques, to make societies more resilient. 4TU.RE focuses on *engineering solutions* (technical solutions and system designs) interacting with socio-ecological systems.

Main Activities in 2023

Community: 2023 was a transition year due to the end of the HTSF DeSIRE programme. See an article on the impact generated by DeSIRE here. Partly prompted by career moves, this led to a refresh of the management team. The MT still meets every month, very constructively! Some DeSIRE Fellows are now **permanently attached to 4TU. RE through (permanent) appointments**. Also, many of the DeSIRE PostDocs have moved on to permanent positions within 4TU and - partly as a result of this - remain driving forces within the Centre.

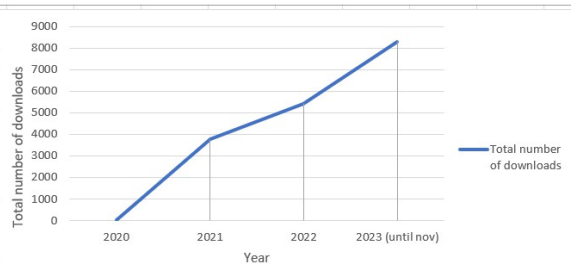


Research: In 2023, 4TU.RE co-hosted the international ICRS congress in Mexico City. We were represented with a delegation of seven researchers. Also in 2024, together with ETH, 4TU.RE co-organises this international resilience congress; by now one of 4TU.RE's flagships!
One of the key methodological issues for resilience remains measuring resilience. However, while there is a plethora of methods, there is a lack of empirical evidence and comparative research. This is why, internally, our methodology programme. The idea is to develop innovative approaches to Resilience Assessment in two parallel lines - quantitative and qualitative. A first successful workshop on this was held from the 4TU.RE Community and follow-up activities will take place in 2024. During this meeting and preparations, this proved to attract a large (>15) number of *new* colleagues, who thus now feel connected to 4TU.RE.

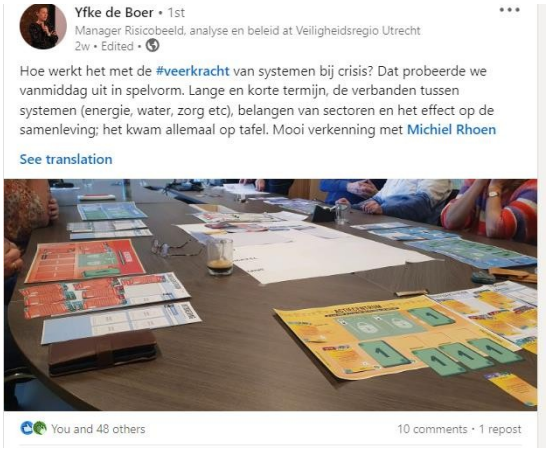
External Impact in 2023

Education: In 2023, 4TU.RE received from SURF access to the data regarding the number of downloads of RE's open education elements. The figures are surprisingly high, but according to SURF in line with the other, very active, OpenEd platforms. In 2024, we will continue to upload new materials and interview 4TU programme coordinators about their interest in the open- RE materials.

Year	Total number of downloads	Video in most demand
2020	6	-
2021	3768	Deconstructing Urban Resilience - Claudiu Forgaci (BK-TUD)
2022	5429	Tutorial: R for NetLogo - George van Voorn (WUR) part 1 of teaching module "Sensitivity Analysis for Agent Based Models"
2023 (until nov)	8300	Adaptive Robust Optimization - Reza Marandi - Course Robust policies for operations management problems



Valorisation: Some safety regions together with the Netherlands Institute for Public Safety, have approached 4TU.RE for a further development of the serious game RElastiCITY. This game is extremely suitable for policy-makers and decision-makers in the public domain who, in daily practice, are confronted with small or large 'stresses & shocks' within the urban context and want to make resilience-enhancing decisions. An RE delegation from various research groups was also involved in a workshop at the Utrecht Safety Region where a start was made on a VRU Resilience Parameters overview. Several other follow-up activities are planned for 2024.



Finally, in 2023, 4TU.RE started a series of interviews with some of our central forces which led to greater visibility of the centre and our work. The LinkedIn community grew and articles were picked up in both professional journals and university magazines.

16 Stan Ackermans Institute

Director	Paul Koenraad (TU/e)
Coordinator	Laurie Baggen (TU/e) (also coordinator TU/e)
Board	Ariana Need (UT), Andrea Ramirez Ramirez (TUD), Wouter Hendriks (WU)
Coordinator TUD	Pieter Swinkels
Coordinator UT	Hans Voordijk
Coordinator WUR	Claudius van de Vijver, Femke Brouwer

The Stan Ackermans Institute (SAI) is the banner under which the design programmes of the technical universities in the Netherlands are presented to potential trainees and industry. The members of SAI's board are the deans of Graduate Schools of the four TUs, chaired by TU/e.
The SAI presents itself with a website, brochures and posts on social media. To recruit potential trainees, the SAI also attends company days at the four TUs and other relevant *career events*. The EngD ambassadors (a group of enthusiastic trainees) support these activities. A project book is published annually with a selection of design projects that trainees have carried out.

Training

TU Delft has three active programmes, University of Twente five and TU Eindhoven nine. Wageningen University has started its first EngD programme: Designs of AgriFood and Ecological Systems. SAI is in contact with the University of Groningen, where two EngD design programmes will start next academic year (2024-2025).

The total inflow into the 2023 programmes at all four universities was 166, of which over 70% were at TU/e. This is similar to previous years. 159 Trainees received their Engineering Doctorate in 2023.

A year of recognition

In 2023, the Stan Ackermans medal, an award recognising extraordinary contributions to the Stan Ackermans Institute, was awarded twice. Giljam Bierman (TUD) received the medal in February for introducing and 'onboarding' more than 250 internationals into Dutch academia and industry. Thanks to his personal approach in doing so, over 80% of them continued to work in the Netherlands after graduation. In June, Pieter Swinkels (TUD) received the 4TU Stan Ackermans medal for his indispensable role in setting up and expanding two of the EngD programmes in Delft of which he is director.

