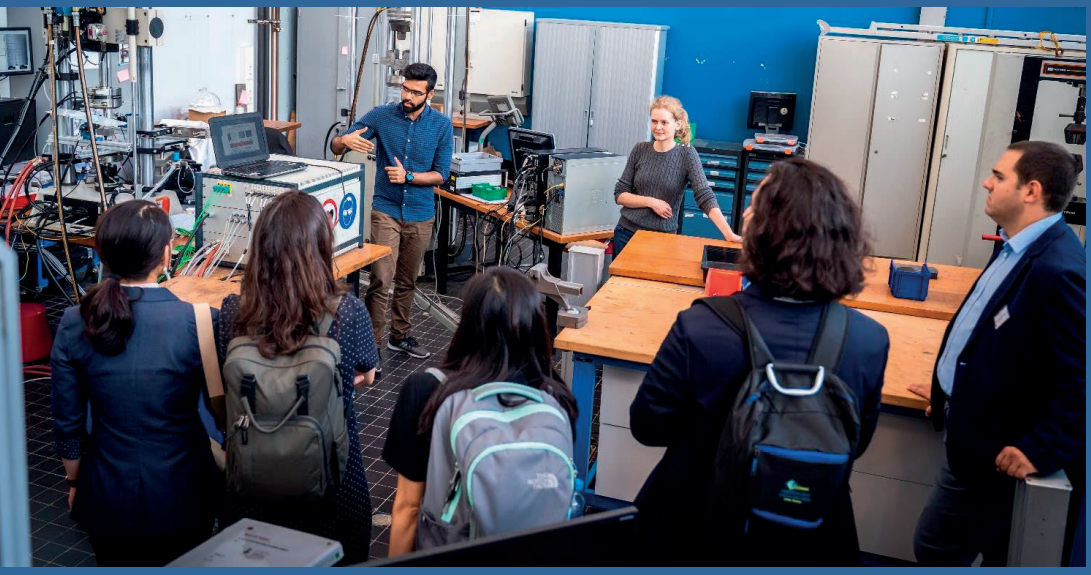
Assessment Committee Report on Research in Mechanical, Maritime and Materials Engineering 2013-2018

Delft University of Technology



April, 2021

Assessment Committee Report on Research in Mechanical, Maritime and Materials Engineering 2013-2018 Delft University of Technology

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Colophon

Title
Assessment Committee Report on Research in Mechanical, Maritime and Materials Engineering 2013-2018, Delft University of Technology

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80 pages (including appendices)
April 2021

ISBN 978-94-6402-906-2

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PREFACE

The Assessment Committee was assigned the task of evaluating the research carried out at the Faculty of Mechanical, Maritime and Materials Engineering (3mE) at Delft University of Technology over the period 2013-2018.

Over three days, we undertook an in-depth exchange and discussion with staff and management of 3mE. This enabled us to understand, validate, and refine the initial impressions that we formed through the faculty self-assessment report.

Two months before the actual site visit, we had to decide that the site visit would take place online, as it became clear that the COVID-19 pandemic would not be over soon and committee members were prohibited to travel to the Netherlands. To have an online site visit was quite an experimental step, in which we could not predict if the Committee would be able to reach the same depth as in the on-site format. We appreciated the major effort that the faculty invested in preparing for this research assessment and the flexibility to change the programme during the online site visit.

The Committee enjoyed the exchange and discussion which took place in an open and positive atmosphere, despite the physical distance. We truly regret we could not meet face-to-face and reflect more on the faculty's challenges. This was simply the situation we had to deal with.

I wish to thank the Committee members for their enthusiasm and hard work, and our secretary Sven Laudy for excellent preparations and support.

Prof. Dr. Arjan van der Schaft
Chairman of the Committee

1. Assessment Committee and Assessment Procedures

1.1 Assessment Scope

The Assessment Committee was asked to assess the research of the seven units that comprise the Faculty of Mechanical, Maritime and Materials Engineering at Delft University of Technology. This assessment covers research in the period 2013-2018. In accordance with the Standard Evaluation Protocol 2015-2021 for Research Assessments in the Netherlands (SEP), the Committee's tasks were to assess the quality, relevance to society, and viability of the research programmes on the basis of the information provided by the faculty and interviews with faculty management and department personnel. Following this, the Committee was to make recommendations for the future.

1.2 Committee Composition

The members of the Committee were:

Prof. Dr. Arjan van der Schaft, Committee Chair, Professor of Systems, Control and Applied Analysis, University of Groningen, The Netherlands;
Prof. Dr. Ir. Ton Backx, emeritus Professor of System Identification and Model Based Control, Eindhoven University of Technology, The Netherlands;
Prof. Dr. Annika Borgenstam, Professor of Micro and Nanostructures in Alloys, KTH Royal Institute of Technology, Sweden;
Prof. Dr. Anthony Bull, Professor of Musculoskeletal Mechanics and Head of the Department of Bioengineering, Imperial College London, UK;
Prof. Dr. Jürg Dual, Professor of Mechanics and Experimental Dynamics, ETH Zürich, Switzerland;
Ir. Thijs Hazenberg, PhD-candidate, Eindhoven University of Technology, The Netherlands;
Prof. Dr. Pentti Kujala, Professor of Marine Technology, Department of Mechanical Engineering, Aalto University, Finland;

Prof. Dr. Ellen Longmire, Professor of Aerospace Engineering & Mechanics, University of Minnesota, USA;
Prof. Dr. Ir. Jan Swevers, Professor of Advanced Control and Mechatronics, Department Mechanical Engineering, KU Leuven, Belgium.

A short curriculum vitae of each committee member is included in Appendix A.

Ir. Sven Laudy of Quicken Management Consultants was appointed process consultant to the Committee.

1.3 IMPARTIALITY

All Committee members signed a statement of impartiality and confidentiality to ensure they would assess the quality of the research programmes in an impartial and independent way. Committee members reported any existing personal or working relationships between Committee members and members of the programmes under review before the interviews took place. The Committee discussed these relationships at its first meeting. The Committee concluded that there existed no unacceptable relations or dependencies that could lead to bias in the assessment.

1.4 DATA PROVIDED TO THE COMMITTEE

The Committee received the following detailed documentation:

- Self-evaluation report of the unit under review, including all the information required by the Standard Evaluation Protocol (SEP), with appendices,
- Previous assessment report 2007-2012,
- Answers to the Committee's 'questions for clarification',
- Outcome of the survey.

These documents together with the interviews and additional information (e.g. data, slides) requested during the site visit were the Committee's key bases for assessment.

1.5 Committee Procedures

The Committee followed the Standard Evaluation Protocol, 2015-2021 (SEP), except for the quantitative scoring of the departments. Contrary to the guidelines of the SEP 2015-2021, yet following the guidelines of the SEP 2021-2027, the committee was asked not to assign each department to a particular category (1, 2, 3 or 4) in each case, but to formulate a well-argued assessment of each department according to the three assessment criteria. Due to its recent establishment, the committee assessed the department of Cognitive Robotics only on the criterion 'Viability'.

Prior to the Committee meeting, on the basis of their specific expertise two committee members were appointed main assessors for each programme and were asked to lead the evaluation of that particular programme. These assessors independently formed a preliminary assessment for each programme. Final assessments are based on these, combined with documentation provided by the faculty, preliminary assessments and interviews. The Committee interviewed the Rector Magnificus of Delft University of Technology, the Faculty Management Team, departments, and teaching and administrative staff of the Graduate School. Interviews took place between October 27 and 30, 2020. As a consequence of the Covid-19 pandemic, it was decided by the faculty and the Committee Chair that the interviews would take place online. The interview schedule appears in Appendix B.

Before the interviews, the secretary of the Committee briefed the Committee on the Standard Evaluation Protocol for research assessments. It was explained that the criteria quality and relevance to society are directed towards assessing past activities, while viability is assessed in a more forward-looking manner. On the same day, the Committee discussed the preliminary assessments. For each programme interview, the Committee prepared a number of comments and questions. The Committee also agreed on procedural issues and aspects of the assessment. All committee members were actively involved in the interviews. However, due to limitations imposed by the online format, the interviews with the departments, Tenure trackers, Tenured staff, PhD students, Graduate School, and the national Research schools were done by two (or three) members of the committee. After each interview, the Committee discussed comments and

recommendations. This could only be done briefly, as the online set up of the programme gave the Committee limited time for reflection. And although the Committee prepared and reflected on each department before and after each interview collectively, the review is based largely on the input of the two main assessors, resulting in an unavoidable imbalance in the report. Above all, the report cannot be used to compare the departments. Overall, while the Committee obtained a good impression of the faculty through the Self-Assessment Report and the online site visit, the format of the online site visit is perceived as inherently more one-dimensional than an on-site visit, lacking 'hands-on' experience and informal contacts. This was especially true for the impressions regarding culture and atmosphere.

