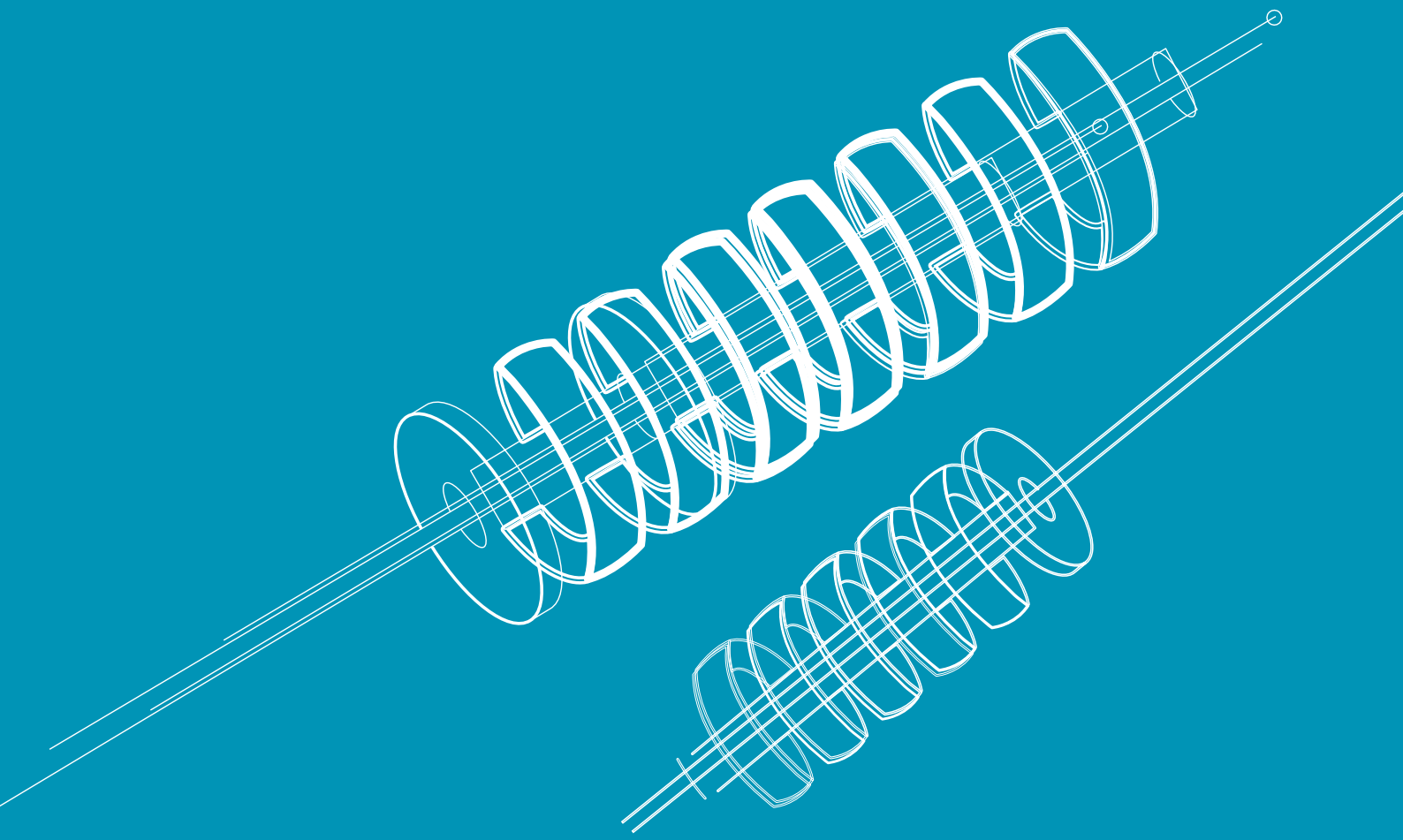
RESEARCH STRATEGY 2020-2030 UNIVERSITY OF TWENTE

THE UNIVERSITY OF TECHNOLOGY THAT PUTS PEOPLE FIRST



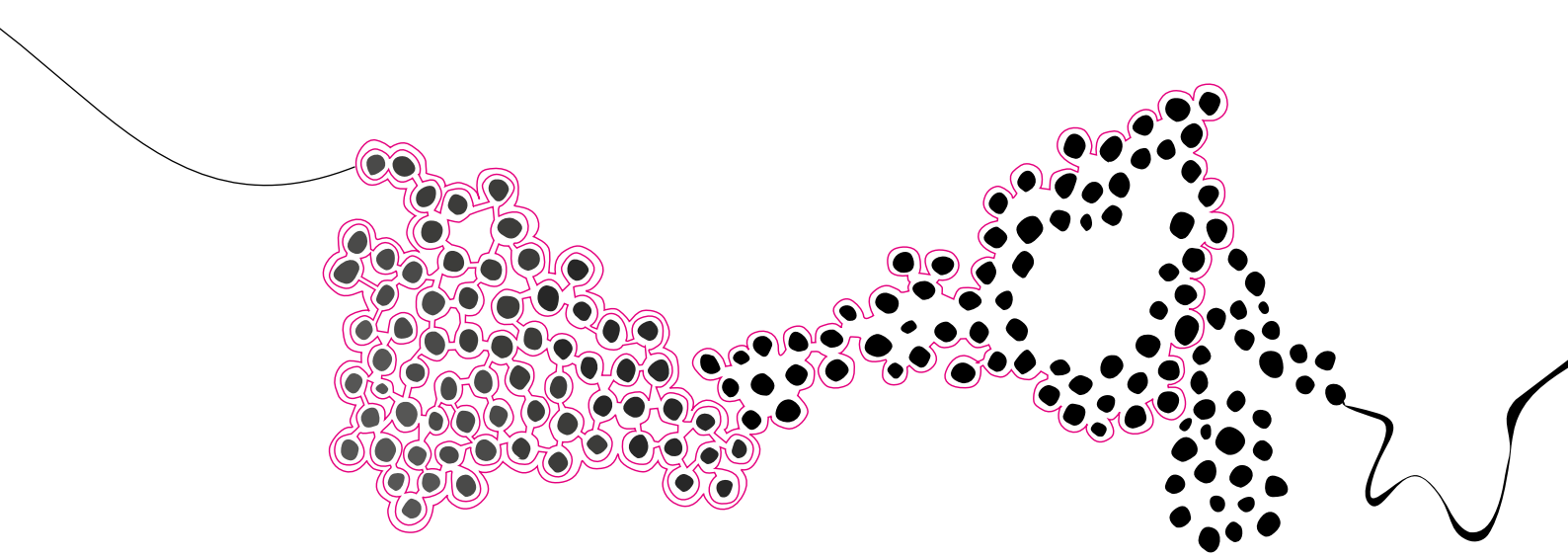
UNIVERSITY OF TWENTE.

EXECUTIVE SUMMARY

Since the founding of the University of Twente in 1961, we have committed ourselves to addressing economic and societal questions through pioneer combinations of technical and social sciences. The UT has developed into a thriving, entrepreneurial university that is known for its strengths in personalised healthcare technologies, smart manufacturing, advanced materials, digital technologies and its engineering capabilities to develop a resilient world.

Our research strategy for the forthcoming years builds upon these existing research strengths and our creative and entrepreneurial mindset. We will put people first, reinforce our engagement with society and generate societal impact. Our research practice is challenge-driven and we cultivate an attitude of excellence, accountability and integrity towards our peers and society itself. In the upcoming years, we aim to foster excellent research as the pivotal route towards making significant and transformational differences within these three societal domains:

- **HEALTHY LIVING & BETTER HEALTHCARE,** which entails research on disease prevention, diagnosis, intervention, self-management, the creation of resilient, healthy urban environments and geo-health.
- **CONNECTED COMMUNITIES,** which entails research on cyber-physical systems, human-machine interactions, data science and artificial intelligence
- **SUSTAINABLE ENVIRONMENT,** which entails research on integrated solutions of technologies, human behaviour, environments and ecosystems, materials and sensing technologies, earth observation, water and energy management.



In order to support our orientation towards societal challenges and to enable our researchers to work within a challenge-driven environment, our way of working needs further development:

- **WE SHALL FOCUS OUR WORK ON SCIENTIFIC AND ENGINEERING PROBLEMS ON SOCIETAL, MISSION-DRIVEN CHALLENGES.** We will closely collaborate with our partners, both public and private, in knowledge technologies and infrastructure. We will facilitate the introduction and embedding of knowledge and technologies in society. We aim to integrate our expertise of technical and social sciences into a systemic proposition to contribute to societal challenges in the three domains mentioned. Our investment in strategic research infrastructure and strategic programs will link UT's strength in research and innovation to societal challenges. We will further develop our research quality management system in order to align the university, research units and individual strategies to support this focus.
- **WE WILL EXPAND OUR ENTREPRENEURIAL AMBITIONS IN OUR WORK TOWARDS THE GENERATION OF IMPACT, BY ACTING AS AN ENGAGED INSTITUTION THAT CONNECTS WITH ALL PARTIES INVOLVED AND GENERATING ACADEMIC, ECONOMICAL AND SOCIETAL IMPACT.** Our focus on Open Science and our Designlab will support these ambitions. We will strengthen our research groups to realise these ambitions by stimulating diversity in individual backgrounds and orientations. We foster teamwork and talent management.
- **WE WILL MOVE FROM ACTING AS A SUPPLIER OF KNOWLEDGE THAT ENGINEERS SOLUTIONS TOWARDS AN ENTREPRENEURIAL UNIVERSITY ENGAGING IN DIALOGUES AND PARTNERSHIPS WITH SOCIETY.** To achieve this we will invest in engaging in dialogues with all parties concerned to demonstrate the relevance of our research, expand our physical proximity to citizens, strengthen collaboration with partners, and invest in the presence of UT at key venues and round table meetings where research programs and initiatives with public and private partners are designed.

