

# MULTIANNUAL PLAN 2021-2025

Faculty of Mechanical, Maritime & Materials Engineering,  
TU Delft

# FOREWORD

**You see before you the 5-year Plan: 2021-2025 for the Faculty of Mechanical, Maritime & Materials Engineering at the TU Delft. It came about in a challenging time and under challenging circumstances: the Covid-19 pandemic, which is putting the resilience of people, society, and the faculty to the test.**

No one knows yet the future course of the pandemic, but what is certain is that we have learned much in recent years – lessons that we can and will take to heart in the coming years. Covid-19 also affected the way in which this Multiannual Plan was developed. Forced to work from home, we had fewer opportunities to sit around the table to reflect and discuss compared to previous editions. Technology played an unintentional leading role in the form of remote consultations via computer screens. Given such complex circumstances, there is all the more reason to thank everyone who contributed to this plan.

Notwithstanding all that, we can be very satisfied with the outcome. This Multiannual Plan sets out important lines for the years to come.

It demonstrates how the faculty actively reflects on and anticipates the future. It also shows a faculty that, with creativity and enthusiasm, is eagerly taking on new challenges both within its walls and beyond. It is a testament to resilience, and that is cause for optimism.

On releasing this plan, the faculty will not of course stop thinking about its future. On the contrary: if living through a pandemic has taught us anything, it is how important it is to continue to meet up and think about how, through research and education, we will find the best answers to the technical and societal challenges of our time.

**The Management Team  
December 2021**



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## 1

# INTRODUCTION

**TU Delft helps society find answers to challenges, both big and small. We do this by training good engineers and by doing ground-breaking engineering research. While that is true for the whole university, it certainly also applies to the faculty of Mechanical, Maritime & Materials Engineering, which performs world-class teaching and research.**

## Growing interest

There has been a considerable growth in interest in the Faculty of Mechanical, Maritime & Materials Engineering by students over the past few years. At least part of this is due to the growing awareness of the important role that technology plays in solving major issues across society as a whole. The engineering sciences, in which our faculty excels, are getting the interest that they fully deserve.

This means that 3mE is growing – but it's not just our size that is changing; the content of our work is changing as well. Step by step, in both our research and our education, the centre of gravity is shifting from engineering geared towards use in heavy industry towards design solutions for major societal challenges. After all, as problem solvers *pur sang*, our faculty can and must play key roles in sustainable production, the energy transition, and human health.

The Covid-19 pandemic presented one wonderful example, when staff and students quickly took on the challenge of finding solutions to an impending shortage of medical ventilators. It demonstrated an open, collaborative, informal, solution-oriented, outward-looking culture. Such a culture can be found across our faculty, and it is what we want to maintain and strengthen in the coming years.

## Education and research

The faculty has advanced greatly in recent years, thanks in part to extra resources arising from the Natural and Technical Sciences Sector Plan (*Sectorplan Bèta en Techniek*) and a report by the Van Rijn Commission (*Adviescommissie Bekostiging Hoger Onderwijs en Onderzoek*). Both highlighted the need to increase the capacity of engineering education. These added resources enabled us to welcome rapidly growing numbers of students together with increased numbers of staff. By

streamlining both the curricula and educational organisation, this helped ease the pressure on education. We maintained the integration of education and research while always allowing best quality to guide our teaching, a principle that we will uphold in the coming years.

In line with the Engineering Sector View (*Sectorbeeld Techniek*), we have been strengthening the three basic disciplines (thermodynamics & fluid dynamics; mechanics, statics, dynamics & materials science; and measurement & control engineering) as well as their application areas. We have invested in recruiting young researchers on topics such as the energy transition, robotics, and artificial intelligence, and helped them apply for personal grants, which is bearing fruit. Research in our faculty contributes to society in many ways, including patents and spin-off companies.

Independent inspections have confirmed a positive picture: the quality of our research has received praise.

In the coming years, the faculty will continue to strengthen the three basic disciplines highlighted in the Engineering Sector View. We will also invest in a growing number of biomedical application areas. At the same time, we will focus our research and education more explicitly on three specific societal challenges, which fit well within the broader TU Delft research themes: Sustainability, the Energy Transition, and Health and Care. A sharpened profile will help increase the faculty's visibility in national and international partnerships.

## Housing

We take pride in our distinctive, historic building. It is a breeding ground for creativity as well as a place for meeting up and working together productively. Over the years it has seen many improvements, and we continue to invest to keep and bring our research infrastructure fully up to date.



Growing numbers of students and staff however are causing the building to almost burst at the seams. That will become even more apparent when the effects of the Covid-19 pandemic fully wear off.

In many places we need to deal with an increasing lack of space. Workplaces and laboratories are already stacked to the roofs. Business as usual is no longer an option: things are simply not going to fit. As a community we'll have to set priorities and make creative choices. We'll need to make the best possible use of our building to do excellent research and offer inspiring education. For some parts of our work, we'll have to explore solutions outside our own faculty building.