Future plans

The SAI, in consultation with KIVI and CCTO, is working on a new form of accreditation of EngD programmes in which institutions will be given greater responsibility for quality assurance and the start and termination of EngD programmes. To this end, all institutions will be assessed in a single national process. Furthermore, the SAI is working on a process whereby EngD programmes within the Netherlands will be clustered into three domains with which more substantive alignment and cooperation will be sought.

Overview of intake and diplomas designer courses 2018-2023

	2018		2019		2020		2021		2022		2023	
	D	I	D	I	D	I	D	I	D	I	D	I
TU Eindhoven												
Process and Product Design (PPD)	30	21	26	22	19	22	20	24	18	22	25	21
Information and Communication Technology (ICT)[1]	10	5	8	5	8	6	3	8	5	5		
Logistics management systems (LMS)[2]	8	0	1	0	0	0						
Mathematics for Industry (MI)	0	0	0	0	0	0						
Software Technology (ST)	20	18	15	19	16	17	18	19	12	18	20	19
Design and Technology of Instrumentation (DTI)	9	0	6	0	1	0						
Architectural Design Management Systems (ADMS)	0	0	0	0	0	0						
User-System Interaction (USI)	10	1	2	1	1	1			0	3	0	7
Automotive Systems Design (ASD)	14	14	13	15	13	16	13	16	14	11	15	16
Smart Energy Buildings & Cities (SEBC)[3]	1	12	15	9	10	23	9	13	17	5	15	10
Clinical Informatics (CI)	12	13	10	14	12	14	10	11	15	11	9	12
Qualified Medical Engineer	6	7	5	4	7	7	4	6	7	11	4	11
Data Science (DS)	9	20	16	25	19	12	21	16	11	16	16	17
Automative Systems Design (ADS) Mechatronic Systems Design (MSD)											*15*	*16*
Design of electrical engineering systems (DEES)											*4*	*5*
Total	*129*	*111*	*117*	*114*	*106*	*118*	*98*	*113*	*99*	*102*	*108*	*118*
TU Delft												
Process and Equipment Design (PED)	10	10	12	13	7	9	6	7	14	8	10	11
Bioprocess Engineering (BPE)	8	7	7	7	6	7	7	7	7	7	7	7
Comprehensive Design in Civil Engineering (CDCE)	0	0	0	0	0	0						
Chemical Product Design (CPD)	9	8	6	8	6	6	6	5	5	1	6	0
Civil & Environmental Engineering	0	5	0	6	2	5	4	6	3	6	6	6
Total	*27*	*30*	*25*	*34*	*21*	*27*	*23*	*25*	*29*	*22*	*29*	*24*
Twente												
Energy and Process Technology (EPT)	9	12	6	10	7	5	6	6	5	5	5	4
Robotics	4	3	2	1	4	1	1	7	0	1	4	1
Civil Engineering (CE)	4	7	6	7	5	6	4	6	5	6	6	2
Healthcare Logistics	0	0	0	0	0	0			2	0		
Maintenance	8	7	2	2	3	4	3	3	0	4	1	2
Business & IT				0	0	1		8			6	2
Total	*25*	*29*	*16*	*20*	*19*	*17*	*14*	*30*	*12*	*16*	*22*	*11*
TU Wageningen												
Design for AgriFood and Ecological Systems											0	13
Total											0	13
Total 4TU	**169**	**154**	**166**	**198**	**140**	**173**	**181**	**170**	**140**	**140**		

[1] *New name: Design of Electrical Engineering Systems*
[2] *New name: Industrial Engineering*
[3] *New name: Smart Buildings & Cities*

17 High Tech for a Sustainable Future

Five research programmes with a total budget of 22 million within the *High Tech for a Sustainable Future* (HTSF I) theme were launched in 2018. In doing so, the 4TU.Federation gave a solid boost to research and education in the field of sustainable technology. In doing so, the four technical universities took the lead in creating significant impact on long-term societal challenges. The research proposals matched the focus topics from the top sector policy, the *National Science Agenda (NWA)* and the *Sustainable Development Goals* of the United Nations. In 2022, it was decided to establish a second round, HTSF II. In this round, four programmes were honoured, Green Sensors, Heritage, REDESIGN, RECENTRE. The programmes from Round I were completed and embedded in the institutions in 2023.

17.1 Plantenna (HTSF-I)

Programme leader: Peter Steeneken, TUD Main results and

external impact in 2023

HTSF event

The 4TU.HTSF event took place in June 2023, looking back on completed projects and launching new ones. Startup company Plense Techologies, a spin-off of Plantenna pitched at this to show what these kinds of collaborative projects can achieve.

Lorentz workshop 'Giving plants a voice'

The workshop 'Giving plants a voice' brought together a multidisciplinary group of over twinting experts in plant physiology, plant diseases, plant-water relations, photosynthesis, remote sensing and sensor technology. In a series of brainstorming and working sessions, inspired by presentations by the experts, the participants together generated ideas for crop disease detection directly in the field. The central idea that emerged is the 'sentinel plant'. Analogous to the canary in the coal mine, a "sentinel plant" signals conditions of disease and stress at an early stage due to its high sensitivity.

Workshop at UNLimited 2023

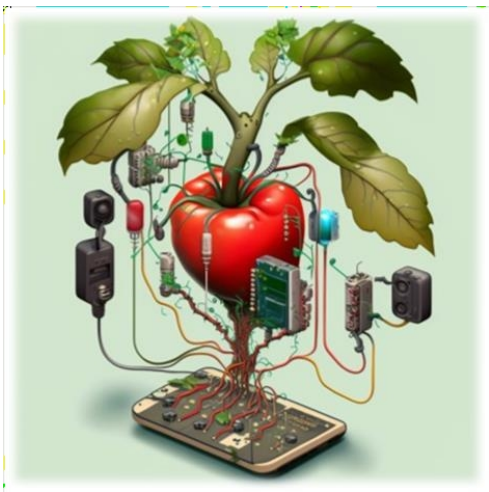
Interactive workshop organised by the 4TU.Federation with the Plantenna team and startup company Plense Technologies, with around 20 participants from universities and government organisations.