In Shaping2030 we formulated the mission, vision and strategy of the University of Twente. Our research strategy is based on the Shaping2030 Strategy. The Research Strategy guides decision making on research activities. The strategy allows for agility in research programming and upholds academic autonomy within the boundaries set by the framework. In our strategy we build upon our existing research strengths and move towards reinforcing our orientation of scientific research questions on societal themes, in line with the 'people first' mission of the University of Twente. Our research activities are aimed at generating impact in three societal domains where UT research can make a difference: healthy living & better healthcare, connected communities and sustainable environment. To generate impact, the UT research draws upon its unique research identity, a specific set of infrastructure, a broad set of key enabling technologies, and its ability to conduct excellent scientific research in the knowledge domains STEM + social & behavioural sciences. The research strategy enhances the way how the UT distinguishes itself from other knowledge institutes by its ability to bring societal questions into the world of science and its ability to integrate and collaborate across knowledge domains and organizational entities.

The Research Strategy has a 10-year perspective. Concrete actions are focused on the first three years of this time frame.

1. RESEARCH MISSION AND VISION

Our research strategy is based on the mission of the University of Twente as formulated in Shaping2030. For research, we crafted a specific vision, using the main building blocks of the vision laid down in Shaping2030.

1.1 THE MISSION OF THE UNIVERSITY OF TWENTE

At the University of Twente, we have a clear mission:

THE UNIVERSITY OF TWENTE IS THE ULTIMATE 'PEOPLE FIRST' UNIVERSITY OF TECHNOLOGY. WE EMPOWER SOCIETY THROUGH SUSTAINABLE SOLUTIONS.

This mission represents the identity of the University: being the ultimate 'people first' university of technology, empowering society and providing sustainable solutions.

BEING 'PEOPLE FIRST' IS OUR CHOICE: we serve humanity, are aware of the interdependencies between people and our planet, and always aim to make sure that people can count on us. We have delivered technological innovations in the past, and we will be a part of the innovations of the future. We are aware that technologies change society, and that science's contribution changes with it. We make sure that our people have the time to grow and deliver quality work. We share our talent and resources on campus, in the region, and with the wider world around us. In the choices we make, large and small, the well-being of people is our guiding principle.

WE ARE A UNIVERSITY OF TECHNOLOGY: our university is a public institution that serves society. We are accountable to society for the ways in which we use our academic freedom. We are responsible for ensuring that the power of science and technology is harnessed to achieve the best possible impact in a changing world. We build upon our existing strengths which is captured in our current set of profiling research themes: Improving healthcare by personalised technologies; Creating intelligent manufacturing systems; Shaping our world with smart materials; Engineering our digital society; and Engineering for a resilient world.

WE EMPOWER: we enable society to tackle the challenges that it faces by making use of science and technology in a prudent manner. We contribute to a balanced understanding of scientific and technological developments, and of their impact on the community and the environment.

WE PROVIDE SUSTAINABLE SOLUTIONS: we aim for thriving and resilient communities, with an eye for innovation opportunities, with authoritative expertise, and with a keen sensitivity to society's needs. Resisting the temptations of blind techno-mania as well as romantic nostalgia, we provide sound, scientific guidance towards environmental, social and economic sustainability.

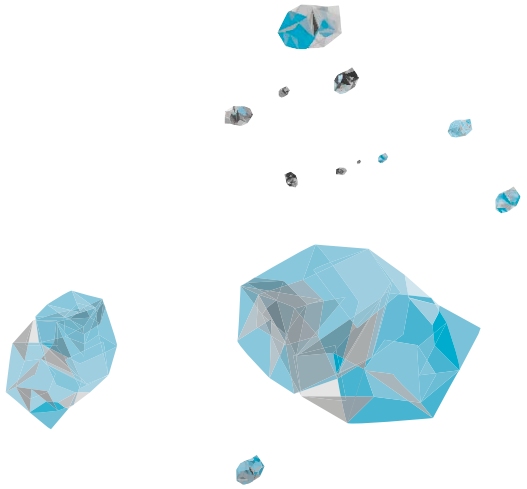
1.2 OUR RESEARCH IDENTITY

Since the founding of the University of Twente in 1961, we have committed ourselves to addressing economic and societal questions through pioneering combinations of technical and social sciences. The very reason for the founding of the University was to strengthen the industrial legacy of our region and the well-being of its population. Putting people first is firmly in the DNA of our staff, students and alumni through our focus on the relevance and application of innovative science and new technologies. Our approach is characterised by out-of-the-box thinking to initiate change, progress and renewal. This has led to our leading position in the Netherlands and in Europe as an entrepreneurial university. Our objective is to create value for and have impact on partners and stakeholders in the region of Twente, the Netherlands, Europe, and society at large.

Traditionally, research at the University of Twente has been driven by a hybrid engine: our curiosity towards profound academic and engineering problems, and our drive to contribute to solutions for economic and societal challenges. We have always presented an engineering approach to societal challenges by merging fundamental technological, social science research and design thinking. We have developed strong competences in the fields of science, technology, engineering and mathematics, social and behavioural sciences. We are known for our research strengths, captured in our current set of profiling research themes and in our strategic programmes: Robotics, Sensing Science & Technology, Smart materials,Personalizing Healthcare Technology: eHealth, Sustainable Healthcare Technology,Engineering for a resilient world, Embedded Artificial Intelligence, Hybrid Intelligence. In the next few years, we build upon our strengths, but reinforce our orientation of scientific research questions on societal themes, in line with our 'people first' mission. We continue to foster research excellence as it is part of the foundation on which our university is built and is pivotal in contributing to societal challenges. Our unique selling point is the way in which we offer additional value by combining our orientation towards societal questions with our research competences, research infrastructure and research identity.

In the Shaping2030 process we have jointly concluded that we want to strengthen the integration of education and pioneering and innovative research in all our education and research programmes. Our campus, including both virtual and physical co-locations, will be strengthened as a living lab and meeting place for our researchers. It will be a place where our students and our researchers will have reliable and innovative learning and research experiences with state-of-the-art digital tools. Our campus already acts as the central hub in a network in which we make connections with venues where societal challenges and questions are articulated. It is a safe and open environment for those who study, work, gather and live there. In combination with an inclusive research culture, the University of Twente attracts staff and guests from all over the world to collaborate in innovative research consortia.

The core values of the UT Shaping2030 strategy are: Entrepreneurial, Inclusive and Open.



Our research identity is characterised by the following values: Pioneering & Entrepreneurial, Integrated & Inclusive, Engaged & Open. A crucial factor in this openness is our trustworthiness, in other words to be Responsible & Accountable.

PIONEERING & ENTREPRENEURIAL

We are pioneers that make a difference, not only by pushing the research frontier, but also by pushing that frontier into new directions. We accelerate the introduction and embedding of innovative solutions. We see opportunities where others do not see them, take risks where nobody else dares to take them and build a team to achieve ambitious goals together. We provide an environment that stimulates and motivates smart, creative minds and creative, smart people by offering excellent support.

INTEGRATED & INCLUSIVE

We support a research culture where everyone is valued, regardless of their personal or cultural background. We stimulate the creative unfolding of talents. Our campus and facilities are a home for our visitors, partners, alumni, students and colleagues. We foster the integration of technical and social sciences, of applied and fundamental research, of qualitative and quantitative methodologies and of citizen science and laboratory research in order to generate integral and systemic solutions.

ENGAGED & OPEN

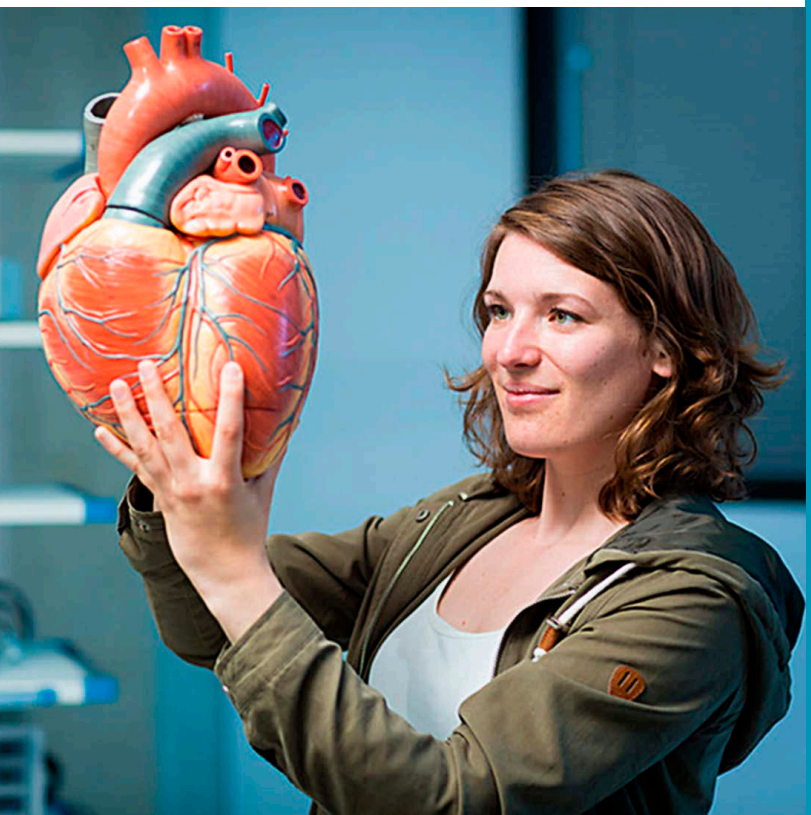
We develop relationships and engage in open dialogues and debates with students, alumni, peers, citizens, businesses, governments and other parties concerned to understand their needs and preferences. We build dedicated networks and take leadership positions in such networks. We discuss our propositions and maximise our added value to partners, regions and society as a whole. Our relations and networks are about mutual ambitions and shared values.

RESPONSIBLE & ACCOUNTABLE

We take responsibility for addressing economic and societal challenges in our research programmes. We enter into societal debates, based on our knowledge and research results. We are accountable for the potential impact of our research for stakeholders and their living environment. Responsibility and integrity in our research practices is part of our DNA. We are explicit about the norms and values that guide our actions and engage in open dialogues on the choices we make in our research.

1.3. OUR RESEARCH PROPOSITION FOR SOCIETY IN 2030

In the coming years we will build on our existing strengths to take the next step in our evolution as a technological research university. People and their living environment are at the core of our education and research activities. Based on our mission as a university and drawing upon our strengths, we take responsibility for three societal domains for which society may hold us accountable: in 2030, we will be known for our leadership in providing integrated perspectives and solutions for the societal domains of Healthy Living & Better Healthcare, Connected Communities, and a Sustainable Environment. Our ambitions for each of these are laid down below.