### Diversity

We are very happy about the growing share of women among our staff in recent years. Among new students, that share is also rising albeit more slowly. But we are not there yet.

Diversity is about more than just numbers of women or men; our community should also reflect society in other ways, e.g., a full spectrum of social and cultural backgrounds as well as physical abilities. In the coming years, we will respond to this challenge by taking some new steps.

Our faculty provides inspiring research and exciting, socially relevant education. We want to identify and lower unconscious, unintended barriers that may hold back some people's ability to participate. We will, for example, aim to reach broader target groups when recruiting students. We will also think about how a more diverse population of students and staff will feel optimally at home within our walls.

### Optimism

Our faculty is in good shape. The quality of our education, research and operational support is outstanding. Maintaining that high quality however requires continuous innovation. To that end, this Multiannual Plan puts various topics on the agenda. They will help us meet the challenges of the coming years and ensure that next Multiannual Plan's tenor will be as proud and optimistic as this one's.

## 2

## STUDENTS AND EDUCATION

**F**or more than 150 years, our faculty has offered excellent education with teams of good teachers, technicians, and education specialists, supported by cutting-edge facilities, and aimed at national and international labour markets. Our students are theoretically savvy, practical problem solvers, who can work together towards a shared goal. In developing these skills, we guide and train them.

In recent years we were able to accommodate growing numbers of students without overloading our staff or compromising the quality of our education. We have made every effort to maintain a good balance between education and research. More so than in the past, our most experienced professors now teach courses that are part of our bachelor's degrees while younger teachers focus more on smaller-scale education within our master's programmes. All researchers at our faculty must also have an affinity with teaching.

#### Our vision on education

Good education targets three goals: qualification, socialisation, and subjectification. With an eye towards *qualification*, we provide students with the knowledge, skills, and competences they need to function in their future professional lives. Through *socialisation*, we acquaint our students with professional traditions, let them reflect on the meaning, norms and values of engineering, and teach them both about their personal responsibility and the need to think critically. In parallel, for *subjectification* we enable them to use their study time for personal growth and maturation, develop an identity and discover their motives and passions. To stimulate and guide students in all three dimensions, all our curricula reserve time for reflection on the engineering profession and for being socially active as well as for teaching technical knowledge and skills.

#### New balance on- and off-campus education

The Covid-19 pandemic has had a great impact on our community. The forced and rapid switch to online education early 2020 created high workloads for teachers, turned educational organization upside down and affected the social and mental well-being of both teachers and students.

The pandemic has also taught us a lot however— for example about the technical and educational possibilities and limitations of distance (online) learning, about added value of new teaching methods and about the vital importance of on-campus activities. In the coming years we will apply those lessons as we seek a new balance between on- and off-campus education methods.

Where it can add to educational quality, we want to keep some of the new off-campus study options in place. Distance education can, for example, continue to be a useful alternative to classroom attendance for lectures aimed at knowledge transfer. Going forward we aim to offer all such education using a 'passive hybrid learning' model in which lectures are streamed live, attended by students both in the classroom and at remote locations. Often, remote students will be able to interact with the teacher as well. Afterwards, students will be able to access recordings of the lecture. Hybrid learning gives students maximum flexibility and may also help relieve some pressure on limited classroom facilities.

At the same time, from our educational vision flows the essence of on-campus education (such as working groups and practical instruction) for reflection and learning transferable skills. On-campus methods will therefore continue to play important roles in all programmes and study years.

#### Student population and courses

After experienced growth in the number of bachelor students in recent years, we expect those numbers to stabilise in the near future. At the same time however the number of master students is likely to continue to grow, which will bring its own challenges.

To continue to achieve all of our educational objectives, we will pay special attention to the following:



- To aim to limit individual master programmes and tracks to a maximum of a hundred students, in part by updating some of our curricula.
- To provide our bachelor students with the option to continue in one of our master programmes, we will cap lateral entry to these programmes. Where needed, we will tighten bridging programmes for master curricula to maintain and ensure quality levels.
- To increase the extent to which our student body reflects diversity in society, we will investigate, among other things, how to reduce underrepresentation of student categories through active outreach (e.g., to more and/or other secondary schools). (More about our ambitions related to diversity are in chapter 4.)
- In our master programmes we want to bring back 'master-apprentice systems' by letting students practice theory and learn about the profession in teacher-supervised groups. We aim for integrated project education in which knowledge and learning skills are combined. This would advance students' personal and academic development and increase their degree of satisfaction with their study.
- We will make master programmes more feasible by improving student tracking systems and strengthening students' social cohesion, e.g. by starting pilots with mentoring and intervision groups for students who are preparing for their graduation.
- We will tailor curricula toward a changing society and changing work fields. Our choice of three key societal challenges (sustainability, energy transition, and health and care) will affect educational content and forms, in some programmes more than in others.
- We will strengthen the socialisation component of our programmes, intensifying the teaching of transferable skills: teamwork, decision-making, communication, planning and prioritisation. We will integrate 'reflective engineering' tracks into all our curricula.
- To manage excessive workloads of individual teachers, we aim to improve the spread of educational tasks over all available staff. To manage workloads more in general, particularly bearing in mind the growing numbers of master students and the need to adapt curricula, we will take a cautious approach toward educational initiatives other than those aimed at bachelor's and master's degrees. This may also concern university-wide initiatives related to open online education (such as ProfEds and Lifelong Learning). (More about our workload management ambitions can be found in chapter 4.)