Joint scientific publication

Steeneken, P.G., Kaiser, E., Verbiest, G.J. and ten Veldhuis, M-C., Sensors in agriculture: towards an Internet of Plants. Nat Rev Methods Primers 3, 60 (2023).
https://repository.tudelft.nl/islandora/object/uuid:ad60e646-b145-4b3f-8c4c-db864fb4b5d6 A major scientific presentation presenting the results of the latest measurement campaign based on the Plantenna sensor network is almost ready for submission.

Philips Innovation Awards, Rough Diamond Award

Plense Technologies, a company set up by MSc. students and scientists at Plantenna. https://www.phia.nl/edition/2023



Other relevant presentations:

- Plantenna: with sensors towards an 'Internet of Plants', by Peter Steeneken, Technet meeting at Koppert Cress (Monster), 21-3-2023 (link).
- Cyberplants and Cellular Communication, Peter Steeneken. InScience International Science Film Festival Nijmegen supporting act at the film Vesper (Nijmegen), 17-3-2023 (link).

17.2 Precision Medicine (HTSF-I)

Programme leader: Michel Versluis, UT

With the integration of *deep learning*, a special form of artificial intelligence, and medical imaging techniques, the 4TU *Precision Medicine programme* aims to take diagnostics to the next level. In this way, the researchers involved aim to unlock more relevant medical information. This will enable a shift from a one-size-fits-all *approach* to a tailored, personalised approach. In this way, long-term care can be kept accessible and affordable.

Tenure tracks

Seven tenure trackers work within this cross-domain programme together with 19 postdocs. In addition to a unique, independent academic profile, all tenure trackers have direct involvement in the improvement and innovation of university-wide education. Although the 4TU programme for the tenure trackers is administratively closed by the end of 2022, the tenure trackers are now firmly embedded in the academic structures of the TUs. All tenure trackers are expected to have a permanent appointment by 2024. The size of the new tracks includes 20 postdocs, 24 PhD students and two researchers. This successful permanent embedding is a very valuable *return on investment*.

New initiatives

Within their now consolidated network, the tracks develop all kinds of new programmes, e.g. also through very competitive personal grants such as NWO VENIs, Marie Skłodowska Curie flagship programmes and ERC Starting grants. Furthermore, the programme's close ties with members of the **4TU.**Health network have led to new initiatives under the National Growth Fund and Gravity, and within the European Innovative Health Initiative (IHI) in applications strongly driven by the *medical device* industry. With that active involvement of the tracks, in particular the implementation of new technology in hospitals in direct collaboration with clinical partners, the programme and its network are sorting towards better and patient-centred healthcare that radiates further into society. The most notable initiative of the tracks is undoubtedly the submission of an NWO Perspective programme proposal (P23.011) on imaging the vascular network for oncological and cardiovascular disease states. This proposal was jointly submitted by all tenure trackers, has now been selected for full elaboration, and demonstrates the quality of the potential and long-term continuity of the programme.

Sustainability

As mentioned, the strength of the programme lies in an interwoven and intertwined network of collaborations with a number of crucial *stakeholders*. These include, first of all, active participation within national research schools, such as the J.M. Burgerscentrum (i.e. biomedical fluid dynamics), the Dutch Medical Ultrasound Association NVMU and the Dutch Cardiovascular Alliance DCVA. In addition, the programme's PIs are directly involved in the implementation and management of research consortia and research infrastructure, such as the ultra-X-treme Perspective programme and the uNMR-NL consortium, which by nature have a strong embedding within non-4TU universities, university medical centres, top clinical hospitals and the *medical device* industry. Conversely, the embedding of clinical professors within this programme is a flywheel for successful translation to the clinic and brings an additional and extremely valuable cross-fertilisation with industry, which together then guarantees a sustainable connection to patient care.

Track 1: Guillaume Lajoinie, assistant professor, Physics of Fluids group
Science and Technology, University of Twente.
Track 2: Jelmer Wolterink, assistant professor, Mathematics of Imaging and AI group Electrical
Engineering, Mathematics and Computer Science, University of Twente.
Track3: Simona Turco, assistant professor, Signal Processing Systems group
Electrical Engineering, TU Eindhoven.
Track 4: Min Wu, assistant professor, PULS/e lab
Biomedical Engineering, TU Eindhoven.
Track 5: David Maresca, assistant professor, Medical Imaging, Dept. Imaging Physics Science
and Technology, TU Delft.
Track 6: Sebastian Weingärtner, assistant professor, MARS lab, Dept. Imaging Physics
Science and Technology, TU Delft.
Track 7: Camilla Terenzi, assistant professor, Biophysics group
Wageningen University of Research.

17.3 Pride and Prejudice (HTSF-I)

Former programme leader: Aarnout Brombacher, TU/e

Pride and Prejudice (P&P) aims to gather new scientific knowledge and innovative technology that can convince and support people to adopt healthier lifestyles. This HTSF programme combines real-life monitoring via sensors (food intake, physical activity and health parameters), the development of design interventions at different levels of the system (person, group, society), and the evaluation of the effectiveness of these combined interventions.

Approach and valorisation

The last year of this programme was mainly dedicated to dissemination of research results and setting up and funding follow-up projects that emerged from P&P. For instance, several P&P researchers presented their projects during Dutch Design Week 2023 and the 4TU.HTSF Cross-over event, at (inter)national conferences (e.g. Healthcare in Shape, ICED23, EHPS23, DCRM23, CHI23, EACR23, ERSCP23), and work was also accepted for conferences in 2024 (DRS2024, CHI2024). From TUD, P&P researchers published the Inclusive eHealth Guide, a handbook for designers, researchers, managers and healthcare professionals for developing inclusive eHealth applications. At the conclusion of P&P, we organised a dinner for P&P researchers and MT members, and we started work on a magazine, describing the results of five years of P&P (expected publication April 2024).