The committee was also asked to give a separate advice to the Mechanical, Maritime and Materials Engineering faculty and Executive Board of the TU Delft regarding possible recommendations for additional research opportunities within the Faculty of 3mE.

Following the online site visit, the Committee finalised the report through email. Following approval by all Committee members, the faculty received a copy of the first version with the invitation to correct factual errors. In response, the Committee discussed these comments, made several modifications to the text and then presented the final report to the Board of the University. This was printed after formal acceptance.

2. Assessment of the Mechanical, Maritime and Materials Engineering Faculty

2.1 The Faculty of Mechanical, Maritime and Materials Engineering

Research and education in Mechanical, Maritime and Materials Engineering (3mE) at Delft University of Technology (TU Delft) is carried out within seven research departments:
Biomechanical Engineering, Cognitive Robotics, Materials Science and Engineering, Maritime and Transport Technology, Precision and Microsystems Engineering, Process and Energy, and Delft Center for Systems and Control.

As mentioned in the self-assessment report, 3mE sees its mission as *"to have its staff, students and alumni making significant contributions to the development of technology for a sustainable global society, as well as prosperity and welfare.".*

The faculty's vision statement is to be internationally recognised for the impact of their engineering science, both scientifically and in the societal relevance of their research.

The Faculty 3mE has set three goals: (1) be an attractive employer, (2) be on the forefront of new scientific technologies and (3) strengthen multidisciplinary collaborative research.

Part of the faculty's strategic foundation are the core values, which have been revised in the long-term strategic plan 2016-2020. These values are:

- Excellence in everything we do;
- Open culture in which employees call each other to account for their conduct and inspire each other;
- Taking personal responsibility by staff and students;
- Delivering good engineers.

REMARKS AND RECOMMENDATIONS

3mE Strategy

During the meeting with the Rector Magnificus of TUD the Committee learned that 3mE has an important role in TUD. The Faculty 3mE fits very well into the idea of comprehensive engineering: Science, Design and Engineering. The focus of 3mE is on Engineering. 3mE is more application-inspired than on the curiosity side, but with sound academic science as its base.

The faculty strives for excellence. To further improve three goals have been set for the faculty: 1) to be an attractive employer, 2) to be in the forefront of new scientific technologies, and 3) to strengthen multidisciplinary collaborative research. These goals are highly relevant and applauded. At the same time these goals only partially contribute to the external visibility of 3mE, as they add limited discrimination from mechanical engineering at other universities.

The committee noticed that no explicit faculty-wide research strategy is defined, and that there are no top-down decisions being made regarding new research areas. Instead, there is a bottom-up approach for defining new research directions based on individual and group initiatives. These initiatives are motivated by societal needs, international research developments, and interests of staff and students. The strategy of the Faculty of 3mE is to support the bottom-up initiatives for new research areas and collaboration. This seems to work well, and the Committee applauds the bottom-up approach to creating collaboration and synergy (within the departments, faculty, and institutes), and for starting new research areas, and the role played by the departments in this. At the same time, the Committee believes that the Dean and Management Team should, apart from stimulating and coordinating the initiatives, develop a clear vision and set ambitious long-term goals for the faculty to become leader in 3-5 challenging societal and industrial application areas. This may be expected to improve international visibility of the faculty by establishing critical mass, focus and cohesion. This may also stimulate internal team building and multidisciplinary collaborative research. Furthermore, the attractiveness for talented junior researchers and research staff to join the faculty may benefit from this.

Convergence strategy
The links with various medical schools (Leiden, Rotterdam) are strong in that there is long-term and deep collaboration, and many different peer-to-peer collaborations. This includes, for example, multiple adjunct full professorial appointments of Biomechanical Engineering staff at the medical schools. However, medical device regulations, ethics, etc. make it hard to bring novel medical technologies to the clinic. The support for these collaborations could be optimised and enhanced. According to the academic staff a lack of such support means that their impact on healthcare is not maximised.

The Committee recommends that the TUD formalises links with at least one medical school through seamless access to shared medical device regulatory, clinical trials, quality management systems, and ethics expertise. The collaboration (e.g. with Erasmus Rotterdam) needs to be more structured. It involves making choices as well. Ideally, there should be a framework in place. In the collaboration with medical schools care should be taken that 3mE has the lead in engineering projects.

2.2 RESEARCH QUALITY

Table 1 shows the demonstrable research output of the Faculty of Mechanical, Maritime and Materials Engineering for the period 2013-2018.

	2013	2014	2015	2016	2017	2018
Refereed articles	396	405	450	482	585	621
Non-refereed articles	3	3	3	8	8	4
Professional publications	30	29	36	11	21	12
Publications aimed at the general public	1		1			
Book chapters	16	35	36	23	15	10
Books	3	5	2	4	2	
PhD theses	55	46	57	57	44	55
Conference papers	320	274	302	267	276	268
Other research output	55	64	55	54	73	41
Total	**879**	**861**	**942**	**906**	**1024**	**1011**

Table 1: Total output Faculty 3mE

REMARKS AND RECOMMENDATIONS

The research quantity and quality are very strong and internationally recognized, e.g. through high number of ERC and NWO grants (15/16) and high rankings: 1st in Europe on Mechanical, Aeronautical and Manufacturing (QS) and Top 5 on Mechanical Engineering (ARWU). There is also a good balance between research grants and contract research.

The Committee sees multiple efforts to come up with criteria for research excellence. Quantitative indicators like the h-index are not regarded as the single or most important measure of quality by TUD. One is looking for other (qualitative) indicators for excellence. However, as of now there seems to be no agreement on indicators on how to measure and identify excellence. Furthermore, there seems to be a gap between how the TUD sees the measurement of research excellence and how the departments perceive this. The Committee acknowledges that it is difficult to find measures that are equally valid

for design, science, and engineering. As a result, such indicators may vary between the departments.

The Committee concludes that there is an ongoing process on what should be used as a measure for excellence, including qualitative measures and holistic ways of measuring. This process is seen as very positive, but until this process is completed a vacuum remains. Researchers need to be provided with guidance now. The committee therefore recommends to strive for more clarity and to provide specific guidelines.

2.3 Relevance to Society

Remarks and recommendations

3mE's research topics are related to many of the societal and economical challenges that are important to society, e.g., advanced manufacturing, sustainability, aging society, energy transition, prosperity, welfare, etc. The societal relevance of the Faculty of 3mE is also reflected by the additional resources provided by the new Sectorplan. Another indicator for societal relevance is the high influx of students at all levels.

The Committee applauds the TUD philosophy "We expect staff to develop themselves to independent researchers who can have an impact on society", which shows confidence in the staff.

The Committee considered it to be positive that the faculty worked on the development of emergency ventilators in Spring 2020. On the other hand, without integration in longer-term research and educational goals, this will remain an isolated activity.

The Committee learned that 3mE does not have an industrial or advisory board for its research. 3mE could consider assembling and convening such a group in order to gather feedback and ideas.

2.4 VIABILITY

The composition of the research staff at faculty level is found in Table 2.

	2013		2014		2015		2016		2017		2018	
	#	FTE	#	FTE	#	FTE	#	FTE	#	FTE	#	FTE
Scientific staff	120	107.0	128	104.8	126	110.5	129	111.8	139	121.1	150	130.1
Post-docs	88	50.8	98	64.5	116	71.4	130	71.4	134	81.2	146	94.6
PhD-students	391		411		392		405		398		419	
Total research staff	**599**	157.8	**637**	169.4	**634**	181.8	**664**	183.2	**671**	202.3	**715**	224.7

Table 2: Staff embedded in the Faculty 3mE

TOTAL	2013		2014		2015		2016		2017		2018	
	k€	%	k€	%	k€	%	k€	%	k€	%	k€	%
Direct funding[1]	29429	59%	30656	48%	32255	46%	34045	48%	35985	53%	39092	53%
Research funding[2]	5583	11%	9989	16%	11628	17%	11322	16%	12151	18%	14018	19%
Contract research[3]	9882	20%	19730	31%	21936	31%	20972	30%	16528	24%	16201	22%
Other[4]	4848	10%	4026	6%	4115	6%	4515	6%	2924	4%	4461	6%
Total funding	**k€ 49742**		**k€ 64400**		**k€ 69934**		**k€ 70853**		**k€ 67588**		**k€ 73771**	

Table 3: Total funding at level of the Faculty 3mE. All amounts in k€.