HEALTHY LIVING & BETTER HEALTHCARE

Our ambition is to enable people to live healthier lives and to make good health care accessible for everyone in case they need it. We pro-actively contribute to healthy living by developing technologies that support a personalised healthy lifestyle. We focus on disease prevention, diagnosis, intervention and self-management. With a personalised approach and integrated knowledge on technologies, biomedicine, human behaviour and health care systems, we contribute to an improved quality of life, and to economic and social innovations while enhancing the sustainability and accessibility of healthcare. Attention is given to planning of resilient, innovative urban environments and on geo-health with focus on people's health as affected by environmental factors such as atmospheric pollution and sanitation.

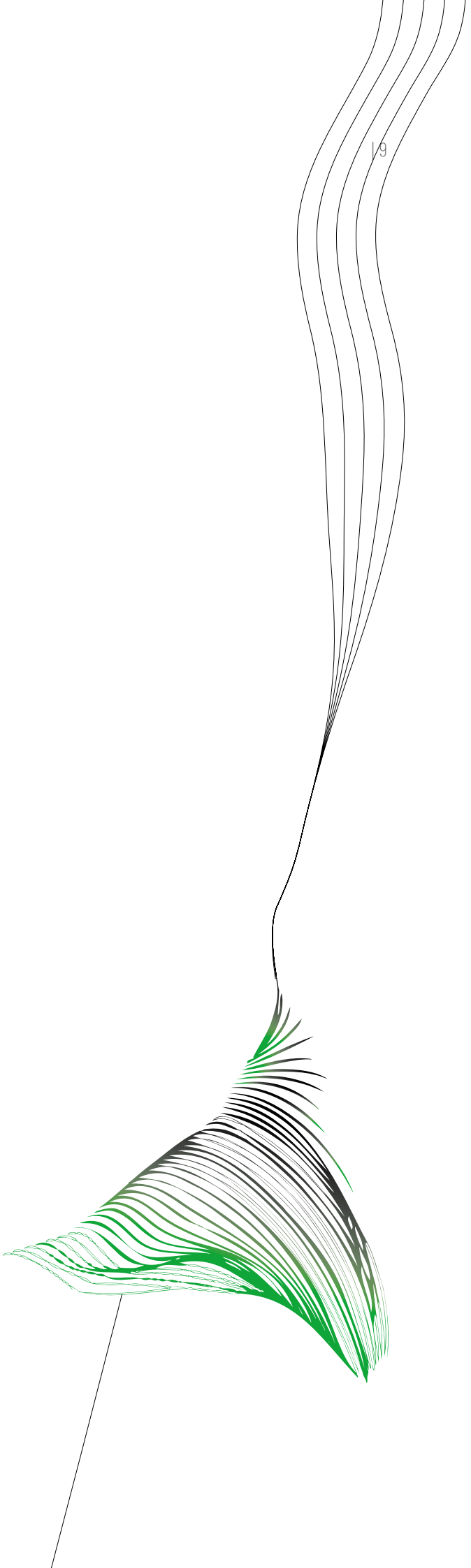
CONNECTED COMMUNITIES

Our ambition is to improve inclusivity and participation of people in society and to enhance human-machine interactions for the benefit of society. We do this by expanding society's knowledge of interactions between digital technologies, systems, individuals and collectives. We improve the connectedness of people and their environment by developing cyber-physical systems in which software and hardware are combined into systems with embedded intelligence. We use our expertise in data science and artificial intelligence, the

integration of hardware and software and human behaviour to work pro-actively towards the fair embedding of novel digital technologies in society. In our citizen science, we make use of crowd-sourced data for all parties concerned and societies as embedded in advanced big data-processing platforms, including machine learning, cloud computing and geographic information systems.

SUSTAINABLE ENVIRONMENT

Our ambition is to reduce the impact of climate change and to create a sustainable living environment for people. We do this by developing sustainable, integrated solutions based on technologies, human behaviour, physical environments and ecosystems. We pro-actively work towards a fair and sustainable distribution of the benefits of new technologies, especially in the area of materials and sensing technologies. We use our expertise in earth observation, water and energy management and technologies and the design of resilient environments to enhance the sustainability of the living environments of people. Rapid population increases, climate change and changes in land use are the main factors contributing to the design and development of sustainable environments.



2. RESEARCH STRATEGY

Our research strategy combines our research identity with our expertise in knowledge and technologies. With our engaged, pioneering, integrated and responsible way of working, we realise 'people first' solutions (see figure 1).

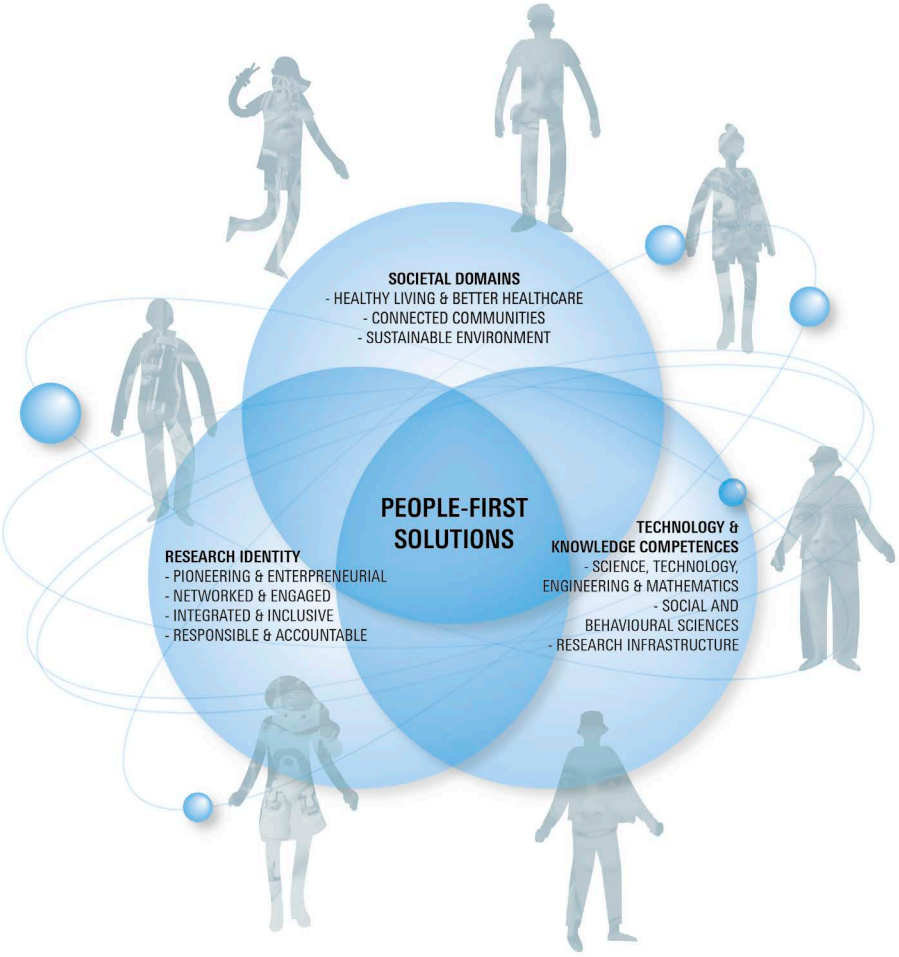


Figure 1: Research proposition of the University of Twente

The future growth and impact of the research activities of the UT is linked to our ability to harness our knowledge of science, technology and society – including the challenges' societies and people are facing – and our ability to build productive networks of people. This requires an entrepreneurial 'shaping' attitude. Our research strategy is guided by the three goals in the Shaping2030 strategy:

- Shaping society,
- Shaping connections,
- Shaping individuals.

As the research strategy and Shaping2030 strategy are intertwined, the research strategy should always be read in conjunction with the Shaping2030 strategy. The time horizon of our activities to realise these objectives is 2020-2023. The research strategy will be updated by 2022 in order to reach our long-term vision on research.

2.1 STRATEGIC GOAL 1: SHAPING SOCIETY

The UT excels in merging fundamental technological and social science research with systematic problem solving. Our research is always conducted with an eye on creating value for partners and all parties concerned in the region, the Netherlands and worldwide. We are enterprising and pioneering in our choices to invest in research areas that are likely to have a significant and sustainable impact on society.

OBJECTIVES FOR 2023 ON SHAPING SOCIETY:

A. **At least 30% of our research portfolio has a recognisable challenge-based signature.**
B. **Our research infrastructure is internationally recognised for its capacity to enable innovative research contributions for challenges in the societal domains.**
C. **Our research staff is recognised as, and regularly contacted for, its expertise and guidance on science and technology contributions to societal challenges in our focal domains.**

STRENGTHENING THE SOCIETAL CHALLENGE-BASED SIGNATURE OF THE UT RESEARCH PORTFOLIO

The UT acts as leader in research and impact in distinctive areas that are on the verge of invoking transformational changes. The natural environments of society and the economy act as drivers for knowledge production and innovation. As the 'people first' university of technology, we engage with all interested parties, including citizens, to develop a research agenda which generates impact jointly. In a quintuple helix of innovation, we solve complex societal problems, inspired by technological development, social innovation and fundamental research. Our research follows the guidelines by Shaping 2030 and matches their research agenda with national and international research agendas set by governments and research funders. To achieve societal relevance and impact, the research agenda also refers to the UN Sustainable Development Goals and the EU's Societal Challenges. To facilitate focus and (re-)direct research activities, the UT will invest in research and infrastructure which invoke transformational changes in the societal domains of healthy living, connected communities and sustainable environment.