New projects & funding

With new funding, new projects were launched in 2023, and existing projects were followed up. P&P researchers from WUR, UTwente and TU/e together received a *seed grant* (€40k) to develop a prototype to measure breastfeeding intake of babies. In addition, a UT project received €60k to develop technology for rehabilitation after CVA, and the TUD to explore AR technology to promote exercise in children in the ICU (€20k). WUR and TU/e's Healthy LIFestyle for low-literate teenagers (LIFTS) project has been awarded €1.4m from NWO-KIC in 2023. A project on obesity and stigma has been transferred to a publisher for further dissemination and implementation in 2023. A broad consortium with researchers from UTwente and TUD received 2.1 million euros (NWO care in its own environment) to set up lifestyle improvement with *remote monitoring* for people with metabolic syndrome. A PhD and a Postdoc have since been hired on the project. Partly due to P&P, the strategic collaboration between TU/e and WUR (together with UU/ UMCU) received an extra impulse, with the establishment of the Institute 4 Preventive Health (I4PH).

Education

Also in 2023, the topics of nutrition and exercise for prevention, *remote monitoring* and behaviour change received a lot of attention in education, and there were collaborations between the different P&P researchers and institutions. MSc students were supervised in 2023 on topics such as eating behaviour and monitoring (WUR and UT), rehabilitation and monitoring in cardiac and CVA patients (TUD and UT), supporting exercise behaviour in elderly people with disabilities, athletes and rheumatoid arthritis patients (TUD, UT), and data collection and visualisation via sensors in athletes (TU/e). P&P researchers are also frequently asked for guest lectures, both at their own institution and outside: UT researchers at Erasmus University Rotterdam on designs for behavioural change, WUR and UT researchers at TUD on behaviour and ethics, and TUD researchers at Design Academy and Erasmus Medical Centre on designs in healthcare. P&P themes and researchers also played a role in educational development: at UT, the P&P project on vegetable intake was integrated into the MSc subject Design of Persuasive Health Technology in Psychology, and at TUD, the subject Supporting Humans is being developed for the revision of the Industrial Design Engineering Master for 2024. With TU/e, a course on Data Mining (for health and wellbeing) was developed within Jheronimus Academy of Data Science.

Publications

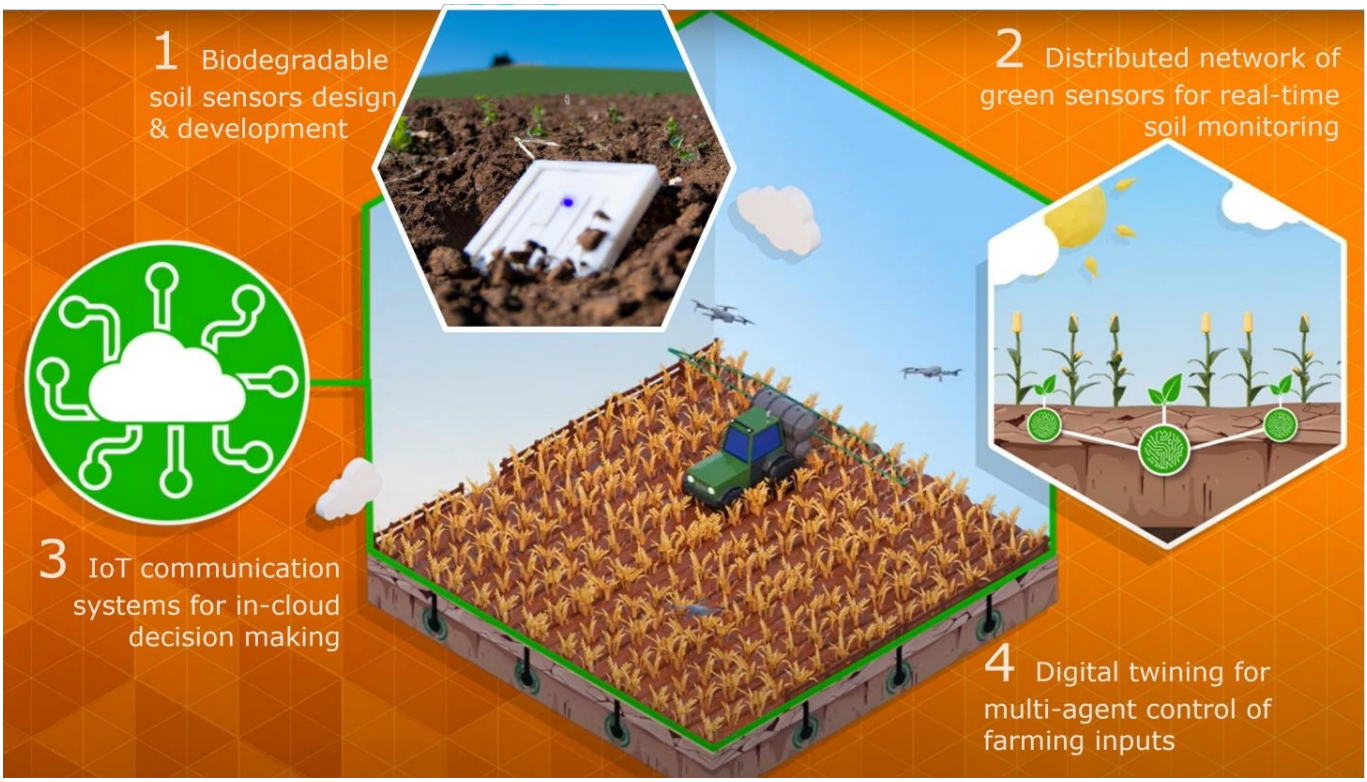
In the past year, several studies have been published that have come about through collaboration between various P&P researchers and institutes. Papers have been published in journals such as Frontiers in Computer Science, Sensors, Design for Health, International Journal of Design, and JMIR, among others, on the topics 'decision support systems for online food shopping', 'social agents

for behaviour change', 'digital twins', 'self-tracking and goal setting', 'inclusive eHealth development' and 'eating behaviour'.