## 3

## RESEARCH AND INNOVATION

**T**he faculty conducts ground breaking, influential research in important application areas in fundamental and application-oriented engineering sciences. Our research scores high in academic rankings and is well known to industry and society. We aim to maintain and add to these strengths. In addition to having talented, motivated, and committed staff, that requires a solid disciplinary basis, sufficient funding, and state-of-the-art research infrastructures.

### Basic disciplines

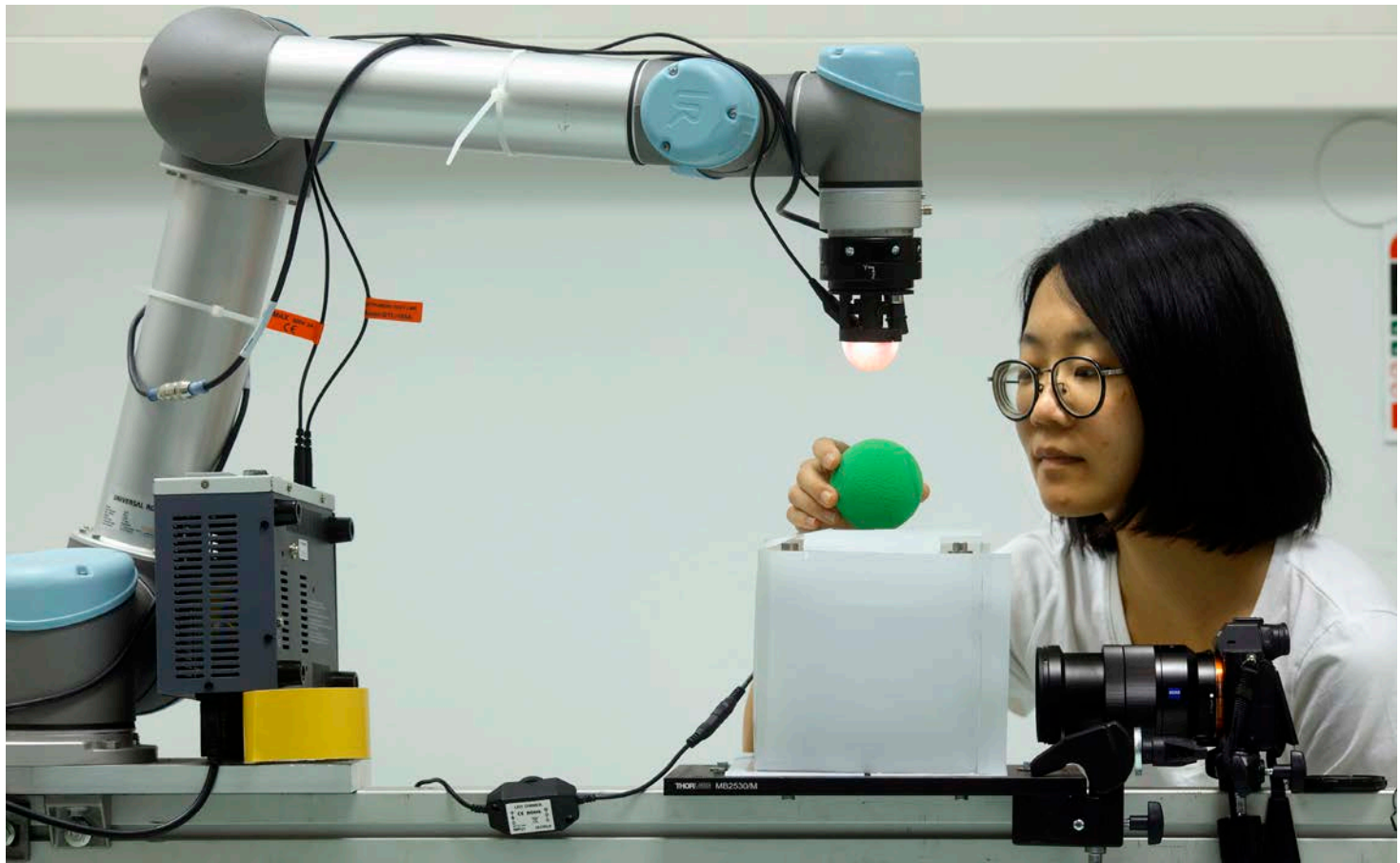
In recent years, the Dutch government has added resources to education in natural and technical sciences, including the engineering sciences. Recommendations from the Advisory Committee Higher Education and Research Funding (*Adviescommissie Bekostiging Hoger Onderwijs en Onderzoek*) and the Natural and

Technical Sciences Sector Plan (*Sectorplan Bèta en Techniek*) contributed to that. A national Sector View (*Sectorbeeld Techniek*) for the engineering sciences identified basic disciplines and focus areas that warrant strengthening.