1. Direct funding by the University, obtained directly from the University, and financial compensation for educational efforts.
2. Research funding obtained in national and international scientific competition (e.g. grants from NWO, KNAW, EU/ERC, ESF).
3. Research contracts for specific research projects obtained from external organisations, such as industry, government ministries, the European Commission, and charity organisations.
4. Funds that do not fit the other categories.

Total funding rose over the years from €49.74 million in 2013 to €73.77 million in 2018 (Table 3). The percentage of direct funding decreased from 59% in 2013 to 53% in 2018. The percentage of funding from research grants increased from 11% in 2013 to 19% in 2018, and the percentage of contract funding decreased from 10% in 2013 to 6% in 2018.

REMARKS AND RECOMMENDATIONS

Hiring and Development of Staff

There is growth in number of students, but the extra funding of the faculty is time-delayed. This may result in temporary understaffing (and increased teaching load, see below) in parts of the faculty. The Committee learned that it is difficult to hire senior staff. The strategy to mitigate the workload appears to be the hiring of assistant professors. This complicates the organisation, since some tasks and duties are less appropriate for assistant professors because of their early careers.

The Committee considers the emphasis that 3mE puts on the development of the individual as very positive.

The Committee received comments that the centralised HR is causing delays in recruitment and recommends investigating this issue in more detail.

Guidance and Promotion of Tenure Trackers

The committee regards feedback to the Tenure Trackers on their performance during their employment as very valuable. Nevertheless, the requirements for getting tenure are *not at all* clear. The Committee noticed that not all Tenure Trackers perceive this as a problem, but that some Tenure Trackers, in some of the departments, are unhappy about this. The Committee believes that this lack of clarity is a significant source of stress and can hinder faculty success. The Committee therefore strongly advises to provide detailed written information on tenure (and promotion) requirements and set up a coaching approach that is similar for all departments. This relates directly to the previously mentioned lack of clarity about measures of research excellence.

The Committee noticed there is a highly variable experience of starting the Tenure Track career at the faculty, often depending on the department. This is mostly noted for the start-up package (non-existent in some cases, more generous in others); the mentorship; the interview process; and the independence. In particular, it is recommended to clarify and substantiate the start-up expectations, and to provide everybody with at least a minimum start-up package.

Furthermore, there seems to be great variability in the level of independence at the start. Some Tenure Trackers are the supervisors of *their own* PhD students. Others are daily supervisors for PhD students of senior staff, etc. In many cases, such lack of independence afforded to the Tenure Trackers can inhibit their growth and development. Similarly, this variability is the case for Master's student supervision. The Committee recommends going towards a PI-cooperative model (with strong support for collaboration) and permitting Tenure Track staff to act as main responsible PhD and MSc supervisors.

Although early tenure sometimes seems to be discussed during midterm review meetings the Committee feels this option is not broadly known, and advises a clear formulation. This requires clearly described and transparently communicated criteria as stated before.

The impression given by the group of TT that was interviewed was different (much more positive) than the results of the survey of TT staff. Might this have been due to (explicit or implicit) selection of TT staff for this interview? Was there an open call to meet with the Committee, or were these individuals targeted? The Committee recommends to have an open call for attendees at such Committee interviews in future reviews.

Promotion of tenured staff
The procedure for promotion to full professor was not clear to the Committee, and the same seems to hold for some Associate Professors. Also, criteria are not clearly formulated and leave a lot of room for own interpretation by the management. No specific qualitative nor quantitative aspects are defined that people need to meet. Only recently, TUD management decided to provide a clearly defined path towards full professor appointment. It is not yet completely implemented throughout the whole TUD organisation. The Committee recommends that the criteria, in written form, be made openly available to all faculty staff.

Management/ Leadership
It struck the Committee that during the interviews with the MT a number of questions were immediately directed to TUD level, and others to the department level. Also, the MT seemed bureaucratic-oriented, rather than a team defining the

faculty's strategy as a whole. Much is left to the departments (see also the Strategy section). The Committee sees real strengths in this approach, but nevertheless thinks that for solving the Grand challenges, faculty leadership and an overarching strategy can be helpful. The management team could work together with faculty leaders to consider and develop such a strategy.

Organisation of research
As mentioned in the Self-Assessment Report, and confirmed during the site visit, the Committee learned that some departments have shifted to a cooperative-PI model, while other departments are still more hierarchically organised. The transition to a cooperative PI-model is in line with several national and international developments, and seems a logical step; also given the fact that for example within EU-funding the focus is on teams and cooperation. For the cohesion of the faculty, it seems desirable to converge to a common organisational structure of the departments; taking into account current best practises of the departments. The Dean and Management Team should have a role in this overall process.

The Committee noticed that collaboration is seeded well through initiatives such as the cohesion projects, especially for junior faculty. This is seen as very positive.

Collaboration
The Committee learned that 3mE is involved in 13 out of 16 TUD institutes. Collaborations across areas are important and useful for long-term sustainability as well as efficiency. On the other hand, the challenge is not to be involved in everything, but to focus. Cohesion projects seem also to be a very good initiative to increase multidisciplinary research. Expansion by two FTE valorisation experts is a good initiative to improve the research funding applications.

Teaching and work load
The monitors/ questionnaires among staff show that stress (together with diversity) is on the top of the list of issues to address. During the interview the Rector mentioned that it is not so much the work load, but more the work pressure (as a result of not being in the driver's seat, and because of unclear expectations). For the staff this is related to lack of clear criteria for getting tenure and promotion. For the PhD students it is related to uncertainty about

mutual expectations and often implicitly expressed expectations about, e.g. number of journal publications.

Another source for stress is the teaching load. The faculty has no control over the global teaching load. This is dependent on intake of students, for which there is no restriction (by Dutch law). Furthermore, the departments that attract more students also see an increase in teaching work load, specifically for the master's project supervision. The teaching work load needs to be monitored closely. From the interviews the Committee got the impression that the teaching work load varies widely over the different departments. However, it was difficult for the Committee to get a real grip on this, since the relevant data for analysis could not be made available to the Committee by the Faculty during the assessment.

The faculty wishes to alleviate the teaching overload by the recruitment of teaching-only staff. Although this approach does address the teaching overload, it won't address the first key recommendation of the Committee, which is to stimulate the development of the academic staff members in order to increase breadth and depth of research. Furthermore, what will happen with this teaching-only staff if student numbers decrease? The Committee recommends to exercise caution in recruiting teaching-only staff.

Furthermore, the Committee recommends setting up a faculty-wide monitoring system for teaching load, as the numbers are currently unclear. In particular the comparison between teaching loads of different departments seems completely unclear. Overall, the Committee strongly advices the university/ faculty/ departments to address teaching overload, and to balance load between departments and individuals. Overall load could be addressed by reducing student numbers (this seems impossible in the current climate) or increasing staff. Distribution in load could also be used to address this point and the Committee also recommends to consider adding flexibility in distributing teaching duties over the departments, so as to make optimal use of the available human resources.

Funding

The faculty has a good and solid financial condition. The balance between various sources of funding is structurally good for an engineering research faculty.

Recently the engineering landscape is quickly evolving and 3mE seems to be responding well to this. The Committee considers it positive that the target of a 1:1 ratio between research and contracts grants is almost reached, although there is quite some variation between the different departments (but this may not be a problem).

Committee has heard about the increasing pressure on co-financing as a point of concern. On the other hand, during the interviews it was generally emphasised that so far, the requirement of co-financing could always be met, and did not prohibit any projects.

Facilities
There is significant investment in facilities. The facilities of the faculty are state-of-the-art and adequate for the research done. Increasing global competition for talented academic researchers means that attention will need to be given to the way the faculty discriminates itself from similar faculties in the world. Selection of specific societally relevant application domains and a strong vision on contributions to be made to these domains may help the faculty to improve its visibility and recognition in the fierce global competition.