17.4 Green Sensors (HTSF-II)

Programme leader: Congcong Sun, WUR

The 4TU 'Green Sensors' programme focuses on developing a new generation of soil sensor systems and network technologies that are biodegradable and must protect agricultural soils from e-waste, heavily occurred due to the use of active electronics in traditional sensor technologies, as an effective and affordable alternative to the current sensing systems. The use of densely distributed network of the proposed sensing technologies in smart applications of farming resources (i.e., fertiliser, water, etc.) aims to combat challenges in agricultural production due to population growth, climate change, resource depletion, and soil degradation.



Kick-off meeting

The 4TU 'Green Sensors' programme kicked off on September 26, 2023, at Wageningen University, aiming to foster connections among a diverse consortium, including agricultural engineers, bio-nano technologists, roboticists, microelectronics, and communication engineers. Participants visited WUR research facilities, gaining insights into agri-food production complexities. The meeting featured presentations, brainstorming sessions, and discussions on developing biodegradable sensing technologies. Despite the challenge of coordinating diverse expertise, the consortium's diversity was seen as an opportunity to create complementary technologies, making the meeting highly inspiring.

Working research team

This programme is in its early phase with a focus on completing its working team, including 4 Tenure Trackers, 2 Postdocs and 5 PhDs, of which 4 have already been hired. TTs are in the lead of designing the scientific scopes and boundaries of the Green Sensors programme, while their corresponding fellows provide suggestions and feedback. Alongside, TTs are developing their individual research lines. PhD students are preparing their research plans through critical literature surveys, aiming to advance scientific development beyond the state-of-the-art. To further strengthen the team work, the whole consortium agreed to have a regular meeting every 6 months, and thus the 2nd meeting is going to be held in April 2024.

Collaboration

Within a short timeframe, the 4 TTs have had several meetings to prepare for a research project submission in 2024, although no concrete decisions have been made yet. Besides, each TT is involved in separate project preparations; for example, TTs in WUR, TU Delft, and UTwente are currently

engaged in preparing a research project aiming to submit for the NWO-OTP grant. A collaborative review paper on green sensors in agriculture is planned to be completed this year. Additionally, TT at WUR has communicated with a soil sensing company (Murata), who could be an active stakeholder in this project. TT at TU/e has made connections with 3 companies (Luxisens, Motis B.V., and Verhaert Masters in Innovation). TT at TU Delft is currently working on a NWO-OTP proposal in collaboration with a company and several stakeholders (Aqualyse, Waterschap Vallei & Veluwe, DASE data science).

Digital outreach

The Green Sensors programme prioritises outreach to societal, scientific, and industrial stakeholders, as well as end users. The programme places significant emphasis on developing content-rich websites hosted under HTSF. It has also agreed to establish a dedicated LinkedIn channel and share scientific updates through the partner universities' websites.

Scientific Outcome:

Although it is early to quantify the research outcomes of the Green Sensors programme, individual team members are highly motivated and dedicated to publishing in journals. The TT at TU/e has already published an article on soft robotics in IEEE Transactions on Haptics (DOI: 10.1109/TOH.2023.3307872).

17.5 Heritage (HTSF-II)

Programme leader: Wim Timmermans, UT

Programme

The 4TU.HERITAGE programme is concerned with answering the question of how we prevent citizens living in ageing built environments from suffering from heat stress due to ongoing climate change. For many Dutch cities, this involves understanding the urban microclimate in 'historic' neighbourhoods characterised by unique street profiles and a significant proportion of aged and historic buildings. This brings additional challenges in energy transition due to low energy labels and restrictions on required interventions. To this end, the HERITAGE team will develop a high-tech detection and design system for the detection, mitigation and prevention of heat stress in such Dutch cities, through socio-technical solutions. This integrated system will detect and predict spatio-temporal patterns of heat stress at very high resolution, aimed at reducing heat stress indoors and in public spaces, by developing urban design guidelines and linking energy transition, housing demand, area redevelopment, climate adaptation and digitalisation.

Team building

In 2023, the cross-disciplinary team took shape through the recruitment of four tenure trackers, two Postdocs and four PhDs (most of whom started on 1 July 2023, one tenure tracker starts on 1 July 2024 and one PhD is foreseen to start in May 2024). This first semester has been used by the researchers mainly for literature reviews to identify scientific gaps at the boundaries between the different disciplines and the research question to be addressed to identify future research directions. A resulting joint *position paper* is in preparation. In addition, the researchers worked in joint sessions to establish urban climate models which, in addition to team building, aims to implement a similar model in each of the Living Labs managed by the groups. This is to facilitate exchange of research results.

Results and activities

This has led to the implementation of a high-resolution urban climate model for Living Lab Enschede, and a submitted contribution to the Dutch Earth Science Congress (NAC) organised by NWO, to be held on 7 and 8 March 2024 in Utrecht. In addition, *special issues* in HERITAGE-themed scientific journals are in preparation, additional manpower has been recruited to serve the HERITAGE programme from related projects and (research) proposals linked to HERITAGE have been submitted. Of these, theURBAN-M4 proposal submitted under the Open ESCience call 2023 to realise the use of images from Google Streetview in climate models has meanwhile been honoured.

External Impact.