Based on the knowledge of the basic disciplines and the methodology of structural design, the 3mE faculty conducts education and research in many application areas. Continuous interaction between basic disciplines and application areas is essential and an important pillar of our approach.





In the area of mechanical engineering, the Sector View named three basic disciplines, which are also strongly represented in our faculty:

- *Thermodynamics & fluid dynamics*, in our faculty focused on, for example, large-scale energy storage, conversion of green electricity into synthetic fuels, and clean and efficient use of these fuels for road and sea transport.
- *Mechanics, statics, dynamics & materials science*, in our faculty focused on, for example, design and construction of equipment and components with additive manufacturing, interactive and hybrid materials, and reusable and durable materials and structures, all at multiple scales.
- *Measurement & control technology*, in our faculty dealing with, for example, digitisation and autonomy with particular focus on actuation and sensor technology.

With knowledge derived from these three basic disciplines, we carry out education and research in important application areas, most importantly maritime engineering, intelligent systems and sensor technology, and biomechanical/biomedical engineering. In all of this, 'constructive design' methodology plays a key role. We consider it essential that basic disciplines and application areas interact continuously. Therefore, we emphasise such interaction in our research and education. Wherever possible we aim to increase

mutual cohesion between the basic disciplines and the various research groups.

In the coming years, additional investments will be made in the increasingly important field of biomedical applications.

The faculty of course remains agile, adaptive, and exploratory with regards to new developments. For example, we expect artificial intelligence (AI) to play a growing role in much of our research. We do not however approach AI as a separate discipline but rather as a powerful tool, which we will develop and apply in our collaborations with others in various fields.

### Three societal challenges

In recent years, general awareness that science and technology play a key role in society's response to major challenges has grown. This also affects national and international funding for research.

In the coming years, we will meet our responsibility to society by focusing much of our efforts in the basic disciplines of research related to three major societal challenges:

- *Sustainability*, e.g. reduced material and energy consumption and electrification of large chemical production processes,
- *Energy transition*, e.g. new materials and other innovations for large-scale and efficient energy conversion and storage, and

- *Health and care*, e.g. the development of multifunctional biomaterials and innovative instrumentation for biomedical research down to the cellular level.

These three challenges are an ideal fit with the strengths and disciplinary breadth of our faculty and the interplay of its fundamental and application-oriented research.

Focusing explicitly on the three challenges will increase the faculty's visibility both nationally and abroad. It may help attract new research funds and (international) research talent. In the coming years, a working group will develop ideas, specifically to help raise the profile of the faculty's (multidisciplinary) research, competences, expertise, and facilities.

### Vital basic disciplines

Major societal challenges are highly complex. They require ground-breaking and multi- and interdisciplinary research. Increasingly, scientific research extends across and beyond boundaries of basic disciplines and neighbouring knowledge domains.

At the same time, there is a risk that there would be insufficient oxygen for the basic disciplines themselves, despite the fact that these disciplines serve to underpin many fields of science and engineering. Because research is intertwined with academic education, the same risk also extends to students' basic training.



The faculty puts a high value on a healthy balance between the basic disciplines, and multi- and interdisciplinary research. This insight will play a role when specific research lines and projects are prioritised: in other words, the faculty will in the coming years, work on a strategy to maintain the vitality of the basic disciplines and to ensure a healthy balance for the long term.

### Major research programmes

The focus on societal challenges also leads some funders to promote large, comprehensive research programmes (of €5 million or more). For these, they often eye national or international consortia that encompass public knowledge institutions and private companies or organisations.

In the coming years, the faculty intends to strengthen its participation in such programmes and possibly initiating and coordinating some of them. The new focus on three societal challenges may further these aims. On average, we aim to seek external funding for three PhD students per staff researcher.

Raising funds for large programmes, with professional support from programme coordinators, will increase the faculty's visibility, impact, and international network.

### State-of-the-art research infrastructure

For excellent research, it is essential to have excellent experimental labs, facilities, and lab technicians. We take pride in our existing infrastructure, which add greatly to our strength and identity, our labs and facilities contributing to a variety of areas of research.

In recent years, we have invested in a cavitation tunnel for research into unstable flows, and in laboratories for marine hydrodynamics, robotics & intelligent vehicles, and 3D micro-nano-characterisation.