1. **We commit to developing the Key Enabling Technologies via investments in our research infrastructure and strategic programmes to strengthen our research proposition for the societal domains.**

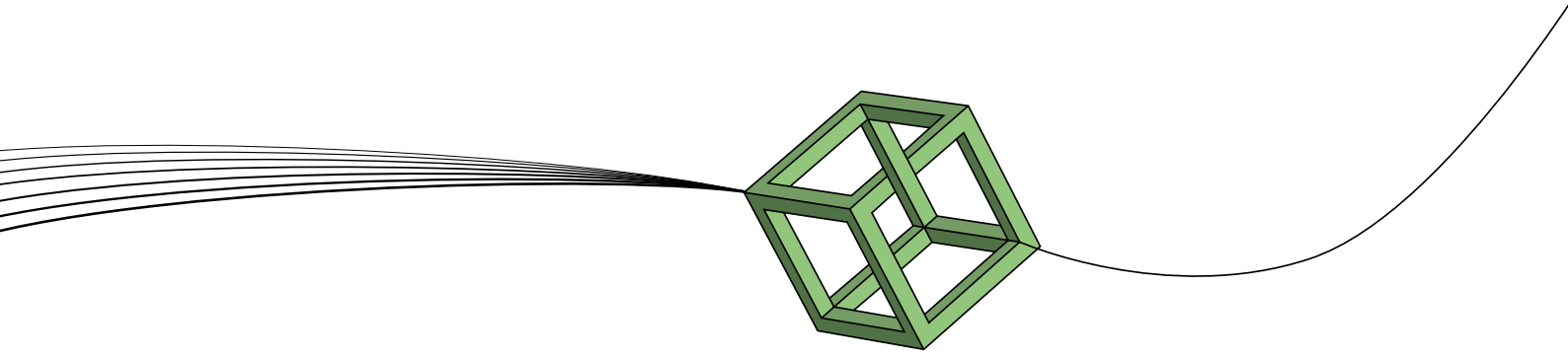
In the European research and innovation policies, Key Enabling Technologies (KETs) are those technologies that will allow European industries to retain competitiveness and to capitalise on new markets. Enabling technologies are the key for developing technology platforms which in turn can be further developed into products. In the mission-driven Top Sector and Innovation Policy, the Dutch government has formulated the following challenges: ensuring a greater, healthier life expectancy, sufficient clean water and safe food, lower greenhouse gas emissions, affordable sustainable energy and a safe country to live and work in. To enhance its leading and pioneering role, the UT will maintain and develop expertise in the following enabling technologies: nanotechnologies (e.g. research on micro- and nanoelectronics, photonics, sensors and actuators by our world-leading research institute MESA+), advanced materials, advanced manufacturing and processing (production technologies), biomedical technology and embedded systems. In addition, we consider digital technologies (e.g. research on artificial intelligence, big data analysis by our research institute Digital Society Institute) as a key enabling technology. We combine and integrate these key enabling technologies across disciplines to target societal challenges with attention for individual needs. We will engage on a national level in discussions on the development of national, integrated policies and investment schemes focusing on specific areas within the KETs to maintain a strong position in the international research landscape.

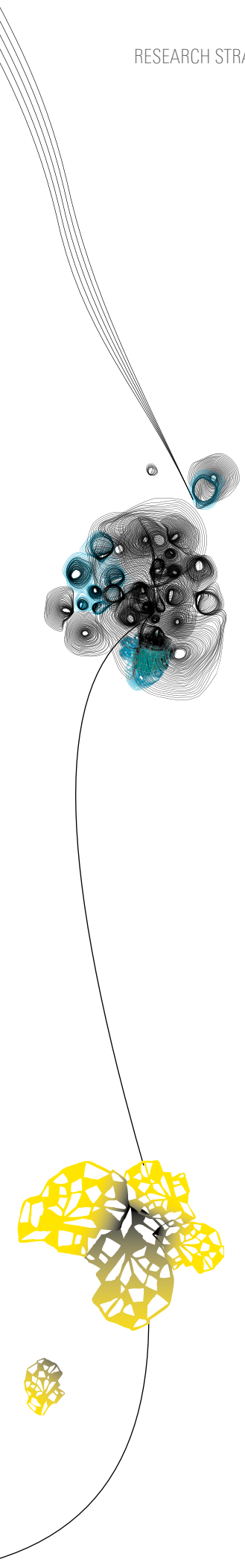
2. **We invest in UT Strategic Programs to initiate and explore new research activities within the domains of healthy living, connected communities and a sustainable environment.**

In order to grow in impact, we invest in strategical research programs in areas where we foresee the UT to attain a leadership role in our societal domains. The programs (currently Robotics, Smart Materials, Sensing, eHealth, and Sustainable Healthcare Technology) are the prelude to the research themes and focus of the future. These programs are set up as an investment program (with a multi-staged approach in a fixed period) and have the character of a 'seed fund' for new initiatives that reinforce our impact or complement our expertise. The programs link the research and innovation strengths of the UT to the societal challenges and to funding and grant programs on national and EU levels. The programs also link the strengths of our faculties: Behavioural, Management and Social sciences (BMS), Engineering Technology (ET), Electrical Engineering, Mathematics and Computer Science (EEMCS / EWI), Science and Technology (TNW), Geo-Information Science and Earth Observation (ITC).

3. **We develop our research strengths towards the focal UT societal domains: healthy living, connected communities and a sustainable environment.**

In the framework of the UT2020, five profiling themes were developed: (1) shaping our world with smart materials; (2) improving health care by personalised technologies; (3) engineering for a resilient world; (4) engineering our digital society; (5) creating intelligent manufacturing systems. These themes capture our present research strengths. We will further develop these research themes towards our focal societal domains of healthy living, connected communities and a sustainable environment. The main criteria for the further development of these research themes include: contributing to societal challenges or missions, scientific quality and feasibility, impact in terms of innovations and applications, potential for (inter)national collaboration with universities, societal partners and/or industrial partners, and for financial self-sufficiency, contributing to the teaching activities of the UT, and the quality of the plans for contributing to Open Science. The profiling themes and societal domains act as a guiding orientation, not as the principles for structuring our organisation.





4. **We invest in the development of Strategic Business Development as a powerful and concrete approach to develop richer relationships with key partners, and thereby create and add significant value on a regional and (inter) national level.**

Strategic Business Development (SBD) is based on the observation that an organisation can achieve its own ambitions better by using its strengths to help its partners achieve theirs. It is not an independent organisational unit; rather, it supports the strengths of the university's existing research institutes, departments, and centres of expertise. The role of SBD is: 1) to support knowledge transfer pro-actively, to impact on activities of faculties and institutes; 2) to develop and manage new strategic corporate partnerships with a commercial orientation. SBD will contribute to increasing the impact of the research activities of the UT and supports the viability of the UT to generate impact in the long term by securing partnerships and funds.

5. **We invest in the development of 2nd-phase and 3rd-phase education programmes which will be aligned with the demands of the labour market and the skills and competencies for professionals of the 21st century. Our 2nd-phase and 3rd-phase education programmes will be founded in our research strategy and ambitions, and will enhance our research profile.**

Integrated MSc-PhD tracks are just one example of how we will use digitisation and lifelong learning methods and models to make our graduate education challenge-based, e.g. the Master in Robotics and the specialisation track of Sports Data Science.
In connection with societal demands, individual needs and economical demands, we will develop a policy on Lifelong Learning (including for instance the PDEng or Industrial Doctorate program). This should also take into account future demands and the framework for the PDEng. We will develop a framework on what, now and in the near future, falls under the term 'technological design(s'. This also encompasses the question which types or combinations of prior education and possible work experience are required or desirable for a future 'technological designer'. In collaboration with the industry and government (regional and national), this will pose a challenge for both the educational system, technical universities, general universities and universities of applied sciences.

OUR RESEARCH INFRASTRUCTURE GENERATES IMPACT ON THE UT FOCAL SOCIETAL DOMAINS

Our facilities are centres of open innovation. They are breeding places for excellent disciplinary and interdisciplinary research. We stimulate facility-sharing and partnerships: we collaborate with internal and external parties such as other knowledge institutes and industry within the region, national and international to optimise the operational use of the facilities and increase their societal and scientific relevance. Together with our partners we invest in facilities to generate ground-breaking, disruptive research and technological innovations which make a difference in the focal domains of the UT. These investments, which are positioned in a broader national and international context and are based on long-term roadmaps and agendas, require a joint effort with our partners.

6. We co-develop and co-invest in our strategic research infrastructure facilities Nanolab and Techmed.

Strategic Research Infrastructures are facilities, resources and services that are used on an open-access principle by multiple internal and external to the UT communities in order to conduct research, foster innovations and deliver on the strategic goals set by the University to increase visibility of the University in a national and international setting.

The strengthening of our infrastructure, such as laboratories, experimental equipment, ICT, databases and libraries, is of fundamental significance for top-level research and education. We stimulate interdisciplinary collaboration and focus on the transfer and exchange of knowledge with society and the industrial and business sectors. In a quintuple helix model, we bring knowledge, innovation and the environment together. Innovation follows collaboration inside and outside of our university, and our campus is making this collaboration and connection possible. It is the physical node where people meet, exchange knowledge, create value.

The UT Strategic Research Infrastructures are the building blocks for open innovation and for the evolution of the (regional) innovation system. Together with our partners we develop a multi-annual strategic infrastructure roadmap and co-investment program. This roadmap should render a sustainable solution for structural (public) funding for research infrastructure and provide security and continuity for researchers, partners and investors in the long term.

The Nanolab and the TechMed Centre labs can be considered strategic Large-Scale Research Infrastructures. They are to be part of the national roadmap on LSRI. The market for nanotechnology is growing steadily and, in the Netherlands alone, can reach a size of € 3 billion by 2021. Science plays a key role in this, and a state-of-the-art NanoLab is indispensable for maintaining and exceeding the excellent scientific level for researchers from MESA+, businesses and scientific colleagues from all over the world. The NanoLab enables us to initiate innovative and ambitious research in public private partnerships and programs; this entails approximately € 25 million in project funding every year. The NanoLab is a crucial component for e.g. Sensing and Materials programs, Photon Delta, Bits and Brains, Sectoral Plans Science, and Technology and Engineering.

Together with its external partners, the TechMed Centre pushes the boundaries of technical medical research, education and innovation. The facilities range from high-tech research labs for early stage research and development activities to simulated health care environments with real medical equipment that can be used for the training of professionals or as a testbed for preclinical studies. The TechMed Centre labs are clustered in 6 domains: (i) Biomedical Imaging and Diagnostics, (ii) Medical Robotics, (iii) Human Physiology, (iv) Bioengineering technologies, (v) Health and Wellbeing technologies and (vi) a Simulation and Training centre.