The Committee learned that in the Netherlands now there is a committee in place (on the national level) that advices the Executive Board on heavy investment in large-scale infrastructure (LSI). The Committee recommends that attention be paid by 3mE leadership on maintaining support of existing facilities, including those not reaching the category of LSI.

2.5 PhD programmes, the Faculty Graduate School and Research Schools

It is the ambition of the University Graduate School (UGS) to train and deliver highly skilled doctoral graduates. Consistent with the agreements of the Bologna Process regarding the doctoral training as a third cycle of tertiary education, the UGS has developed its educational programmes into a distinct part of the academic training leading to a doctoral degree. PhD students have to be registered at the University Graduate School, their progress is recorded on a

central level, and the University takes the responsibility for thesis defence and diplomas. The Faculty Graduate School organises the intakes with the new PhD students and supports them in case of problems with their department and supervisors.

The Faculty 3mE coordinates two interuniversity research schools, i.e. the Dutch Institute of Systems and Control (DISC) and the J.M. Burgerscentrum.

The success rates of the PhD candidates at faculty Level are found in Table 4.

Enrolment				Success rates						
Starting year	**Male**	**Female**	**Total (female + male)**	**4 years**	**5 years**	**6 years**	**7 years**	**Total**	**Not yet finished**	**Dis-continued**
2009	83%	17%	48	17%	44%	63%	69%	75%	4%	21%
2010	78%	22%	73	11%	51%	62%	64%	71%	5%	23%
2011	84%	16%	44	5%	59%	73%	80%	80%	7%	14%
2012	78%	22%	60	3%	43%	63%	73%	75%	13%	12%
2013	71%	29%	59	10%	39%	66%	76%	76%	15%	8%
2014	74%	26%	70	6%	44%	64%	64%	64%	23%	13%
2015	70%	30%	43	9%	40%	49%	49%	49%	40%	12%
2016	76%	24%	63	5%	8%	8%	8%	8%	90%	2%
2017	78%	22%	58	2%	2%	2%	2%	2%	93%	5%
2018	81%	19%	75						95%	5%
Total	**77%**	**23%**	**593**	**6%**				**48%**	**41%**	**11%**

Table 4: Success rates of the PhD candidates at faculty Level

PhD programmes and the Faculty Graduate School

REMARKS AND RECOMMENDATIONS

Regarding PhD quality, the output is typically 3 to 4 journal and several conference papers, which is very good. Those that pursue an academic career can be found at the best universities worldwide. Topic-wise the PhD research is excellent. It is considered very positive to have a go/no-go meeting after the first

year. The Committee learned that 3mE has a PhD-council in place that seems to be very active, especially during the Covid19-crisis.

While progress has been made, PhD-students still take far too long to complete. This problem is currently being addressed, it seems, by mainly imposing significant pressure on the PhD students. Yet it seems this is not having the desired effect. Furthermore, putting extra pressure on PhD students may have a detrimental effect on their well-being, and ultimately their completion rates as well. The faculty MUST look at ways to address this problem by clarifying and adapting the expectations of both staff and students. In some departments there seems to be a huge focus on publishing, with sometimes a few qualitative targets. Clarifying and adapting the expectation on the number of papers/conference presentations, etc. would also assist with this. At least one department (MSE) has implemented a PhD schedule timeline with regular planning and checks that appears to be an excellent model. This model appears to be good first step towards clarifying expectations and monitoring progress. Some universities, as a more severe measure, do not permit PhD submissions beyond four years, resulting in completion rates coming down to approximately 3.5 years. Perhaps this would be too draconian, but even a five-year absolute deadline would change things.

Most PhD students started a PhD because of curiosity in fundamentals. Overall, the PhD students seem to be happy with their work, with lots of variety. TUD provides ample opportunity for PhD's to develop an academic network, although at the moment limited due to Covid-19 restrictions.

The students evaluate their supervision as good. Overall, choices are left to the students, while strong directives are given when necessary (e.g., when students get stuck on a specific problem the supervisor could suggest to leave it at what it is). Teaching load seems to be mostly up to the PhD student. On average, less than 10% of time is spent on teaching, which is considered completely acceptable by the committee.

The Committee thinks the PhD student should be protected (as much as possible) from the bureaucratic challenges that external relations can bring. However, this is not easily avoided since each of these parties' interests are understandable and

reasonable. Creation of an open atmosphere where any of such conflicts of interest, if they arise, can be discussed is crucial. Also, the Dean and Management Team should have a role in this; not leaving this exclusively to each department. In fact, in case of conflict between PhD student and supervisor/promotor (or external relations) it is highly advisable to let somebody from outside the department help mediate. Departments should also be open to best practices from other departments, especially when PhD's do not feel sufficiently supported to finalize their PhD thesis on time, or are hindered by a non-inclusive culture in the department.

DISC

The research school DISC is an interuniversity research institute and graduate school that unites all academic groups in the Netherlands that are active in systems and control theory and control engineering. It offers a nationally organised extensive graduate course programme for PhD students in this field. The Faculty of Mechanical, Maritime and Materials Engineering (3mE) of TU Delft is the administrative responsible faculty of DISC.

REMARKS AND RECOMMENDATIONS

The self-assessment report states that the quality of the courses is high and that the course programme is internationally recognized as high level and relevant for control students worldwide. This was recognised in all accreditations, up to 2016 when the KNAW accreditation system stopped. Elements that indicate this high quality currently are:

- Very positive feedback from PhD students that experience these courses as a very good and necessary time investment. The ratio of gain (knowledge in the field) and time investment is high;
- All groups of all Dutch universities active in systems and control are associated with DISC;
- All courses, summer schools and winter schools are successful (high numbers of participants). Also, a significant number of PhD students from non-Dutch universities follow DISC courses/summer schools. Estimated

ratio is about 1/3 attendees are from non-Dutch universities with many of the "Dutch" participants actually being non-Dutch PhD, Postdoc or Tenure Track people working in one of the groups affiliated with DISC;
- The PhDs consider it as an important achievement if they get a DISC certificate at the end of their PhD (21 ECTS);
- The fact that DISC is a nation-wide organisation contributes to the quality: the best teachers and top experts are selected to teach the courses, and a broad range of courses can be offered;
- The program committee follows the evolution in course/research topics and the program is adapted accordingly, e.g. a summer school on learning.

The committee recommends the following for the DISC PhD programme:

- The Committee suggests to explore the option of further internationalization of the course program, by offering courses online, using a mix of lectures in a classroom that are streamed and recorded, with online interactions and homework feedback;
- The quality of PhD research in the broad field of systems and control hinges on a high-quality graduate school on this topic. Therefore, the Committee recommends to continue with offering this high-quality systems and control courses. The Committee is convinced that the nation-wide approach taken by DISC is the correct approach to ensure that the offering of a sufficient number of courses of high quality and wide range of topics can be guaranteed. This is something local graduate schools cannot accomplish;
- The Committee also recommends that the current mode of operation of DISC is maintained: embedding in the Faculty of 3mE, which guarantees the administrative support and financial support from all participating departments of all universities in proportion with the number of their participating PhD students;
- The subsidy from TUD benefits the University *directly* as there are many researchers who participate and it attracts better students to the various PhD programmes, as well as *indirectly*, through leadership and profile.

J.M. BURGERSCENTRUM

The research school J.M. Burgerscentrum (JMBC) is an interuniversity research school that unites most of the academic groups in The Netherlands that are active in fluid mechanics in one way or another. The research school offers a variety of courses for PhD students and postdocs in this field. The Faculty of Mechanical, Maritime and Materials Engineering is the administrative responsible faculty of the J.M. Burgerscentrum.

REMARKS AND RECOMMENDATIONS

Structure
JMBC has a successful structure, supported by core funding from TUD, the administrative home of the Centre. The Centre is a lean organisation with 1 ½ days' commitment from senior academic leadership and an administrator. They maintain:

- an excellent programme of short courses and summer schools open to all members of the Centre;
- formalised membership, certificates of attendance at the courses, and the "JMBC certificate";
- The business model for the Centre is that academic research groups across the country (mainly three large groups who are represented on the management team) pay an annual 'membership fee' per FTE researcher who wishes to participate in any of the courses offered. Many academic staff members contribute to the teaching of courses pro bono. Some international/external members are invited to speak and funding is available for this. This membership funding brings in approximately 110k Euro/ annum and the TUD support is approximately 75k/ annum.
- The subject matter of the courses and membership is very broad, covering all areas of fluid mechanics/dynamics.