The programme was put in the national spotlight by an interview in the Financieel Dagblad (Universities investigate how overheated cities should remain liveable even later), by giving a seminar hosted by the KNAW (Klimaat van alle kanten - Hitte in de stad) and by the AVRO/TROS TV programme Wereld van Morgen with an item on our urban climate research.
International momentum has been built by presenting the HERITAGE programme at the sixth Recent Advances in Quantitative Remote Sensing conference in Valencia (Spain) and the "International Workshop on High-Resolution Thermal Earth Observation", in Frascati (Italy) and by bringing the organisation of the "International Conference on Urban Climate - ICUC-12", the previous edition of which was in Sydney, to Rotterdam in 2025 with the theme 'HERITAGE'.

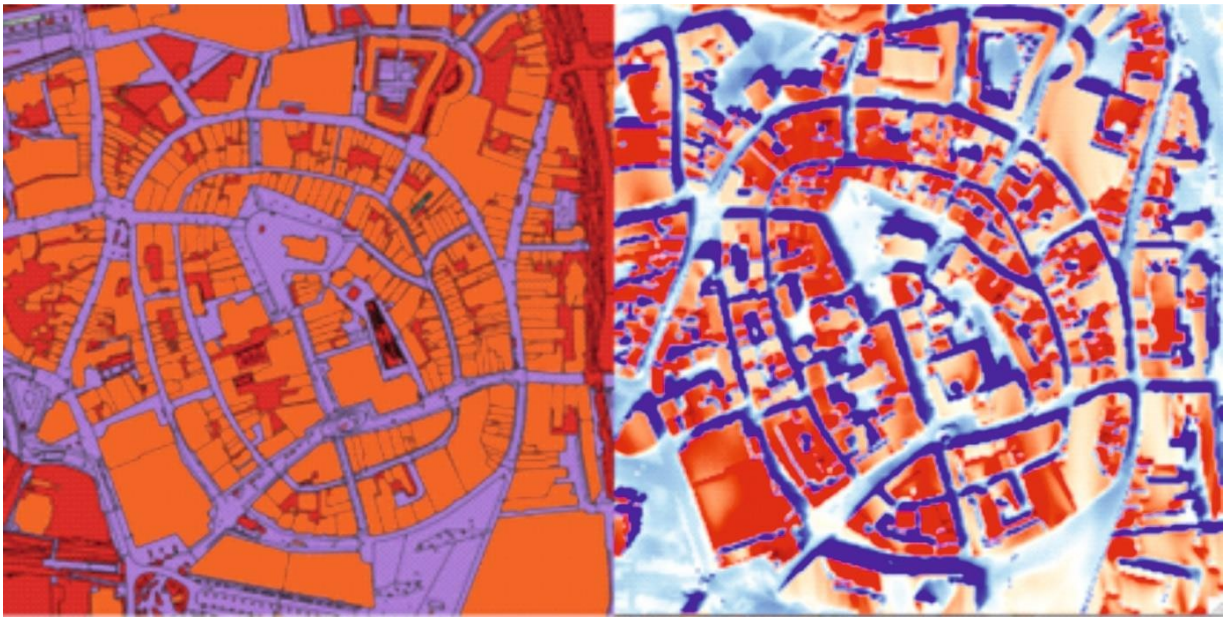


Figure: Mounted urban climate model. (Left) Input geodata such as footprints of buildings, pavements and water bodies for downtown Enschede. (Right) Land surface temperature obtained from PALM4U with a resolution of 2 m.

17.6 Redesign (HTSF-II)

REthinking the food system together; DESIGNing a high-tech and data-driven food system of the future

Programme leader: Miranda Meuwissen, WUR

Target

4TU.Redesign aims to design a food system that focuses on local embeddedness, healthy food, sustainability and resilience. We translate this into a system that revolves around fresh fruit and vegetables grown in local greenhouses, i.e. close to the consumer. Because of the use of greenhouses, the system is capable of year-round delivery. Pivotal to the system are data; individual health data are linked to local fruit and vegetable production, and depending on a consumer's wishes, products can be delivered to their homes, for example. In short, although parts of such a system already exist, what is innovative about 4TU.Redesign is that we are connecting the complete system.

Challenge

It is a beautiful picture: year-round production of healthy fruits and vegetables tailored to local conditions, desires and culture. Yet there are also a number of challenges. For instance, can we set up the system so that everyone has confidence in what happens to the data? Is it cost-effective, and how can we compete with the high demand for land in urban areas? How can we set up the digital side so that we reach everyone, including consumers who are less consciously looking for a healthy lifestyle?

Same language

Interdisciplinary projects require the consortium to speak the same language. This is where we invest time. All tenure trackers and PhDs work on a joint paper in which we discuss opportunities and challenges of the 4TU.Redesign system and show the added value of collaboration.

Figure 1: A local food system - connected by high-tech & data.

From science to practice

Every time 4TU.Redesign goes public, it leads to new ideas. An overview of activities can be found on the website.

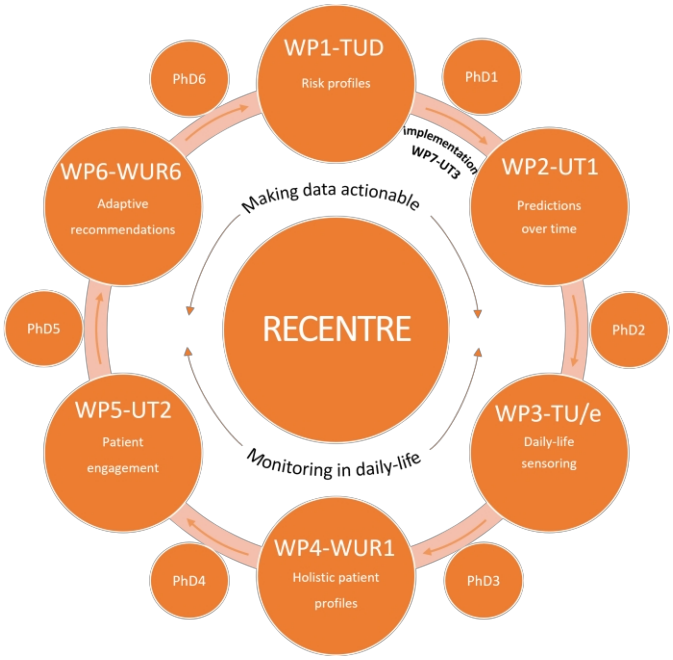
17.7 RECENTRE (HTSF-II)