7. **We invest in the development of a digital competence centre (DCC) which will provide excellent support on the application of digital technologies in research.**

Digital technologies play an ever-increasing role in all research disciplines, be it for acquisition, further processing, storage, analysis or visualisation of research data. The digital competence centre (DCC) provides state-of-the-art solutions to support research with digital technologies. The DCC offers knowledge of and access to: (1) secure storage of research data, including advanced authorisation mechanisms; this storage can be on the premises or in a cloud, temporarily or permanently. Various storage solutions for research, both during and after a research-facilitating co-operation with external parties, will be further developed; (2) support for FAIR use of research data (Findable, Accessible, Interoperable, Reusable); (3) research data analysis and visualisation tools, making use of existing knowledge of big data and data science at the UT; (4) computing power, including access to the HPC facility (High Performance Computing); (5) special-purpose, cloud-based hardware (e.g. many so-called accelerators are readily available to final users, but also a variety of storage devices including fast disks [SSDs] as well as hard drives).

The DCC will advise researchers on data solutions taking into consideration privacy, security and IP issues based upon data classifications. Where possible connections will be made to national and international solutions for specific research disciplines and or cloud-based services. The DCC closely monitors new developments in research support with digital technologies. Employees of the DCC will be knowledgeable sparring partners for researchers to advise them on which digital technologies to use.

8. **We co-invest in infrastructure that has a university-wide impact and that facilitates open innovation and multi-disciplinary collaboration. We stimulate a multi-disciplinary collaboration and facility sharing by connecting our existing labs into a university wide research facility: the Smart Campus Lab.**

In addition to the two large strategic infrastructures Nanolab and Techmed, the UT together with its partners invests in labs that foster multi-disciplinary collaboration across faculties and facilitate open innovation practices with our partners. Facilities such as the Roboticslab and Energyhub will offer a platform for UT researchers and their peers, as well as companies and other parties concerned, to develop promising solutions to key issues in one or more of the societal domains.

To stimulate multi-disciplinary research and facility sharing, we will virtually connect new and existing labs such as the BMS lab, Virtual Reality Lab, LEO centre for Service Robotics, into the Smart Campus Lab, thus facilitating interdisciplinary research and improving access to researchers and guests in the next few years.

9. **We will have developed and implemented an integrated risk assessment scheme by 2022 to support researchers and decision makers when venturing into new research directions and investing in facilities.**

When deciding about investments in new facilities, contracts with third parties, or collaboration schemes with various partners, risk analyses and risk management will be part of the decision-making process. In our risk assessment we adopt an integrated perspective by including financial, legal, ethical and societal aspects. We develop a comprehensive safety and security scheme to deal with issues such as cybersecurity, privacy, facilitation of sharing of data where appropriate and limiting access to data where needed, and proliferation of sensitive knowledge.

STRENGTHENING THE UT'S REPUTATION AND VISIBILITY IN SOCIETAL DEBATES ON SCIENCE AND TECHNOLOGY

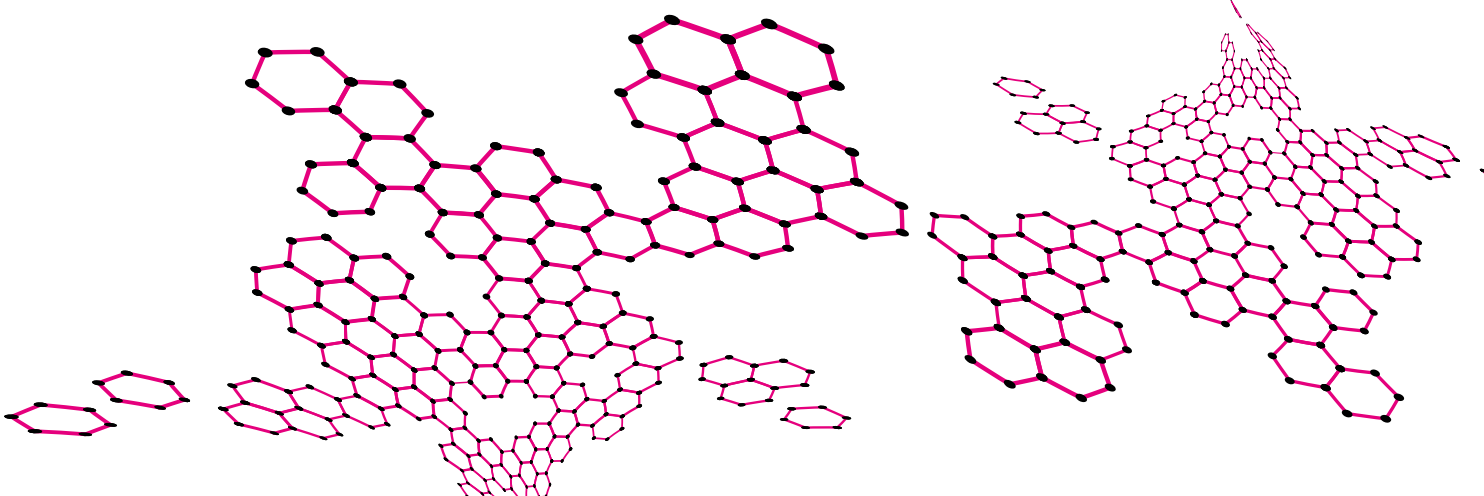
We share our expertise for the benefit of society and to learn from and interact with views and perspectives of our partners. Engagement, integrity, safety and security, privacy and the code of ethics are incorporated into our research and knowledge transfer practices and are key to maintain academic autonomy.

10. **We develop ways to showcase our challenge-based research activities and their outcome related to the focal societal domains of the UT.**

We engage in societal and political debates where we can share our expertise for the benefit of society and to learn and be inspired about views and perspectives of parties concerned. We embrace our role as scientists extending beyond the publication of our findings; what this entails is that we bring our results to those who are impacted by them or who can be empowered to generate impact themselves, and we take accountability for those results.

11. **We cultivate an attitude of accountability for taking corrective action in the event of any violation of our rules of integrity, safety or security. We will realise a 'house of integrity', including responsibilities of individual researchers and of the institution, by 2022.**

Reliability and integrity are the keystone on which universities are built and the UT fosters the moral compass and scientific craftsmanship of its (scientific) staff and students. Recent developments (e.g. new European and Dutch codes of conduct) and the UT's own high standards regarding professional and responsible conduct in research



and education have induced the UT to strengthen its policies regarding scientific integrity. Current scientific integrity policies include the training of PhD students (TGS), Research Data Management (LISA and Faculties), research ethics and code(s) of conduct. To support awareness and accessibility of scientific and other integrity policies, the UT code of conduct and related regulations will be reviewed, revised where needed and disseminated by means of a revised website and other communication channels in 2020.

12. **We invest in the DesignLab in order to foster responsible design practices among staff and students, together with our research collaborators in the three societal domains of the UT.**

The DesignLab will stimulate collaboration on societal challenges within and outside of the UT and also increase external funding (indirect government funds and contract research funds.). The goal of the investments is to develop the DesignLab as the experimental space for UT in line with Shaping 2030. The DesignLab creates a Responsible Design program and a Citizen Science Hub, where the approach and methods for responsible design and citizen science are translated into a 'transferable' manner (e.g. toolkit, manual, modules, course and network of DesignLabs).

2.2 STRATEGIC GOAL 2: SHAPING CONNECTIONS

Being a 'people first' university implies strong connections with our colleagues, partners and associates. It is about building communities. We strengthen relationships and engage in open dialogues and debates with our students, alumni, peers, citizens, firms, governments and other parties. To connect and create value, we must engage, commit and understand different needs and preferences. We build dedicated physical and digital networks and take leadership positions in networks, which enables the UT to have significant impact in the domains of healthy living, connected communities and a sustainable environment.

OBJECTIVES FOR 2023 ON SHAPING CONNECTIONS:

D. **We have extended our networks and physical presence to bridge gaps between research, innovation and society and have co-defined our research agendas with public and private partners.**

E. **We have developed new ways of co-operating with all parties involved in an Open Science Fashion. Open Access publication and FAIR data is the norm for researchers.**

EXTENDING OUR NETWORKS AND PHYSICAL PRESENCE TO SHAPE CONNECTIONS

We strengthen our relations with partners and build strong networks connecting educational programmes, research strengths and knowledge transfer activities. We invest in relationships for the whole research cycle: from the development and execution of research plans to the dissemination and use of research results.

13. **We select our public and private partners based on a shared vision towards the societal domains of the UT.**

The UT aims to contribute to a digital, fair and sustainable society in 2030 by making major contributions to three societal domains. We seek collaborations with partners in research and education who share these orientations and share our sense of responsibility and integrity as specified in the codes of conduct. Our research ethics infrastructure supports students and researchers in making decisions regarding research partners and research directions.

14. **We will co-initiate new research activities with strategic partners supported by research collaboration investments. We explore opportunities to build satellites to strengthen our physical proximity by looking closely at our joint strengths and demands from societal parties.**

We will develop new research activities with VU Amsterdam to extend our current collaboration. We will collaborate with municipalities, knowledge institutes and businesses in the eastern part of the Netherlands to explore the presence of a UT satellite based on local and UT research strengths. We will co-initiate new collaborations with the federal state of North Rhine Westphalia in the western part of Germany. With the establishment of Fraunhofer Project Centre and the Max Planck Centre on Complex Fluid Dynamics, the UT is the German-Dutch Science Hub for the Netherlands. Together with the University of Münster we invest in joint research activities, among other things on energy and on entrepreneurship. Our research is mutually complementary and by joining forces we want to participate in externally funded joint research programs in Germany, the Netherlands and Europe, to build an interregional

innovation system, and to design an energy roadmap and agenda in the so-called Euregion with the help of local and regional governments and industries.