Achievements
The PhD students benefit greatly through interacting with other groups and through the courses. It is so successful that students from other countries

frequently participate. The academic staff also benefit as their students obtain great training without duplication of effort. There is a strong collegiate approach. An example of this is that on answering the question "what is in it for you?", then the academic leadership simply answered that it was 'a duty' to support this excellent Centre. The Centre has maintained coherence and activity throughout the COVID-19 period.

Potential Future Initiatives
The Centre has a great opportunity for increasing international recognition and visibility through other leadership activities, if they choose to do so. These could include organising international conferences, book writing, leading international research consortia, etc.

For TUD Leadership
Many other countries could learn from the achievements of the JBMC. The subsidy from TUD benefits the University *directly* as there are many researchers who participate and it attracts better students to the various PhD programmes, as well as *indirectly*, through leadership and profile.

2.6 Research Integrity

The core values of TU Delft are diversity, integrity, respect, engagement, courage and trust. To ensure that the TU Delft community acts on the basis of these values, a vision on integrity has been developed based on a broad community consultation. This resulted in an integrity policy around three pillars: academic integrity, social integrity and organisational integrity.

Remarks and recommendations

The research integrity policy is well formulated. The policy on research integrity fully aligns with both national and European guidelines and preferences. All integrity aspects -Academic integrity, Social integrity, organisational integrity- are well covered. Monitoring and control mechanisms are established.
It was mentioned in the report that many researchers maintain public repositories for code (such as GitHub). The Committee got the impression that

these were initiatives of the researchers themselves, not a structural thing. The Committee would suggest that this should be organised in a more systematic way, not only because of research integrity reasons but also to improve dissemination of research results and it is a good tool to manage continuity of research within a team: transfer of knowledge from one PhD to another and knowledge build-up goes much smoother in that way.

2.7 Diversity and Culture

Diversity is one of the core values of TUD and, together with inclusion, one of the main topics for the Faculty of 3mE for the coming period. Diversity covers, amongst others, ethnicity, age, nationality and gender. To further encourage diversity, the main focus for coming years is more specifically on gender, in particular in the hiring and career development process as well as engendering a cultural shift for diversity. On the short term, the faculty is striving to increase the number of scientific female staff, within the constraints of the labour market that still has a minority of women with a background in (mechanical) engineering.

Remarks and recommendations

From the interview with the Rector the Committee learned that a lot of discussion on diversity takes place, trying to create an open culture. But TUD is also aware that there is unconscious bias in everybody.

The Committee noticed that a Diversity officer is only in place at TUD-level. It is unclear how this Diversity officer interacts with 3mE, and 3mE has no "climate or diversity committee", nor a culture or climate champion. The Management Team has currently only one female member. Efforts toward increasing ethnic/racial/gender diversity at all levels are unclear as described. Much focus is on the numbers, not on creating an inclusive culture or atmosphere. N.B.: such a climate committee should not rely exclusively on female or minority faculty for its leadership and membership.

The Committee strongly feels a more inclusive environment is needed. A focus on more women alone is not enough. A cultural approach is necessary.

The personal responsibility and open culture are frequently highlighted as a way to success. One member of the Management Team stated that "culture changes by itself". The Committee disagrees and thinks a much more proactive approach is needed. Otherwise, the pace of change will be much too slow, and certainly slower than in competitor Universities.

The Committee recommends that the faculty and leadership:

- be trained in how to mitigate implicit bias in hiring, evaluations, and promotion procedures as well as in everyday operations;
- makes a longlist at department level of high potential female candidates for future vacancies. Maintain this longlist actively and communicate this list of potential candidates with all (senior and junior) staff. Seek input and comments from both female and male staff members;
- put an inclusive culture on the agenda of the faculty as well as the departments to raise awareness for inclusiveness;
- set up a system of promoting and monitoring an inclusive environment within each department, ideally through a diverse committee of stakeholders; this could include monitoring of diversity, receiving active bystander training, inviting a diverse set of visitors/speakers, etc;
- make diversity and an inclusive culture part of the recruiting plans.

2.8 Faculty's Extra Question

"In recent years, the Faculty of 3mE has invested in the growth of their research capacity, resulting in the formation of the department Cognitive Robotics in 2017. At the same time, major topics, including energy transition and artificial intelligence, have played a major role in the research projects within the research programmes. Finally, six existing focal points were further strengthened with additional resources from the national "sector plan". From the perspective of the current research portfolio and

CHOICES THAT HAVE BEEN MADE REGARDING THE GROWTH AREAS, DO YOU SEE WORLDWIDE SCIENTIFIC DEVELOPMENTS OR RESEARCH AREAS THAT SHOULD BE ADDRESSED WITHIN ONE OF THE RESEARCH UNITS OF THE FACULTY OF 3ME WHEN ADDITIONAL GROWTH OPPORTUNITIES ARISE?"

3mE is a very large faculty covering a diverse set of areas. This is in the nature of Mechanical Engineering, which is a very broad discipline. The faculty appears to cover a wide range of relevant areas and is on top of expanding into recent areas of importance, e.g., AI for specific areas. Also, the foundation of a robotics department makes a lot of sense. It is important that cross-links are nurtured among the departments. The Committee recommends sharing best-practices among the departments.

The 3mE strategy is mainly department oriented, and the visibility is also shown there. The question that the Committee would like to ask to the faculty is: does there need to be a more orchestrated strategy at the faculty level, i.e. does 3mE get the most out of the bottom-up approach? The committee thinks there is a strong strategy for developing new collaborations and research areas with a bottom-up approach; at the (inter)departmental level but also for example postdocs seeding within the faculty and institute seeding between faculties. This provides cohesion.

The department-oriented approach means that possible new areas are also to be seeded within and between individual departments. Areas of growth worth consideration include the biological aspects within the BMechE, and artificial intelligence within Cognitive Robotics. On the other hand, critical mass is needed for all research areas covered. Thus, 3mE should find the right balance between expanding in promising new research areas, and maintaining critical mass in all of them. The current, successful, bottom-up approach for research strategy could have the tendency to diversify into too many areas. Therefore, the departments need to come up with clear research plans, and synergies between the departments could be a way to increase critical mass and external visibility. The Committee would like to encourage the 3mE faculty also to look into ways of stimulating such converging initiatives.

Summary of Recommendations

Overall, the committee believes the research and research organisation of the Faculty of 3mE is very good. The following recommendations echo some points made in the preceding discussion of 3mE.

- The bottom-up approach for defining new research areas and initiating collaboration is seen as very positive. Care should be taken to maintain critical mass and focus in all areas covered;
- The dean and management team should aim for adding cohesion and visibility to the bottom-up initiatives;
- The Committee recommends sharing best-practices between the departments to make sure the departments become (even) more connected;
- The Committee recommends to set up a holistic system to measure research excellence, and to communicate this clearly;
- The Committee suggests to install an advisory board for research;
- Criteria for getting Tenure and for promotion need to be formulated and communicated much more clearly. Although the search for more qualitative criteria and less emphasis on quantitative criteria is laudable, this has raised a level of insecurity amongst some of the Tenure Trackers;
- The university/ faculty/ department MUST address the teaching overload;
- A pro-active plan for improving diversity, open culture, and equity across all levels is recommended. The faculty should have a role in setting up guidelines for diversity at faculty level;
- The committee recommends considering the possibility of getting early tenure based on exceptional performance.

3. Assessments of Individual Research Departments

The Committee assessed the seven research departments of the Faculty of Mechanical, Maritime and Materials Engineering of Delft University of Technology:

The department of Biomechanical Engineering (BMechE)
The department of Cognitive Robotics (CoR)
Delft Center for Systems and Control (DCSC)
The department of Materials Science and Engineering (MSE)
The department of Maritime and Transport Technology (MTT)
The department of Precision and Microsystems Engineering (PME)
The department of Process and Energy (P&E)

The detailed assessment of each department follows[1].