Risk-based lifEstyle Change: **daily-lifE** moNiToring and REcommendations

Programme leader: Annemieke Witteveen, UT

Target

In RECENTRE, we work together to empower people to take a leading role in their lifestyle and health in their own environment. Through holistic monitoring of vulnerable populations in the home environment and tailored recommendations, we shift care and prevent the development or exacerbation of diseases through timely intervention, resulting in higher quality of life and lower healthcare costs. Consortium meetings at all four TUs have taken place to consolidate the collaboration and we are very happy that we are now complete with six new tenure trackers and six PhDs.



WP1 has been instrumental in developing mathematical, graphical tools that are interpretable and useable by healthcare experts to simplify complex healthcare decision analysis, such as determining patient release timing and post-surgery risk assessment. Additionally, we have been teaching risk analysis, expert judgment, and uncertainty analysis at TUD, empowering students and faculty with essential mathematical skills in healthcare decision-making. The expertise gained through RECENTRE has already helped the Department of Applied Mathematics at TU Delft to strengthen its position in healthcare research through its contribution to the newly created centre called MatheMedics.

Within **WP2**, are developing models that can be used for health predictions over time. We have also conducted a review on which specific late effects after breast cancer will benefit from early detection through continuous monitoring. An abstract has been submitted to the annual meeting of multinational association of supportive care in cancer. Other projects focus on continuous wearables-based monitoring to predict complications after colon cancer surgery, mobile-phone based digital phenotyping for the detection of long-term effects after breast cancer and risk modelling and benefits of daily-life monitoring for detecting cardiac toxicities after breast cancer treatment.

The current scope of **WP3** would focus on in-home monitoring sensor technologies for cancer or obesity patients. However, the question regarding the choice among sensors and metric selection remains unclear. Consequently, a literature review to address this issue has been initiated. The review aims to explore contemporary non-invasive, wearable, or unobtrusive sensor technologies relevant to patients with cancer or obesity. It seeks to identify the types of sensors utilised, the metrics measured, and the integration of data from multiple sources. The first draft of the review's structure is completed.

Within **WP4**, we are working on the construct of a holistic patient profile. Furthermore, we have been working towards establishing a long-term prospective cohort study measuring health of patients undergoing obesity treatment in a holistic way by capturing measurements reflecting health of all eleven organ systems. Within this study, the feasibility and validity of home monitoring strategies will be

explored in collaboration with the other WPs. The protocol to be shared with the Medical Ethics Committee is expected to be finalised in March 2024. Recruitment of patients is expected to start in Q2 of 2024.

Within **WP5,** the research designs of VR experiments and two literature reviews on current VR applications were designed. In the first VR experiments, we will conduct futuring studies in which we find out needs of people with cancer and obesity about sensor technology in an innovative way. The components for this have been determined and translated into a list of instructions for the programmers, who have started designing. The systematic literature reviews are almost completed, and in the selection phase, respectively. Abstracts have been submitted for the ARPH 2024 and HealthbyTech 2024 conferences.

Within **WP6**, we are conducting a rapid realist review on adaptive lifestyle interventions for patients with metabolic syndrome. We have conducted stakeholder interviews and are currently conducting a systematic review that will inform the later phase of the realist review. The protocol is registered on PROSPERO. We have submitted an abstract on this study to the European Healthy Psychology Society Conference 2024. In addition, we are currently supervising three student projects on the development of a reinforcement learning algorithm and the needs assessments of patients and stakeholders.

WP7 supports RECENTRE with awareness and guidance on health technology innovation and implementation. During the past year we have explored, together with all work packages, implementation definitions, assumptions, and support needs. We have performed an initial stakeholder analysis in relation to the clinical use cases of obesity and colon cancer. Identified follow-up activities have been documented in a draft implementation strategy plan.

Selection of RECENTRE dissemination activities and news

- Ana Coiciu (WUR) participated in The Cookery installation by the DesignLab (UT) at the Dutch Design Week.
- Agnes Berendsen (WUR) contributed to the 4-part series Brightful Minds.
- During the symposium: 'Winning by Losing? Nutritional consequences of bariatric surgery', Agnes Berendsen (WUR) presented her research.
- RECENTRE was represented at the expert sessions for the development of the Dutch Cancer Agenda.
- Annemieke Witteveen (UT) received both the KNAW Early Career Award and Henk Stassen Award.
- Agnes Berendsen (WUR) presented at FoodforThought from Alliance Nutrition in Care
- After invitation by the Dutch Government, Annemieke Witteveen (UT) joined an innovation mission to India focussed on digital technology and oncology.
- Maurice van Keulen and Annemieke Witteveen (both UT) gave a presentation at the 2nd BOOG Real World Evidence Symposium on AI
- Arlene John (UT) gave a lecture at the IoTalentum winter school organised by Idelfonso Tafur Monroy (TU/e).

18 Partners and collaborations

Financial partners

NEMO Kennislink

NEMO Kennislink has been making scientific information accessible to a wide audience, and specifically to schoolchildren and secondary school teachers, for over 15 years. They do this through news, background articles, dossiers and multimedia about the breadth of science. The support of the 4TU.Federation is reflected in Kennislink's production figures in the field of Technology.

KIVI

KIVI is the professional association of engineers in the Netherlands. Among other things, KIVI supports engineers in their professional practice and making connections with research, education, society and among themselves. Support from the 4TU.Federation is specifically for the promotion of engineering education.