Our ambition is to remain at the forefront of research using both existing and new, high-quality infrastructure. In the coming years, reflecting our priority for the basic disciplines and societal challenges, we will continue to invest in updating and expanding state-of-the-art infrastructure. The following investments are planned, among others:

- *Micro-nanofabrication (MNF) lab*: Equipment for additive and subtractive production, and instruments for characterisation of products and materials;
- *Magnetic resonance imaging (MRI) facility*: Measurement facility for understanding non-transparent flows;
- *Biofluids lab*: Facility for studying the propulsion of small organisms and the technology based on these;
- *Bio-optomechatronics facility*: Microscopy/laser lab/microCT facility for bio-optical and biomechanical experiments and designs up to single/few-cell levels, including organs-on-chips in collaboration with the HPTC;

- *Robot lab, Drone zone*: Vehicle simulator on 3D motion platform, two autonomous vehicles and a vehicle-pedestrian simulator; large, high spaces for research into drones and robotic arms; labs for research into soft robots, telerobotics, rehab robots, eye trackers, haptics, and robots for reconnaissance and rescue operations;
- *Windshape lab*: Facility for validating new control and operational strategies of (floating) wind turbines and wind farms, including a 'windshaper' i.e. a grid of small fans that generates reproducible, time-varying wind fields in which to study the aero-elastic response of scaled turbines and wind farms.

## 4

## PEOPLE AND COMMUNITY

**T**o work successfully and enjoyable in a large and complex organisation such as our faculty, paying attention to the work processes and the culture is important. What is needed to enable employees to develop their talents optimally and flexibly where possible, how do we want to work together, what are our values. We recognize our role in society and want to give expression and meaning to our academic responsibility and our connection with society.

#### 4.1 Our values

The values of TU Delft are summarised under the acronym 'DIRECT': Diversity, Integrity, Respect, Engagement, Courage, Trust. These values also guide the work of the faculty, and the functioning of our community of students and staff as well. At the faculty level, we aim to give more concrete meaning to these values.

##### Diversity

The faculty does not see 'diversity' as a buzzword but as a value that directly affects the quality of our education, our research, and our functioning as a community. The better we reflect the full diversity of society as teams and as a faculty, the more talents, perspectives, and insights we can merge into a broad palette of educational and research activities and processes. It also makes it easier to interact with each other in open, respectful, and productive manners.

At present, the faculty does not yet fully reflect Dutch society in all major respects. For example, some categories (such as first-generation students) are underrepresented in our community, and diversity (for example in terms of gender) is limited at faculty management levels as well.

In recent years, the faculty has made significant progress in seeking a more balanced gender distribution within its workforce.

Between 2018 and 2021, thanks to focused attention on talent recruitment and selection, the appointment of new tenure trackers, and the setting of concrete goals, the share of women in our research and education staff grew rapidly, from 13% to 33%.

In the coming years, we aim to address challenges in diversity in a broader sense (for example, with regards to sociocultural background, and physical and mental abilities).

Amongst other things, we're aiming to reach and recruit broader categories of prospective students. This can be achieved by building up contacts with more and different secondary education institutions in the region, for example, and by seeking greater diversity in the teachers and researchers that we put forward as role models.

We also want to think however about how we can offer a more diverse population of students and staff an inclusive learning and working environment once they are in the faculty. Does everyone always feel optimally at home, valued, and fully part of the faculty culture? Could our education, our buildings, or elements of our culture constitute unintended barriers that we may not be aware of? How do we bring the best out of combinations of people with different with character traits for example introverts and extroverts?

Identifying blind spots within our own home is hard for any organisation. In the coming years, we want to use outside input, firstly to map out our strengths and weaknesses related to diversity. We will discuss often unconscious and unintended dividing lines, barriers, or ceilings that students or employees may experience that may lead them to drop out. Then, in conjunction with the diversity-related activities and ambitions of the university, we will identify specific areas for attention, set goals, and develop an action plan. Student associations could be involved in such a plan.

As a first step, we will appoint a faculty diversity officer, who will report to the dean and the management team, to broaden and anchor attention to diversity in the organisation. Our recent advancements toward more balanced gender ratios among tenure trackers give us the confidence that broader efforts in the coming years will be just as effective.

### Integrity, Respect, Trust

Generally speaking, the faculty has an attractive, informal, productive and non-hierarchical culture with much room for collaboration and open conversation. That is what we always strive for. Nevertheless, employee surveys (Medmon) sometimes flag situations in which mutual interactions and relations became less open and more hierarchical. In the coming years, we will continue our efforts to monitor social safety at the faculty and to recognise and correct incidental cases of undesirable behaviour as quickly as possible.

### Engagement

The faculty aims to strengthen engagement in the coming years by linking education and research more explicitly to major and current societal challenges, among other things, specifically on the themes of sustainability, energy transition and health and care. This ambition is detailed in section 4.3.

## 4.2 Our students and staff

The faculty wants to enable students and staff to develop their talents optimally and -- where possible -- flexibly, and to maintain a good *work-life* balance, in part by keeping their workloads manageable.