[1] The assessments of the departments are in the order in which they appear in the self-evaluation report

3.1 Research Department of Biomechanical Engineering (BMechE)

Head of Department	Prof. dr. Dirk Jan Veeger
Research staff 2018	33.9 Research FTE (excluding PhD)

As mentioned in the self-assessment report, the research and education portfolio of the Department Biomechanical Engineering (BMechE) is positioned at the nexus of Mechanical Engineering, Biology and Medicine, with the general aim of impacting health. By developing and applying novel modelling and design approaches to biological systems, BMechE aims to advance the understanding of the interaction between humans and technical systems, to design and build such systems, and, through this, to improve the quality and safety of life.

Within BMechE, the research activities are stated as being organised around three research themes and corresponding sections:

- Biomechatronics & Human Machine Control, focuses on the design of assistive devices (prosthetics, orthotics, neurostimulation) to enhance neuromuscular control in patients with neurological disorders and muscle deficiencies.
- Medical Instruments & Bio-Inspired Technology conducts fundamental research into the mechanical interactions between technical and biological systems with the aim of developing instrumentation that allows for local diagnosis and treatment with minimal damage to the healthy surrounding tissue, and thereby significantly improving the quality and efficiency of medical interventions.
- Biomaterials & Tissue Biomechanics aims to improve the treatment of skeletal diseases through the development of advanced functional biomaterials and implants that replace and/or enable regeneration of damaged tissues.

However, on interview, it is clear that these themes are more cross cutting than distinct, and the department has a much more horizontal structure without a sectional approach.

The research staff is composed of 18.2 FTE scientific staff, 15.8 FTE post-docs and 54 PhD-candidates (2018).

Table 5 shows the demonstrable research output of the department of BMechE.

	2013	**2014**	**2015**	**2016**	**2017**	**2018**
Refereed articles	117	127	132	140	146	162
Non-refereed articles	1	1	1	1	3	
Professional publications	3	2	6	3	5	2
Book chapters	1	2	11	3	2	3
Books					1	
PhD theses	10	10	9	5	5	11
Conference papers	40	28	46	53	26	32
Other research output	17	8	23	17	17	16
Total	**189**	**178**	**228**	**222**	**205**	**226**

Table 5: Total output of the Department of BMechE

The composition of the research staff at level of BMechE is found in Table 6.

	2013		**2014**		**2015**		**2016**		**2017**		**2018**	
	#	FTE	#	FTE	#	FTE	#	FTE	#	FTE	#	FTE
Scientific staff	21	18.2	22	19.2	23	19.8	24	20.5	21	17.2	20	18.2
Post-docs	26	15.9	34	22.6	38	26.0	39	21.0	25	10.9	27	15.8
PhD-students	75		83		72		73		55		54	
Total research staff	122	34.2	139	41.7	133	45.8	136	41.5	101	28.1	101	33.9

Table 6: Staff embedded in the Department of BMechE

The total funding of BMechE is found in Table 7.

TOTAL	2013		2014		2015		2016		2017		2018	
	k€	%	k€	%	k€	%	k€	%	k€	%	k€	%
Direct funding[1]	2364	37%	2704	28%	3164	21%	3931	30%	3888	37%	3901	42%
Research funding[2]	2001	32%	3191	33%	4440	30%	3664	28%	3111	30%	3049	33%
Contract research[3]	1703	27%	3804	39%	6580	44%	5440	41%	2928	28%	1747	19%
Other[4]	278	4%	-24	0%	712	5%	242	2%	499	5%	637	7%
Total funding	k€ 6346		k€ 6993		k€ 10901		k€ 10309		k€ 8233		k€ 7389	

Table 7: Total funding at level of the Department of BMechE. All amounts in k€.

1. Direct funding by the University, obtained directly from the University, and financial compensation for educational efforts.
2. Research funding obtained in national and international scientific competition (e.g. grants from NWO, KNAW, EU/ERC, ESF).
3. Research contracts for specific research projects obtained from external organisations, such as industry, government ministries, the European Commission, and charity organisations.
4. Funds that do not fit the other categories.

RESEARCH QUALITY

All three themes have published well as quantified by standard normalised metrics.

As mentioned above, the sections are a way of presenting the research thematically, yet the management of the department is flat. This means that individual staff are free to work in different areas and collaborate with one another: collaboration is strongly encouraged and evident across the department.

RELEVANCE TO SOCIETY

There is no doubt that the department not only has a focus on societal relevance, but is achieving it very successfully.

One of the strengths of this department is its focus on health and medical aspects. There is a focus on medical technology (in both education and research). Key to this strength is the collaboration with medical schools. In fact, a number of research staff have honorary appointments at these medical schools and seem to seamlessly work together with them. However, there remains a barrier to further, deeper, and more widespread societal impact due to difficulties with working across different institutions, particularly with respect to translational aspects: ethics, clinical trials, regulatory aspects, and quality management requirements. It would be very helpful for there to be a stronger convergence between the medical school(s) and the department. This is best delivered at the whole university level.

VIABILITY

Organisation of Research

The research area is well defined and focused. The Committee notes that the department has been restructured over the past number of years that has resulted in greater critical mass that has allowed the research to be presented as the three main research themes. The department's focus on improving quality of life at the nexus of biology/medicine and mechanical engineering is clear and is being achieved.

Research grants and contract research expenditure has dropped over the past few years, however grant income increased in the most recent year documented. One reason for the historical drop could be due to one group leaving the department to help form CoR.

Demographic

The Biomechanical Engineering department has approximately 20 academic ('research') staff, with split demographic of a number of senior professors who will be retiring in the upcoming five years and many more junior academics. This demographic is being well managed with a couple of mid-career appointments, and successful promotions of the more junior staff. Although the department expressed that there was some concern about this in the medium term, the

Committee were convinced that the management of this transition is good and doesn't cause major concerns.

Diversity in academic staff is very highly shifted towards middle aged males. It is good to see that there are plans to address this with already appointed incoming hires.

Research Culture
The department's culture is potentially unique in 3mE. First, there is a very flat structure that is modelled much more on the "cooperative PI model" rather than the "Group model". This means that investigators are free to collaborate widely and form groups flexibly. This is a major strength of the department and is one potential cause for the junior staff doing so well. There is no formal group structure, although the written report presents three 'nominal' groups; these are flexible and non-hierarchical. They are a way of presenting the department's research to the outside world and could easily be changed dependent on the research directions, success of funding applications, and growth of faculty members.

Second, the department is truly multi-disciplinary and collaborate widely within the department, across the faculty, across the university, and externally, particularly with medical schools such as Leiden and Erasmus. This culture is highly reflective of other bio(mechanical) engineering departments across the world. One point where this department differs from other such comparator departments is the lack of critical mass in both breadth and depth (the number of faculty staff is very low), and the small amount of 'truly' biological work as a proportion of its overall activity.

Third, the department feels that they are seen as an 'outlier' and perhaps 'not one of the 3mE family'. This is not surprising given the subject matter of the work, yet it is also recognised that this department is able to teach some of the core ME subjects and so is key to the good functioning of the BSc programmes. The Committee does not believe that this is a significant concern.

Teaching
The teaching in the department is onerous. There is an extremely high teaching load. For example, there are approximately 600 master's students that are being

supervised in the department. This equates to a large number of master's projects to be supervised by each academic at any one time. This is unsustainable and there is a very high risk that excellent staff will leave due to workload. The faculty/ university must look carefully at the business model of the department that has resulted in such a high teaching load without significant growth of space and staff.

Finally, the Committee notes that the strong inclusive culture in the department is welcoming to a diverse group of staff. The department is actively increasing diversity and creating an environment that is accommodating of such a diverse group of staff and students.

RECOMMENDATIONS

The Committee recommends that the university/ faculty/ department considers an increase in academic staff in both breadth and depth. In terms of breadth, we recommend moving more towards the biological end of the spectrum of research; and in terms of depth, we are pleased to see that the department is recruiting in musculoskeletal modelling to account for imminent retirements and to maintain strength in a core area of international reputation of the department. The appointment of staff members in cardiovascular biomechanics is also welcomed as this is an important area of societal need and fits extremely well in the department. The university/ faculty/ department MUST address the teaching overload (see also comment in the faculty section).