15. **We invest in the presence of the UT at key venues and round table meetings where new research policies or research initiatives are being developed which affect our ability to grow and generate impact.**

As a small, outward-oriented university, it is crucial to form consortia and enter into alliances with public and private partners. This requires prominent presence of UT's research leaders in networks, committees and coalitions or at round tables where new policies and research initiatives are being presented and developed such as national strategies on KETs or societal missions. This is important in order to generate impact and because of the current science policy context. A mission-driven approach and integrated values are the drivers of the new governmental policies on innovation and science such as the 'topsectorenbeleid' and NWA in the Netherlands. The mission-driven approach was already transparent in the European agendas and in the NWO strategy and was the forming principle for the innovative agendas and contracts (KIA and KIC's) in the Netherlands. Key elements in this approach, such as application-oriented research, public-private collaboration and multi-disciplinary teams, are part of the UT's DNA. Exploitation of this potential fit with the UT requires dedicated work towards investing in the development of networks and relationships. The Sector Plans of the Dutch government are important in this context, because they lay down the structure for the coming years and therefore also for the connection of the UT to these roadmaps, agendas, etc. We will continue to establish connections with the Sector Plans in close co-operation with the other universities and scientific institutes.

We will set up expertise groups of researchers structured along the lines of national and EU mission domains as well as the three UT focal societal domains, to co-ordinate the collection and sharing of strategic intelligence. These expertise groups will act as platforms to co-ordinate the UT's presence in relevant networks.

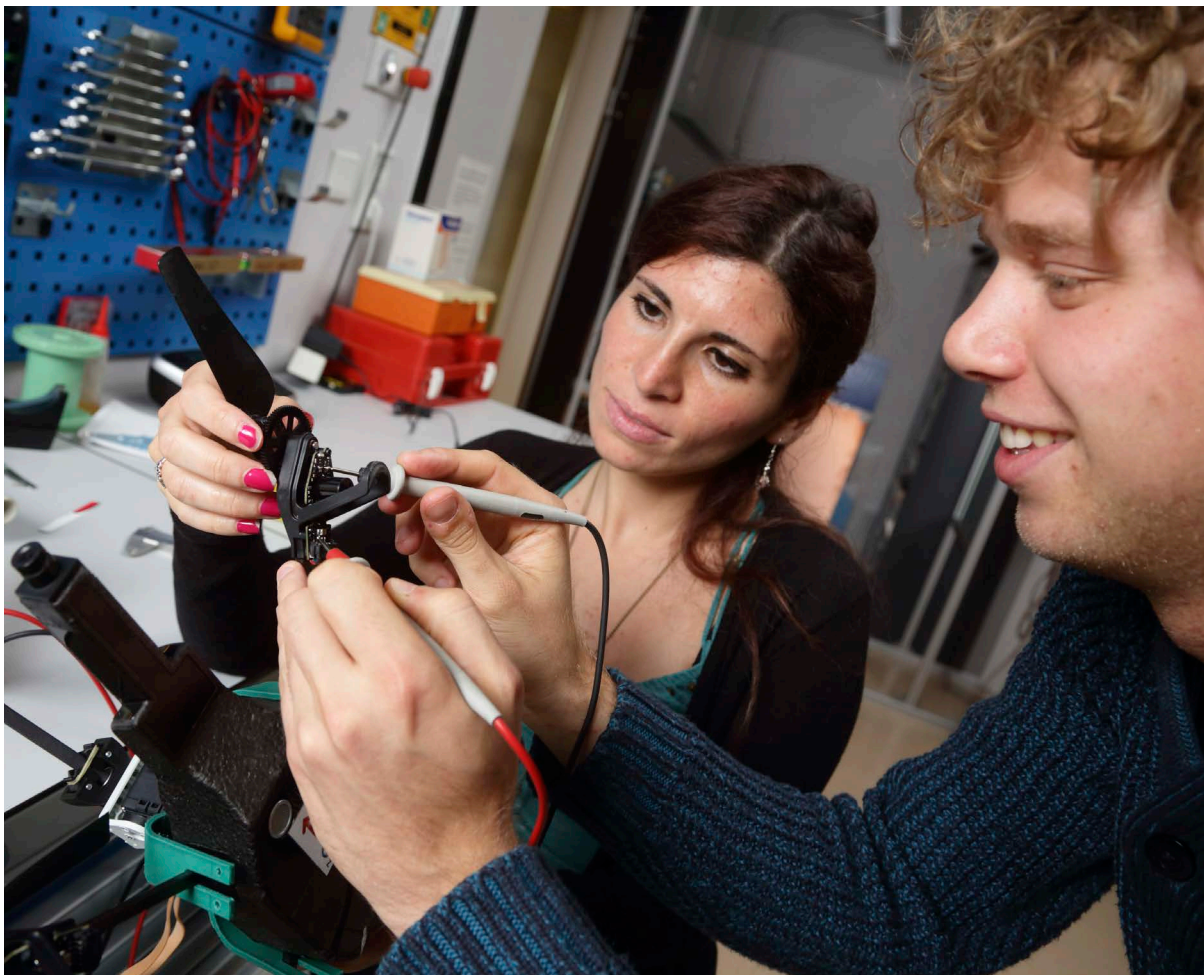
DEVELOPING NEW WAYS OF CO-OPERATING WITH PARTIES INVOLVED IN AN OPEN SCIENCE FASHION

We embrace Open Science and this deliberate choice is transforming why, where and how we conduct our research. Digitalisation enables us to involve large numbers of citizens in new citizen science programmes in order to ensure better access to research data and to reach potential students and colleagues. Open Science, like other Open concepts such as Open Education and Open Innovation, introduces new opportunities for the UT to shape new connections with society.

16. **We will significantly strengthen our Research Data Management practices to comply with norms of transparency and integrity and we will setup a stronger infrastructure to support researchers and students with Open Data and Open Software Activities via the Digital Competence Centre.**

Proper research data management (RDM) makes science more transparent and improves scientific integrity and societal trust. Research data underlying publications will be Findable, Accessible, Interoperable, and Re-usable (FAIR). These insights are gradually translated and formalised in international, national and local policies and frameworks formulated by science institutions, research funding agencies, and policymakers. The UT embraces the Dutch National coalition agreement of 2017 on 'Open science' and 'Open access'.

Our RDM policy stimulates the awareness of the need and benefits of good research data management and offers clear rules for managing research data at the UT. The UT scientific community, e.g. researchers and research managers, who have the main responsibility of data management in research projects, are actively engaged. In the faculties the RDM policy has become effective and operational by assigning 'data stewards' and by their embedding in the digital competence centre.



17. **We support the transition towards Open Science through the creation of an Open Science program, including Open Access, Citizen Science, FAIR Data and Software.**

This program explores the meaning and implications of research in the future world of Open Science and offers tools and inspirational practices for researchers to navigate through the emerging world of Open Science. The program articulates new ways of how Open Science practices add value to scientific peers as well as societal partners. Handling research data will be one of the main pillars in this program as the value of publications is expected to change in the future. There will be a strong connection with Open Access to the underpinning research data.

2.3 STRATEGIC GOAL 3: SHAPING INDIVIDUALS

We support a research culture where every person is valued and appreciated regardless of their personal or cultural background. We encourage the unfolding of talents in research, education, impact and organisation. To empower our researchers, we offer dedicated support facilities throughout the whole research cycle, including business development, grant and strategy support, project management, research support tools and information services.

OBJECTIVES FOR 2023 ON SHAPING INDIVIDUALS:

F. **We have established an integrated set of instruments to foster the development of talent**

G. **We have established a novel annual cycle for our strategy development and the research quality management processes of our research units.**

IMPROVING HOW WE ATTRACT, DEVELOP AND RETAIN TALENTS

We will develop strong research groups and stimulate diversity in background and orientation. It is better to cluster talents in research, education, knowledge transfer, organisation, engagement with society and collaborative skills in working across disciplines and organisations in teams than to search for them in single individuals.

18. **We will have developed an integrated vision on UT talents and a set of instruments to support research leaders in identifying and supporting talents by 2022. We will implement personalised development programmes to empower staff at personal, career, HR and leadership levels to prepare them for leadership roles, and implement more effective recruitment programmes to attract talented staff and to increase diversity.**

Fostering the development of talents in research, education and support is of major importance to the UT. A talent management project was initiated in 2019 and will continue in 2020 with the aim of developing an inclusive vision on talent and the development of policy instruments to support administrators and group leaders in identifying and stimulating talents. In 2020, the development of new tools and approaches will be completed by means of pilot projects in close collaboration with the faculties.

The UT needs talented staff, people who excel in what they know and their competences to deliver a sustainable result in a specific context. In UT's every-day practice, it is essential to identify all sorts of talent and talent development opportunities. A number of initiatives have been started in this area, such as improved strategic planning of prizes and awards; developing strategic personnel planning insights within faculties and staff departments; identifying and rewarding teaching excellence, including a career path based on the teaching excellence framework; the tenure track, the fast track career path for multi-talented scientists; a UT vision on student talent development. We continue to develop the digital competences of our staff to empower them in our digital societies. The momentum generated by these initiatives will be maintained and expanded in the coming years.

19. **We embrace the values of 'Recognition and Rewarding' of researchers and invest and will have implemented new schemes and instruments in the UT by 2023 that will help the UT in attracting, developing and keeping talents.**

The understanding of what it means to be a scientist is changing and the recent 'recognition and rewarding' debate in the Netherlands is accelerating this development. VSNU, NFU, KNAW, ZonMw and NWO want the system of recognition and rewarding to fit in better with the core tasks of the knowledge institutions in the fields of education, research, impact and patient care, and wants the appreciation that scientists receive to be more in line with the needs of society. This requires a system of acknowledgement and appreciation of scientists and research that a) enables diversification in career

paths and promotion of excellence in each of the core domains; b) does justice to the qualities of individual scientists as well as those of team performance; and, c) emphasises the quality of work over quantitative results, stimulates open science and encourages academic leadership. The UT will identify good practices develop the best practical approach to reach this goal and implement them in the organisation in the next few years. The UT will actively contribute to this debate with its focus on talent management for researchers and for supporting staff, which will stimulate talents in the domains of research, impact, education and organisation.