### Sustainable career development

In the coming years, the faculty will work towards more sustainable career development and employability through greater flexibility and diversity in competence development and career paths. Spearheads are:

- Special attention will be given to sustainable employability, career development, and growth opportunities (internal or external) for supporting staff such as secretaries and technicians e.g. by including these issues in all relevant R&D interviews. Helping support staff members participate in cross-departmental communities can be a part of this.
- Within the general goal of keeping education and research closely linked, staff members should be able to excel and specialise in education, valorisation, management and so on, in addition to doing research. Young talents with special interest in education will be identified and supported in their didactic development, for example through a tenure track plan focused on education. Allowing scientists to gain experience with administrative tasks (including HR and financial matters) also broadens their footing and forms an investment in future faculty leadership. Aside from the number of research papers produced, academic staff must also be appreciated for their achievements related to quality,



scientific integrity, creativity, external communication, contributions to teams, collaborations and/or society as well as for their contributions to individual research domains and career profiles. A scientific career with more emphasis on teaching is conceivable, for example. All this ties in with national policies aiming to broader 'recognise and reward' (Erkennen en waarderen) employees' achievements, and with the development/recalibration of the university function-ordering system (UFO). Greater diversity in career paths may also result in more distinct research profiles e.g. 'curiosity-driven' or 'application-driven'. Horizontal development and career paths will be encouraged, and attention will be paid to the motivation and development of employees at later stages of their careers. For this purpose, effective systems can be developed in line with university-wide initiatives.

- Support for tenure trackers using mentors and communities should also be enhanced.

### Keeping workload manageable

In education, the recent rapid growth in numbers of bachelor students has been accompanied by increased staff size. However, the workload experienced by all staff remains high on the agenda, both in terms of work processes and culture.

- Our aim remains to reduce the student/staff ratio, in part by creating and filling sufficient positions.
- In the last few years, as well as supporting the faculty's own education programmes, our junior teachers have been able to get training to become secondary education teaching professionals. This option is highly valued by both junior teachers and teaching staff and will be continued.
- The aim of keeping workloads acceptable faculty-wide is an explicit and fixed part of all R&D interviews. In general, the faculty encourages staff to share existing knowledge and experience, and to prioritise and to assign sufficient time for new projects when necessary. Whenever new tasks are created, old tasks should expire. Tasks should also be assigned to the appropriate employees. It is expected that managers to lead by example in all these areas.



### 4.3 Our role in society

Society is expecting a lot from engineers and scientists: making breakthroughs in knowledge and technology, contributing to prosperity and well-being, and educating our young. The faculty is very aware of its bond and responsibility to society. This is also reflected in our explicit choice to address three major societal challenges: sustainability, energy transition, and health and care.

#### Students and education

The faculty has a major impact on society that comes from training good and committed engineers who actively help the transition to a sustainable economy. In the coming years, we will give a permanent place in our bachelor and master education to knowledge and skills related to sustainability. By integrating a 'reflective engineer' component into all curricula, we will train responsible and cooperative engineers for the future. In master's courses that once used to focus on 'old industries', the balance will shift further towards sustainability, societal relevance, and responsible innovation with emphasis on reflective engineering. The faculty is considering introducing new thematic minors such as 'recycled materials' and 'marine eco-transport'.

At our faculty, we witness daily how new generations of students are very inspired by major societal challenges. The faculty welcomes student initiatives that link their education to sustainability issues.

#### Researchers and research

In recent years, much of our research has already trained its focus on societal challenges. The new focus on three of those challenges (sustainability, energy transition, and health and care) will demonstrate even more clearly our work's societal relevance to the outside world. It will also help our researchers complement scientific excellence with skills to effectively articulate and communicate the significance of their research.

#### Outreach

Our impact on society can take many forms. We can, for example, advise governments, companies, or other organisations on our areas of expertise, participate in the public policy arena, or give guest lectures at primary, secondary or vocational schools. The confluence of urgent societal challenges such as climate change and growing floods of misinformation tasks us with clear, reliable, and effective science communication.

Interacting to a greater degree with society also benefits the faculty itself. It enables us to identify and respond to new trends, developments, and sensitivities sooner and better. Our researchers will, when participating in outreach activities, extend their networks by having more exchanges with peers, policy makers and the media. Learning to explain their research concisely and attractively to general audiences helps researchers think outside the box and be creative. Experience teaches us that they tend to find it highly instructive and satisfying.

The faculty therefore encourages scientists to put their research in social contexts and to bring their knowledge to various lay audiences. In recent years, the university function-ordering system (UFO, see also 4.2) has gained more options to recognise and reward staff members for achievements in this area.

The faculty's communication team creates and maintains external communication channels and encourages, advises, and supports researchers and research groups in their outreach efforts.