3.2 Research Department of Cognitive Robotics (CoR)

Head of Department	Prof. dr. ir. Hans Hellendoorn
Research staff 2018	13.9 Research FTE (excluding PhD)

As mentioned in the self-assessment report the Department Cognitive Robotics (CoR) was established in July 2017 with the mission to benefit society by the responsible development of robotic technologies for human-inhabited environments. Cognitive robots are mechatronic systems that can perceive complex environments and physically act upon them, move around safely and effectively, learn independently or through interaction with humans or other robots, and can explain their actions.

The research activities within CoR are organised around four research themes and the corresponding sections:

- Intelligent Vehicles performs problem-driven research to increase the safety, comfort, and efficiency of transportation. The section addresses the interdisciplinary spectrum of machine perception, dynamics and control, and human factors.
- Learning and Autonomous Control focuses on robot control methods spanning the whole range from high-level cognitive approaches to low-level motion control, such as adaptation, learning, motion planning and multi-robot control.
- Robot Dynamics & Control studies the software architecture for the dynamic control of robotic systems in complex environments in the presence of noise, disturbances and potential component failures.
- Human-Robot Interaction aims to ensure that humans and robots can understand each other's behaviour in order to move and act together in the same space.

The research staff is composed of 10.7 FTE scientific staff, 3.3 FTE post-docs and 32 PhD-candidates (2018).

Table 8 shows the demonstrable research output of the Department of CoR.

	2017	**2018**
Refereed articles	41	47
Professional publications	1	1
Book chapters	1	
PhD theses		5
Conference papers	42	27
Other research output	5	3
Total	**90**	**83**

Table 8: Total output of the Department of CoR

The composition of the research staff of CoR is found in Table 9.

	2017		**2018**	
	#	FTE	#	FTE
Scientific staff	10	9.0	14	10.7
Post-docs	3	1.5	4	3.3
PhD-students	29	---	32	---
Total research staff	42	10.5	50	13.9

Table 9: Staff embedded in the Department of CoR

The total funding of CoR is found in Table 10.

TOTAL	2017		2018	
	k€	%	k€	%
Direct funding[1]	1.098	45%	1.813	40%
Research funding[2]	547	22%	1.324	30%
Contract research[3]	529	22%	848	19%
Other[4]	263	11%	498	11%
Total funding	k€ 2437		k€ 4483	

Table 10: Total funding at level of the Department of CoR. All amounts in k€.

1. Direct funding by the University, obtained directly from the University, and financial compensation for educational efforts.
2. Research funding obtained in national and international scientific competition (e.g. grants from NWO, KNAW, EU/ERC, ESF).
3. Research contracts for specific research projects obtained from external organisations, such as industry, government ministries, the European Commission, and charity organisations.
4. Funds that do not fit the other categories.

The department of CoR started in 2017 and is therefore only assessed on viability.

VIABILITY

The department has grown significantly since its start in 2017. The department is feeling the fast expansion of the department with many new hires of relatively young people with limited experience as its major challenge. Despite of this young staff, since 2018, which is the last year covered in the self-assessment, many new projects have been acquired with a total value of 10.6 MEur for the department. Their financial situation is healthy.

The department will enter its new lab facilities (~1000 m^2) in the coming period. These labs will have sufficient space for all lab equipment and setups of the department. It will be the lively place for researchers to work and meet.

The way the department is organised should enable good monitoring and control of research quality. The management and section leaders do have proven track records, which is the basis for achieving high quality standards. The governance

of the department with Prof. Hans Hellendoorn being Head of Department and four experienced group leaders leading the four sections of the department should work well, assuming they have been able to establish a strong team spirit, as appears to be the case.
The research area is relevant for society in the coming decades to support the major changes society is facing. The research themes defined, -Intelligent Vehicles, Learning and Autonomous Control, Robot Dynamics and Human-Robot Interaction -, all are at the core of societal needs. This also should enable sufficient access to research funds.

The research objectives defined require a clear long-term vision and focus. Striving for research excellence is laudable. However, the committee advises to formulate a more concrete ambition or focus by setting an ambitious vision for two to three areas they want to become leader in.

Hence the Committee suggests to establish more research focus and build up critical mass on a few well specified areas in which they can excel and maintain and establish recognised global research excellence. This will help the department to:

- Maintain research facilities adequate to assure top quality research and related long-term viability of the department;
- Increase international visibility and becoming an attractive employer, in order to cope with the international competition with other research institutes on recruiting talented staff, as Robotics is a very popular area.

The Committee would also welcome a better formulation of the collaboration as an important objective of the department. Now this collaboration within the department arises bottom-up, and gives very good visibility and research satisfaction. The Committee thinks that if the department would present itself in a more coherent and focused way, it would be able to more easily attract (large) projects which require a broad spectrum of expertise. The Committee applauds that the department has good interaction with industry and is doing quite some application inspired projects supported by industry and improving cohesion. The project with Ahold is a good example of such a project, establishing coherence and collaboration within the department on motion planning, vision,

manipulation, etc. Also, students benefit from this through student projects and in courses.

The facilities available in the department should be adequate for assuring good quality research and related long-term viability of the department. The committee would welcome a well-defined strategy to maintain and further develop these facilities, in harmony with a well-defined research and collaboration strategy.

The Committee agrees that there is much international competition on recruiting talented staff with other research institutes, as Robotics is a very popular area. Strengthening the research focus will help in being an attractive employer.

The Committee also applauds:

- The involvement of the department in setting up spin-offs and encourages them to continue this;
- The strong long-standing collaboration with the Aerospace faculty;
- The establishment of new collaborations with several other faculties and departments: Technology Policy and Management, Design Engineering;
- The establishment of a strong collaboration with the working title *Future of Work* with groups of several other Dutch universities.

RECOMMENDATIONS

- Selection of well defined, ambitious application inspired long term research goals for the department will help people to focus their research and to be used by them as a guide. It will drive towards coherence in research, increase critical mass and visibility of the department, help prioritise future development of facilities and equipment;
- Solidly discuss research focus with all researchers. Build strong research teams with sufficient opportunities for each staff member to specialize and achieve research excellence recognition for their contributions;
- Build on the expertise of each of the individuals and continuously learn from each other's successes and failures;

- Very important for the department is fast realisation and opening of the new Lab facilities. The Lab is going to be crucial for research collaboration and social cohesion in the department;
- For the near future the department needs to develop a strategy for working closer together with Data Science and AI;
- In the interview the impression was established that the Tenure Trackers and the PhDs are well supported and guided. It is worthwhile though to have clearly documented expectations with milestones and procedures to manage uncertainties and expectations of both Tenure Trackers and PhDs. The department experiences the current size as being optimal. Hence the Committee supports the department's ambition to stabilise it at its current size.

3.3 Research Delft Center for Systems and Control (DCSC)

Head of Department	prof.dr.ir. Bart de Schutter
Research staff 2018	23.9 Research FTE (excluding PhD)

As described in the self-assessment report, the Department 'Delft Center for Systems and Control' (DCSC) coordinates the education and research activities in systems and control in the Faculty of 3mE. Its mission is to provide education and to perform research at high internationally recognized level, as a "competence centre" at 3mE and at TU Delft as a whole. The major research areas at DCSC include modelling, analysis, control, and optimization for complex dynamical systems that are relevant in science, engineering, healthcare and economics. Fundamental research plays a central role: to develop theory, methods, and tools that are applicable to a wide range of dynamical systems. Furthermore, DCSC develops computational methods for the analysis, synthesis, and implementation of advanced control systems with applications in sustainable transport, energy and healthcare.

Within DCSC, the research activities revolve around several research themes that are organised in four sections or groups:

- Hybrid, Adaptive and Nonlinear Systems and Control focuses on optimization-based, estimation-based, and model-based systems and control methods, complemented with computer science and operation research approaches
- Numerics for Identification and Control focuses on the analysis of signals in the area of systems and control.
- Data-Driven Control focuses on the integrated design, analysis, and decision making for large-scale (in physical size) dynamical systems.
- Networked Cyber-Physical Systems aims at improving our understanding and control of cyber-physical systems composed of a large number of interconnected and embedded components.

The research staff is composed of 16.8 FTE scientific staff, 7.1 FTE post-docs and 61 PhD-candidates (2018).

Table 11 shows the demonstrable research output of the Department of DCSC.