20. **We will have a fully operational mentoring system for guiding our PhDs, postdocs and starting assistant professors and for helping them prepare for their careers inside, or outside, academia.**

The Twente Graduate School (TGS) has a major role in the development of a vision on Graduate Education and the quality assessment of PhD programs. The (inter)national developments in strategies and policies for graduates, such as a broader categorisation of PhDs (e.g. societal, industrial doctorates), new collaborations with industry (PDEng), or additional financial and

jurisdictional issues (e.g. the student-promovendus pilot, international PhD students), ask for a university-wide approach and processes. The quality assessment will be strengthened in the coming period and will be aligned with the new Standard Evaluation Protocol, which is due in 2021. As the TGS has to set the agenda for further academic development and to guarantee academic quality and quality management, it was vital to strengthen the school's academic leadership by appointing a dean of TGS. As of January 2020, the Dean of the TGS will guide the school into its next phase of development and provide leadership internally for the students, nationally and abroad.

21. We tailor our research support services and expand the structural capacity in research support services.

To realise our vision on research, we create time for our researchers in what they do best. We offer dedicated support facilities throughout the whole research cycle: from developing ideas with the help of business development officers, strategy support, developing proposals, project management and administration support, tools to support the assessment of privacy and ethical issues and the crafting of Research Data Management approaches, library and information services, support in terms of open access publications and opening up research data via FAIR data schemes. The Strategic Business Development unit plays a major role in this development, as well as faculty-based research support staff and the digital competence centre.

STRENGTHENING STRATEGY DEVELOPMENT AND RESEARCH QUALITY MANAGEMENT OF RESEARCH UNITS

The UT research strategy offers the framework for making decisions regarding research, but for specific directions on the level of individual researchers and groups, further translation steps are required. Research units (clusters) will be responsible for an ongoing strategy development and execution cycle. They interact on a daily basis with our partners and form our ears and eyes in society. Research units are best positioned to tailor this to the demands and needs for new knowledge and technology. This reservoir of strategic intelligence is input for crafting unit-based research strategies. Strategies of research units subsequently need to be aligned and compiled into a recognisable research portfolio on the level of the UT.

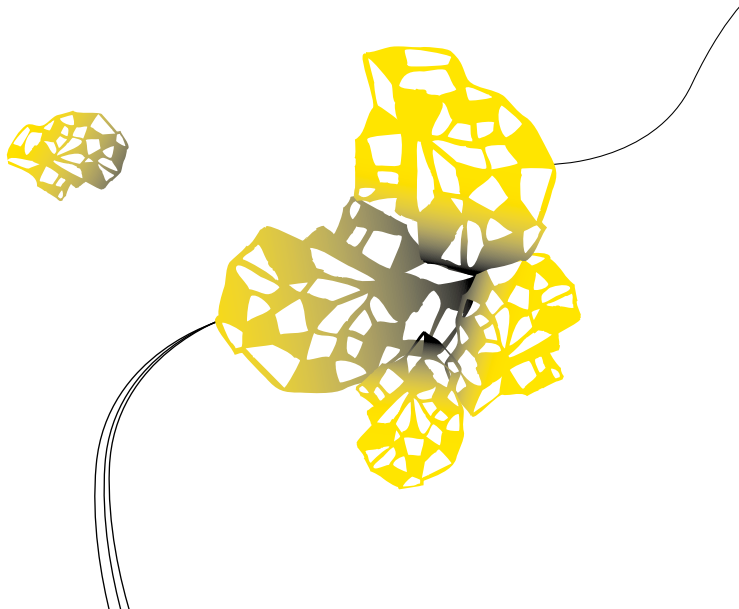
22. We develop and implement a cycle for research quality management at the level of research units at all faculties by 2022.

Academic research in the Netherlands is evaluated every six years on a rolling basis. The main goal of a research evaluation is to evaluate a research unit in light of its own aims and strategy. SEP assessments help to monitor and improve the quality of research conducted by the research unit. The assessment evaluates the performance of the unit: 1) research quality, 2) societal relevance and 3) viability. Within these assessment criteria, the committee takes into account at least four specific aspects: 1) Open Science, 2) PhD policy and training, 3) Academic Culture and 4) Human Resources Policy. The UT will further develop its research quality

management system by introducing an annual cycle, integrated with other review cycles. This will reduce the administrative burden of a six-year evaluation process by introducing routine processes and strengthen the focus on ongoing research quality management. In addition, the six-year review will then be embedded in the institution's quality assurance processes. By 2023 we are able to evaluate the research strategy of the UT in conjunction with the strategies of the research units and assess the strategic choices which have been made in this process.

23. We improve the setting of priorities regarding research activities in the UT and support the primary process to identify and capture research opportunities and to increase reputation and profile of the UT.

We will develop a lean procedure to attune the strategic research agenda of Research units, Faculty Boards, Institute Boards, the Executive Board and Service Departments to improve the setting of priorities concerning research activities. This will contribute to the aggregation of individual strategies into a recognisable research portfolio of the University of Twente. The research portfolio will be reviewed and updated regularly in order to anticipate and respond to changing needs of funding partners and societal groups, but at the same time it will take a long-term research focus into account. This way of working will enable researchers to identify and seize research opportunities and increase the reputation and profile of the UT by working in a co-ordinated and coherent fashion.



We work with a dynamic research programming process that caters to the needs and preferences of all parties involved (quintuple helix), we collaborate with partners and draw upon our strong research base to develop integrated solutions for our three societal domains (figure 2).

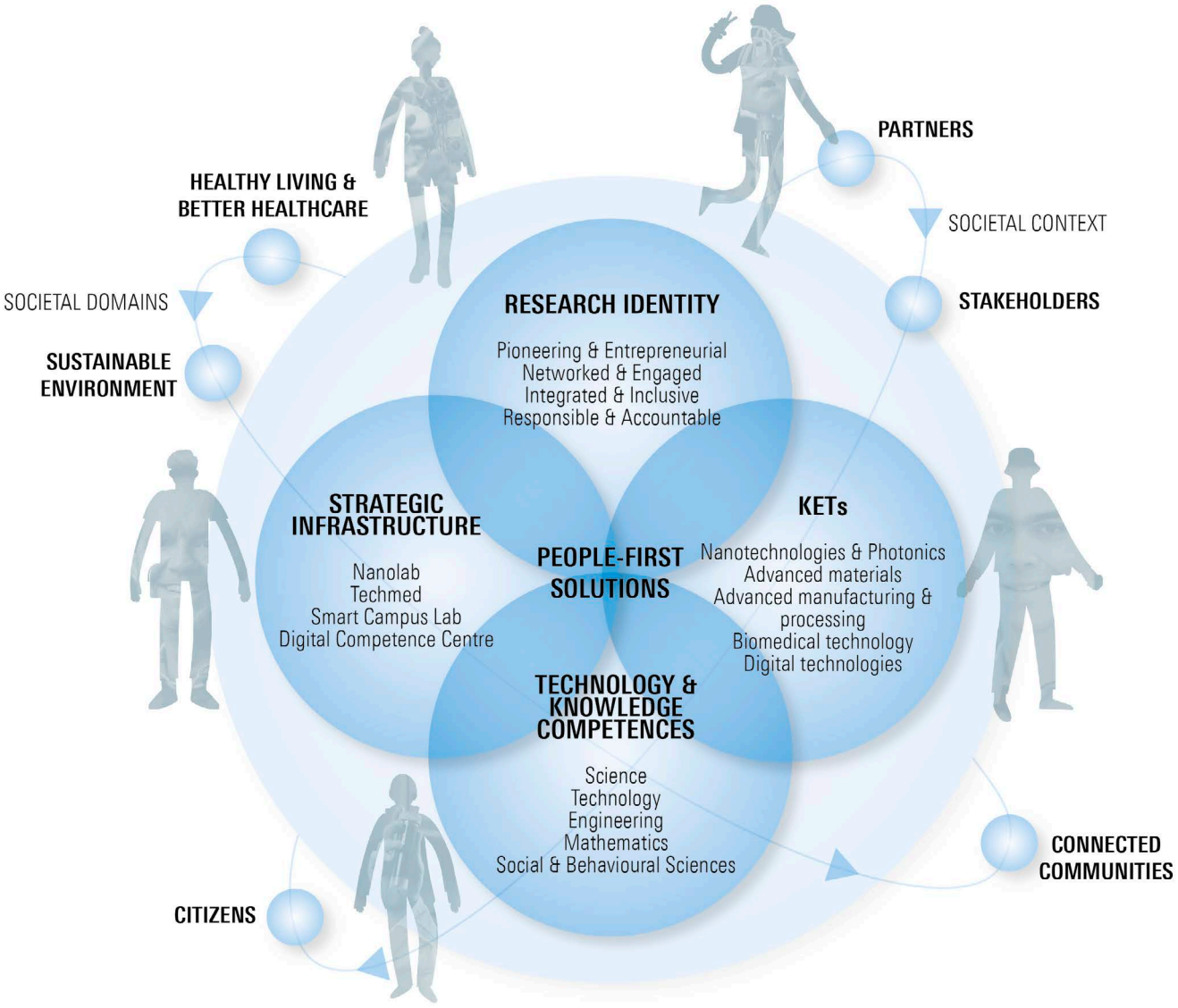


Figure 2: Research programming of the University of Twente

3. STRATEGY EXECUTION

To achieve our strategy, we continuously need to steer towards our ambitions. The strategy constitutes our framework to guide decision making and support the development of detailed strategies on the level of faculties, institutes and research units. We will embed the mindset of our mission and vision in ongoing projects and programs, as well as in basic processes such as research support services, personnel management, research quality management, financial management, planning and control cycles and management reviews. We gear the implementation of the research strategy to the implementation of the Shaping2030 strategy and other running programs.

To guide and govern the implementation, we take three main actions: 1) we identify existing projects and processes which require, and benefit from, alignment with the new research strategy; 2) we develop and update a programme plan, including a portfolio of activities; 3). we re-design our resource allocation model to support the execution of the research strategy.

3.1 EMBEDDING THE STRATEGIC OBJECTIVES INTO ONGOING PROJECTS AND TAILOR OUR DECISION PROCEDURES TO EMPOWER THE ORGANISATION.