## 5

## HOUSING

**TU Delft is an on-campus university. This certainly also applies to our faculty, where theoretical and experimental work go hand in hand. Much of our experimental research is tied to our historical, architecturally distinctive building, which houses unique, indispensable, state-of-the-art laboratories and research facilities. Our building also fulfils vital functions in education. Construction engineering education often occurs at project tables and frequently requires workshop facilities. Students' presence in the building is also of great importance for their natural academic development and for becoming connected with their research.**

In recent years, a steady growth in the number of students, staff and laboratories has put pressure on the faculty's main building. A variety of creative solutions have stretched the number of usable square meters considerably, but urgent measures will be required in the coming years, if we are to continue to fit everyone in. As part of that process, the faculty aims to follow TU Delft's housing standards for students and staff as closely as possible, but reality also forces us to note that in the short term this will not always be feasible.

The building has monument status, and so there will be limits to the creation of working space through renovation. Ultimately solutions may have to be found through extensions or entirely new construction projects: however such projects will certainly extend beyond the five-year time horizon of this Multiannual Plan.

In the short term, other solutions must be found. In the coming period, we will seek campus-wide solutions in close consultation within the TU Delft.

Potential short-term solutions fall into three categories: students and education, research and support staff, and laboratories. In each of these categories, we will make a distinction between activities that are tied to the building, and those that can also take place elsewhere (either on campus or at home) without compromising quality standards. We will apply lessons from the Covid-19 pandemic about the opportunities and limitations of studying or working remotely. In effect we have to use the available space and facilities more efficiently, when- and wherever possible, by sharing or reorganising them. In some cases, this objective can be achieved along with the goal of promoting

collaboration and cross-pollination between departments and disciplines.

#### a. Students and education

For our students' study success, a bond with the study programme and the building is important. Given the limited space in the building, not all students can use all facilities at the same time. Unfortunately, we are forced to make choices here. For first-year students, presence in the building is crucial for bonding with the course, with the lecturers and with each other. Thanks to this strong bond built up in the first year, second- and third-year bachelor students and non-international first-year master students are less tied to the building for their study success. The wider TU Delft campus provides alternative spaces and facilities for self-study, collaboration, lectures, and practical instruction.

The final study year is dominated by graduation projects, which often tie in with research projects in which PhD students and staff also collaborate and experimental setups are used. Graduating and PhD students therefore require space within the faculty walls, preferably within departments and close to their actual research. During the pandemic, students and teachers have learned to re-evaluate online and on-campus education options. While it proved possible to transfer knowledge remotely, other academic competences and skills required the student to be present in the building. So given the projected shortage of space, we must look critically at the use of space for education in the coming years. Several considerations will guide us:





- For knowledge transfer, hybrid forms of education can be very useful.
- For academic development and transfer of skills, in-house education is preferred.
- Self-study places for second- and third-year bachelor students and first-year master students, as well as small-scale instructional education, can be accommodated elsewhere on the TU Delft campus, preferably not far from the faculty building.
- Within the faculty building, group-based forms of education such as project- and specialised education are prioritised.
- Master students should preferably have shared workplaces in the departments where they are to graduate.

#### **b. Workplaces for research and support**

Within the available space, we aim to meet all staff's needs for concentration, cooperation, feeling at home, job satisfaction, cross-pollination, and academic development optimally.

The faculty's 2018 Housing Vision has already noted that growing staff numbers have led to a shortage of (desk) workplaces. The Covid-19 pandemic and associated lockdowns have given temporary respite and showed that opportunities for working remotely and flexibly in terms of work hours are growing, thanks in part to advancing technology. At the same time, it has become apparent that physical meetings are essential for intensive consultations on complex technical and organisational matters as well as for spontaneous human interaction.

Bearing all this in mind, we will have to rethink work rhythms, the role of personal and shared offices and workplaces and the need for meeting spaces. Several items will be on the agenda:

- Employees should continue to have enjoyable workplaces in the faculty building.
- More rooms will have to be shared more often. Unfortunately, because of great scarcity, it will no longer be tenable to offer each UHD a personal office. Faculty-wide, the norm will be for assistant professors and associate professors to share an office with a fellow assistant professor or associate professor.
- Flexible working, even within the context of hybrid working, will not become the norm. There will however be room for customisation: employees who prefer to work from home frequently will be able to do so within certain limits, providing their tasks allow it. We will investigate how much space this can save.
- Since demand for meeting rooms will exceed supply, the faculty will encourage full professors to make their offices available for consultations when they are away. A reservation system could facilitate this.
- The faculty wants to invest in rooms dedicated to hybrid and online working such as call cells, video consultation studios and small conference rooms for seminars, conferences, etc.

- For many PhD students and postdocs, a fixed room is more important than a fixed work desk. If a group of employees works remotely one day a week on average, they can choose a model in which they share flex desks in a fixed room. We will also investigate a model in which the number of desks can exceed a room's maximum occupancy level provided an attendance schedule is used to prevent overcrowding.