Foundation for the History of Technology

The History of Technology Foundation (SHT) was established in 1988 on the initiative of the Royal Institute of Engineers (KIVI) and the universities of technology. In 2023, the 4TU. Research gave the SHT the status of a 4TU.Centre. With the new name The 4TU.Centre History of Technology, the centre will launch on 1 January 2024.

NAE

The Netherlands Academy of Engineering (NAE) brings together top experts active in technological sciences and applied research and development. They come from knowledge institutions and industry and share a passion for engineering-based innovation as a means to overcome many of our societal challenges and to maintain our country's earning capacity within the European and international context.
In 2023, 4TU.Research contributed to the creation of the NAE through start-up funding and bringing together relevant parties and advice.

Collaborations

Engineering Deans

After the creation of the second Engineering Sector Plan, engineering deans further organised themselves in the Council for Technical Sciences (RvTW), formerly Engineering Deans' Consultation. Besides the four TUs, the University of Groningen (RUG) and NWO-TTW are also affiliated in the RvTW.

Discipline platforms

Ten disciplines have been identified within the engineering domain (seven within the constructive engineering sciences, i.e. agrotechnology & food, (bio)medical technology, civil engineering, electrical engineering, aerospace engineering, technical informatics and mechanical engineering; and three within the design engineering sciences, i.e. construction engineering, industrial design, and engineering business and public administration). Cooperation within these disciplines is further strengthened by organising national consultations, through specific discipline platforms (e.g. civil engineering, electrical engineering, mechanical engineering), or through existing 4TU.Centres (e.g. 4TU.Built Environment, 4TU.Design United, 4TU.Health).

RUG

With the RUG, long-term collaborations have been established with the Centres 4TU.HTM and 4TU.NIRICT to strengthen each other within the themes of these Centres. In 2023, the Centre 4TU.AMI and 4TU.CEE also started (exploratory) collaborations.

CTI

Since 2021, the 4TU secretary has been a member of the Coalition Technology and Inclusion (CTI). CTI is committed to ensuring that technology is developed and used for an inclusive labour market, so that people with disabilities are better able to (continue to) work. The Coalition honoured and supervised eight pilots and the concluding symposium on these pilots took place in 2023.

19 Visibility

In 2023, there were again many collaborative successes to share from the 4TU.Centres and programmes. But it was also a politically turbulent year in which internationalisation was on the agenda and the four technical universities pulled together to communicate their views on it.

Cooperation RUG

The entry of the RUG into the Centres 4TU.HTM and 4TU.NIRICT could count on visibility through the social media channels of 4TU and of the RUG and interviews with the scientific directors of the 4TU.Centres and the RUG institutes involved about the advantages of substantive cooperation in the fields of High-Tech Materials and ICT.

HTSF II

The research of the High Tech for a Sustainable Future programme generated the necessary media attention. The occasion was the HTSF Crossover Event on 9 June where cross-fertilisation took place between the experienced researchers of Round I and the researchers of the just-started Round II.

Start-up entrepreneur Berend de Klerk talked in BNR's science podcast about the plant sensor developed from the Plantenna programme and Aimée Sakes explained the flexible needle inspired by the sting of a wasp, an invention spawned from the Soft Robotics programme. The Saturday FD newspaper had a page dedicated to the HERITAGE programme explaining the complexity of heat stress in cities and how the four TUs are tackling the problem.

1 sept 15:05

Universiteiten onderzoeken hoe oververhitte steden ook straks nog leefbaar moeten blijven

Ardi Vleugels

Door klimaatverandering is hitte een levensbedreigend probleem in oude binnensteden. Onderzoekers van de vier technische universiteiten brengen die warmte nu nauwgezet in kaart met een gezamenlijke missie: hoe kan de stad straks leefbaar blijven?

Projectleider Wim Timmermans met een weerballon van de Wageningen University and Research. Foto: Cees Elzenga voor het FD

The 4TU series 'Brightful Minds' focused on the careers of tenure trackers, the talented, often still young, scientists associated with these programmes.

Internationalisation

The 4TU.Federation, like many other knowledge institutions, took the opportunity to respond online to OCW's draft bill 'Internationalisation in Balance'. 4TU pointed out the importance of international students for shortage sectors on the labour market and that it is important that part of engineering bachelor's programmes remain English-language. An opinion piece by the four chairs also appeared in the Volkskrant. The MPs knew how to find 4TU for more information on the subject.

deVolkskrant

Topverhalen vandaag Opinie Cartoons Cultuur & Media

NIEUWS

Technische universiteiten roepen politiek op: pas op met weren van buitenlandse studenten

Nederland moet oppassen met het drastisch terugdringen van het aantal buitenlandse bètastudenten, vinden technische universiteiten. Het tekort aan technisch personeel zal volgens hen alleen maar groter worden wanneer studenten uit andere landen worden ontmoedigd hun opleiding in Nederland te gaan volgen.

Tjerk Gualthérie van Weezel 13 november 2023, 06:00

Communication from centres and programmes

But there was also active communication from the centres and programmes themselves. For example, 4TU.Built Environment, in cooperation with Innovation Origins, published stories about the collaborations ongoing on various themes in construction such as circularity and digitalisation for which this centre has set up various Domain Booster Teams.
4TU.Energy consistently highlighted different researchers in its Meet our Energiser series, and 4TU.HTM and 4TU.Resilience Engineering published similar research stories.

From 4TU.IMPACT, extensive social media campaigns gave visibility to the Dutch 4TU Impact Challenge and a new series Insightful Innovators was released in collaboration with Innovation Origins, featuring stories of entrepreneurial students and scientists from the four TUs.

The other centres also released news about their collaborative successes on a regular basis. These included the launch of the Cardiovascular Technical Research Agenda from 4TU.Health, and communicated on the progress of the 4TU.Responsible Sustainability Challenge from 4TU.HTM, 4TU.Energy and 4TU.Ethics & Technology and on the various calls for ICT funding from 4TU.NIRICT.