The research strategy offers a university-wide framework for making decisions regarding research. This strategy does not offer specific directions for individual researchers and research units. This requires translation of the strategic framework to the research environment of individual groups. To shape the way in which the UT with its research activities adds value, and creates a distinct UT profile within various networks, lobby interactions, rankings, media outings, etc. we will:

- develop a visualization and guide to support communication with individual researchers and research units about the Research Strategy and its implication for day-to-day research activities.
- discuss with the Faculty Boards and Boards of Institutes the implications of the research strategy for crafting strategies of research units, faculties and institutes and their contribution to the strategic objectives of the UT research strategy.
- map existing projects and programs of faculties, institutes and service departments and evaluate how well they are aligned with the research strategy.
- discuss with senior management how the identified projects and programs can be aligned with the research strategy; discuss continuation and discontinuation of activities in order to manage workload and work pressure; identify which projects and programs exemplify the new

research strategy and should be monitored and shared as good practices as part of the implementation of the research strategy.

3.2 GOVERNING AND MONITORING STRATEGY EXECUTION

Strategy execution requires ongoing attention of the Executive Board, Faculty Boards, directors of institutes and service departments. It is a collegial endeavour which requires ongoing co-ordination, alignment of agendas, tailor-made solutions and careful setting of priorities. We recognise that it will be a learning process in which we will need to work continuously towards improvement and perform reality checks regularly. At the same time, we realise that our strategy is not cast in stone: if needed, we will respond to changes in our environment and adapt the speed and direction of our efforts.
In order to do so we will:

- monitor the execution of our strategy by means of our co-ordination meetings (UC OZ, EB-Deans, Strategic Board and Supervisory Board).
- create a portfolio of projects and programs in 2020 and periodically update that portfolio. The portfolio will act as a major vehicle in the execution of the strategy.
- develop with the faculties and institutes a program plan for the years 2020-2023, with an overview of the ambitions, objectives and actions which will be further detailed into SMART goals and associated tasks and resources.

3.3 RESOURCE ALLOCATION MODEL FOR RESEARCH

Funding of research occurs via direct government funds to the University, indirect government funds via funding agencies and contract research funds. The current allocation model distributing direct government funding has developed historically. To support the UT research strategy, a new model will be developed and its effects and the possible need for adjustments will be evaluated in 2022. When adjusting the model it is essential to 1). safeguard the current basis; 2) accommodate strategic stimulation; 3). emphasize that our infrastructure is crucial. By using our infrastructure effectively and efficiently it will provide the opportunity to invest strategically.

Taken this into account the resource allocation model will be developed in accordance with the following guiding principles:

MULTI-DISCIPLINARY RESEARCH (CROSS-FACULTY)

We combine our expertise in science, engineering, and social sciences to create more impact. Our allocation model should support this.

STRATEGIC RESEARCH INFRASTRUCTURE FOR OPEN INNOVATION

Our research infrastructure is important to generate impact. Strategic infrastructures are open, innovative facilities and are positioned in a wider national and international context, based on long-term agendas, roadmaps, and co-investments from partners. We improve coherence, co-ordination, and connections between existing labs at faculties.

FUTURE-ORIENTED ALLOCATION OF FUNDS

At this point, budget allocation is largely based on past performance. For example, the allocation of the PhD bonus is solely based on diplomas presented. The primary research budget is currently also being divided on grounds of earlier agreements on proportional distribution among institutes. In the new model, future-oriented parameters are incorporated enabling new research orientations and new partnerships.

EXPERIMENTS (CURIOSITY-DRIVEN, FUNDAMENTAL RESEARCH IN INDIVIDUAL SPACE)

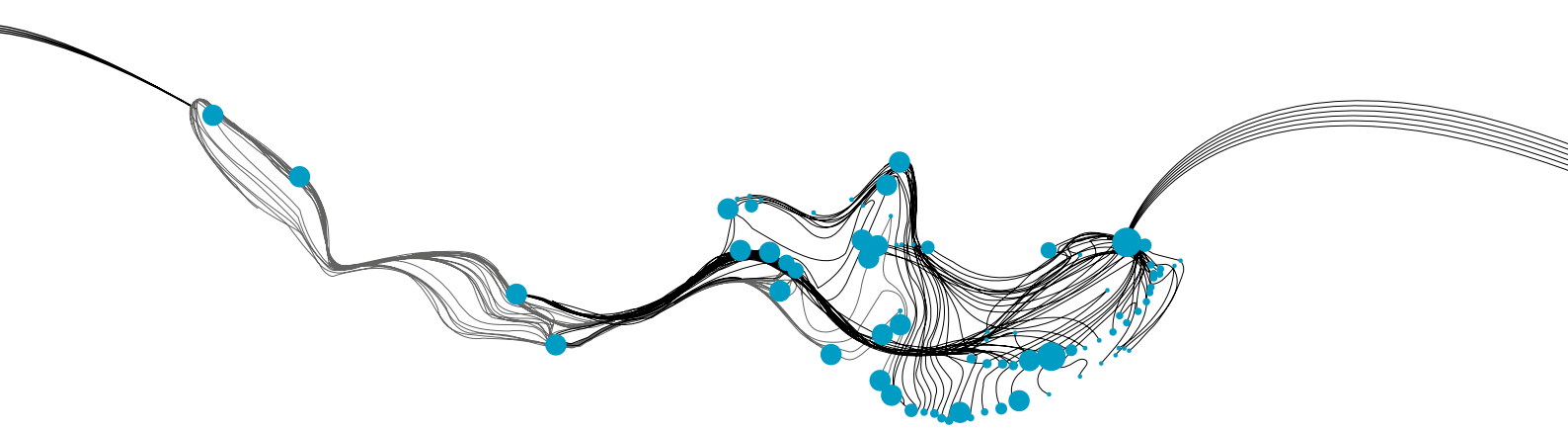
Curiosity-driven, fundamental research on the level of individual scientists is paramount for innovation, excellence, and impact. We create time and space for experimenting and 'crazy research'.

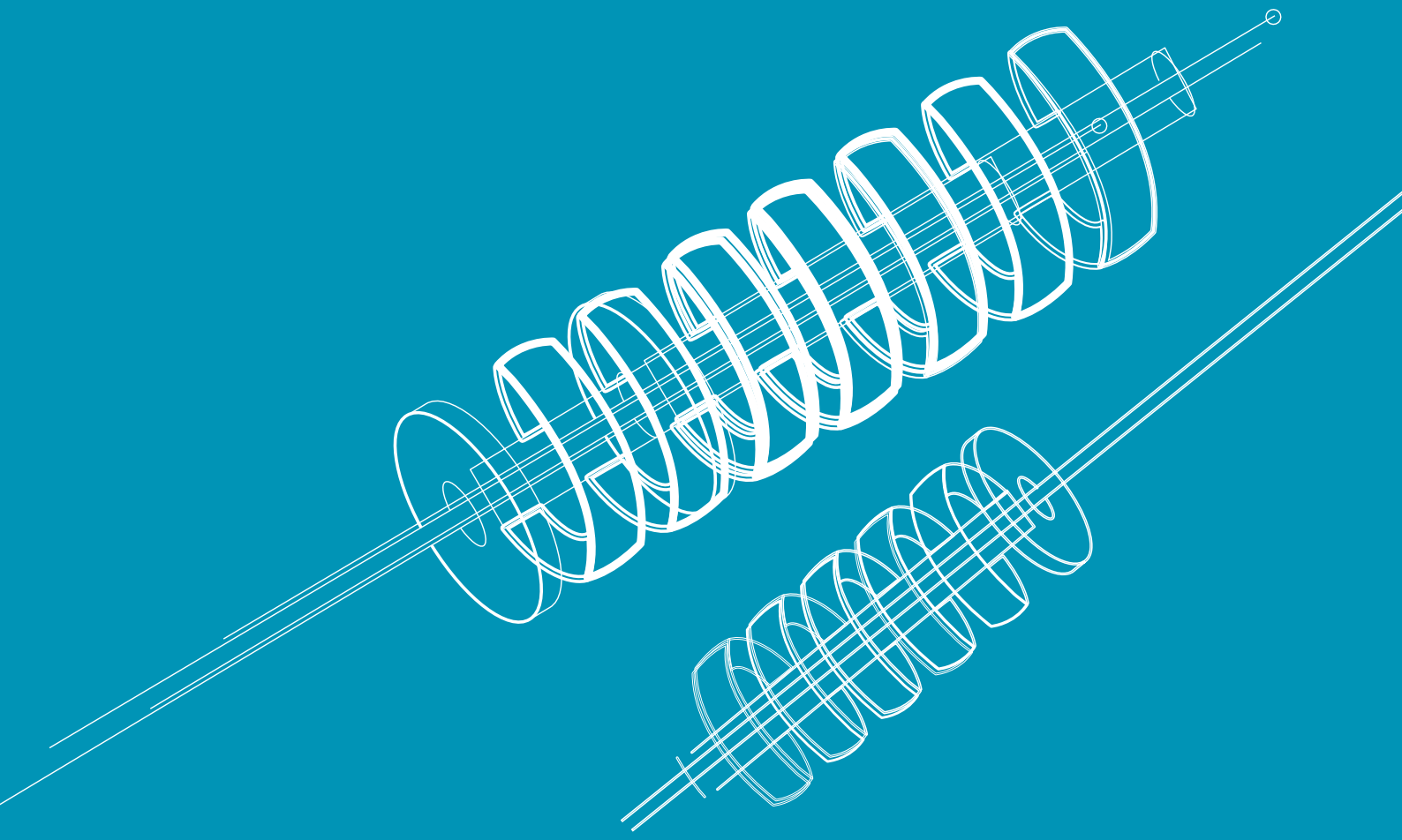
TO SAFEGUARD INTEGRITY AND TALENT DEVELOPMENT (BEHAVIOUR, PERFORMANCE, AND PROCESSES)

Shaping individuals is one of the strategic goals. The research strategy provides a set of instruments to identify and support talent and high potential. The financial scheme should assist this talent development as well as integrity.

'PEOPLE FIRST'

Our vision is to be the ultimate 'people first' university of technology; this means that we do not only focus on the agendas of the big funding agencies, but that we also include questions and preferences of societal actors and citizens in our research agenda. Therefore we engage in activities as Citizen Science as part of the Open Science agenda.





CAMPUS ADDRESS
University of Twente
Drienerlolaan 5
NL-7522 NB Enschede
The Netherlands

POSTAL ADDRESS
University of Twente
PO Box 217
NL-7500 AE Enschede
The Netherlands

T +31 (0)53 489 91 11

info@utwente.nl
www.utwente.nl

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