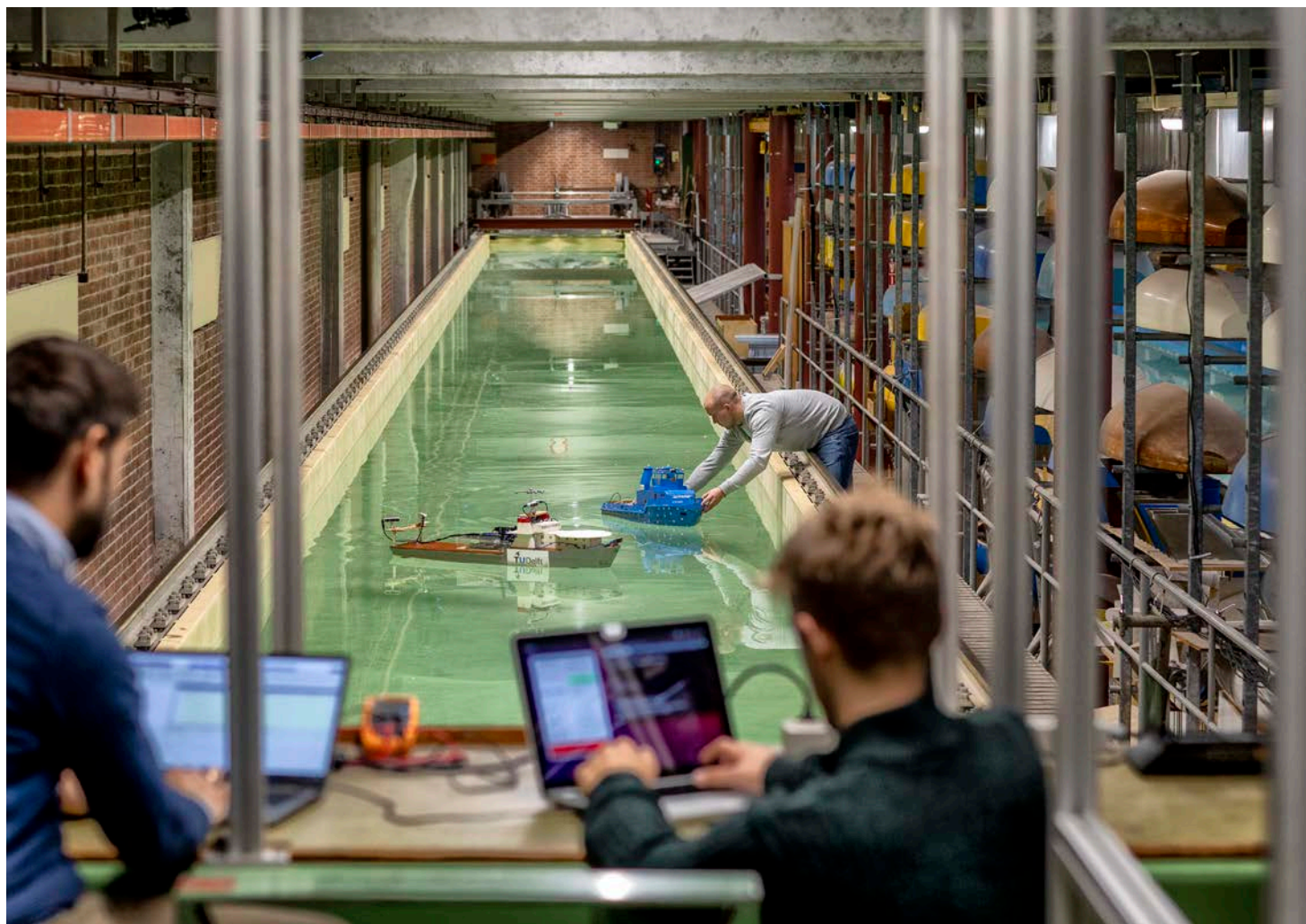
### c. Laboratories

Our laboratories contain unique and state-of-the-art research facilities. They are an integral part of our primary process and inextricably linked to the building. They give rise to ground-breaking innovations, distinguish the faculty from others and help to attract talent. In the coming years, we will invest significantly in new equipment and facilities that continue to enable research at the forefront of mechanical engineering. This will include the relocation projects in halls F and J, investments in the context of the Natural and Technical Sciences Sector Plan and the construction of an ad-

ditional, shared Bio-optomechatronics lab (see also Chapter 3: Research and innovation).

Nevertheless, our laboratories cannot escape the reshuffling of scarcely available space, some of which is already underway: the creation of the new Cognitive Robotics department has prompted significant internal relocations and reorganisations of laboratories that have touched almost all departments. In the coming years however, yet more choices will have to be made and smart solutions be found to keep us from having to compromise on the quality of our research.

- In many laboratories, space is currently taken up by setups or equipment that are no longer in use. Clearance, or storage in less prominent areas, can free up high-quality space for new setups and equipment.
- Some basement rooms can be used to house laboratories.
- Some laboratories can be used more efficiently by sharing them between multiple departments. This would have the additional advantage of increasing the opportunities for new and spontaneous interdepartmental 'cross-pollination.'





# COLOPHON

## **Edition**

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## **Text**

The Management Team of the Faculty in collaboration with colleagues, students and participation council

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## **Photography**

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