	2013	**2014**	**2015**	**2016**	**2017**	**2018**
Refereed articles	53	50	53	76	78	102
Non-refereed articles						1
Professional publications	5	2	7	1		
Book chapters	3	2	9	3	1	2
Books	1			1		
PhD theses	5	9	10	10	6	8
Conference papers	77	79	80	86	88	81
Other research output	3	2	2	3	12	1
Total	**147**	**144**	**161**	**180**	**185**	**195**

Table 11: Total output of the Department of DCSC

The composition of the research staff of DCSC is found in Table 12.

	2013		**2014**		**2015**		**2016**		**2017**		**2018**	
	#	FTE	#	FTE	#	FTE	#	FTE	#	FTE	#	FTE
Scientific staff	14	11.0	16	11.8	16	13.3	16	13.2	16	13.1	19	16.8
Post-docs	14	6.3	12	7.2	21	11.7	18	9.7	17	9.6	14	7.10
PhD-students	55		60		56		56		51		61	
Total research staff	83	17.3	88	19.1	93	25.0	90	22.8	84	22.7	94	23.9

Table 12: Staff embedded in the Department of DCSC

The total funding of DCSC is found in Table 13.

TOTAL	2013		2014		2015		2016		2017		2018	
	k€	%	k€	%	k€	%	k€	%	k€	%	k€	%
Direct funding[1]	2088	51%	2283	38%	2487	37%	2555	41%	2559	42%	2669	44%
Research funding[2]	614	15%	1433	24%	1503	22%	1231	20%	1149	19%	667	11%
Contract research[3]	738	18%	1753	29%	2093	31%	1731	28%	2090	34%	2246	37%
Other[4]	669	16%	566	9%	667	10%	688	11%	316	5%	512	8%
Total funding	**k€ 4109**		**k€ 6035**		**k€ 6750**		**k€ 6205**		**k€ 6114**		**k€ 6094**	

Table 13: Total funding at level of the Department of DCSC. All amounts in k€.

1. Direct funding by the University, obtained directly from the University, and financial compensation for educational efforts.
2. Research funding obtained in national and international scientific competition (e.g. grants from NWO, KNAW, EU/ERC, ESF).
3. Research contracts for specific research projects obtained from external organisations, such as industry, government ministries, the European Commission, and charity organisations.
4. Funds that do not fit the other categories.

RESEARCH QUALITY

The ambition set by DCSC to strive for excellent research at the highest worldwide levels is the right ambition. Overall average performance is very good. The scientific results realised in 2013-2018 and referred to by DCSC confirm good quality and align with the research focus set for the Centre.

Point of concern is the significant reduction in new projects initiated in the period 2015-2017. An improvement is shown in 2018 though. This improvement has been confirmed to be steady and structural in the meantime.

RELEVANCE TO SOCIETY

The research areas worked on have significant societal relevance and support societal needs in the coming decades. Internet of Things, the energy transition, societal transition to a circular economy, the aging population' all require higher level of automation and autonomy in systems, increased complexity of systems, breakthroughs in sensor system performance. The research activities all contribute to these societal needs.

VIABILITY

The research topics selected – Hybrid, Adaptive and Nonlinear Systems and Control, Numerics for Identification and Control, Data-driven Control and Networked Cyberphysical Systems- are highly relevant for solving the challenges that the Dutch, European and Global society are facing throughout the coming decades. More coherence in research, and establishing strong multidisciplinary research teams, are expected to further improve performance. As part of the future strategy, clearly defining long term ambitions and lines of research aiming at achieving these ambitions will help to improve global visibility, research performance of the Centre, and capability to attract talented people.

The balance between various sources of funding is good. In the coming years some additional attention may be needed for maintaining the level of funding from research grants and contract research. This may need dedicated staff. DCSC is well equipped for the research done.

The management team and research staff are well qualified. This team should be able to maintain performance in the long term.

RECOMMENDATIONS

- Point of attention is the coherence and critical mass in the research areas. DCSC may benefit from selecting a few coherent research lines that support specific, well selected, fields of application as part of the strategy. Collaboration in research teams working on these lines of research will enable team members to benefit from each other's strengths. This will

help improve global visibility of the Centre and achieve excellence. This may also help in attracting talented people;

- In the coming years some additional attention may be needed for maintaining the level of funding from research grants and contract research;
- The department experiences the current size as being optimal, and the Committee supports the department's ambition to stabilize it at its current size.

3.4 Research Department of Materials Science and Engineering (MSE)

Head of Department	Prof. Dr. Ir. Jilt Sietsma
Research staff 2018	39.3 Research FTE (excluding PhD)

As mentioned in the self-assessment report, the mission of the Department Materials Science and Engineering (MSE) is to develop fundamental knowledge on the behaviour of materials throughout the materials life cycle. Maximum performance of materials under increasingly demanding conditions as well as smart and cost-effective materials solutions are needed to ensure the advancement of technology towards solving major societal issues like the energy transition and long-term sustainability. Focus of the research is therefore on materials for energy and sustainability. Fully circular and sustainable usage of materials is needed to ensure long-term technological quality.

The scientific approach of MSE is based on the sequence of materials processes throughout the materials life cycle. These materials processes form the research themes of the department:

- Design: This research theme investigates the design of novel materials following innovative approaches towards improving properties and performance
- Processing: This research theme involves the investigation of advanced processing, such as Additive Manufacturing, and industrial processes, such as forming and welding, that affect the microstructure and thus the properties and performance of materials.
- Microstructure: This research theme includes fundamental research on microstructure formation, such as nucleation and growth mechanisms of phases.
- Properties: This research theme focusses on fundamental understanding of the relation between materials microstructures and the resulting mechanical and functional properties.

- Performance: This research theme involves the fundamental analysis of service-life performance and durability of materials.
- Recycling: This research theme is crucial for optimised sustainability of materials usage, since it closes the materials life cycle.

The research staff is composed of 15.4 FTE scientific staff, 23.9 FTE post-docs and 60 PhD-candidates (2018).

Table 14 shows the demonstrable research output of the Department of MSE.

	2013	**2014**	**2015**	**2016**	**2017**	**2018**
Refereed articles	84	74	69	96	117	113
Non-refereed articles		1	1	1	2	1
Professional publications	9	8		1	1	
Book chapters	4	11	6	7	3	1
Books	1					
PhD theses	17	9	8	8	5	8
Conference papers	31	34	21	5	5	14
Other research output	7	7	2	5	9	3
Total	**153**	**144**	**107**	**123**	**142**	**140**

Table 14: Total output of the Department of MSE

The composition of the research staff of MSE is found in Table 15.

	2013		**2014**		**2015**		**2016**		**2017**		**2018**	
	#	FTE	#	FTE	#	FTE	#	FTE	#	FTE	#	FTE
Scientific staff	17	15.1	18	15.6	18	16.1	19	16.1	19	15.2	19	15.4
Post-docs	12	5.4	15	8.2	15	9.6	18	13.0	29	19.7	35	23.9
PhD-students	61		64		63		59		54		60	
Total research staff	90	20.5	97	23.8	96	25.7	96	29.1	102	35.0	114	39.3

Table 15: Staff embedded in the Department of MSE

The total funding of MSE is found in Table 16.

TOTAL	2013		2014		2015		2016		2017		2018	
	k€	%	k€	%	k€	%	k€	%	k€	%	k€	%
Direct funding[1]	2632	51%	2588	37%	3039	38%	2843	32%	3212	35%	3046	32%
Research funding[2]	396	8%	938	13%	1513	19%	2419	28%	2561	28%	3082	32%
Contract research[3]	1550	30%	2709	38%	2937	37%	3079	35%	2719	30%	3062	32%
Other[4]	550	11%	842	12%	441	6%	432	5%	563	6%	428	4%
Total funding	**k€ 5127**		**k€ 7076**		**k€ 7930**		**k€ 8772**		**k€ 9055**		**k€ 9618**	

Table 16: Total funding at level of the Department of MSE. All amounts in k€.

1. Direct funding by the University, obtained directly from the University, and financial compensation for educational efforts.
2. Research funding obtained in national and international scientific competition (e.g. grants from NWO, KNAW, EU/ERC, ESF).
3. Research contracts for specific research projects obtained from external organisations, such as industry, government ministries, the European Commission, and charity organisations.
4. Funds that do not fit the other categories.

RESEARCH QUALITY

The department has an excellent publication record (including citations/ pub) and an increasing number of funded post docs with steady number of PhD students. The research quality is very high, especially in microstructures which is central and plays a role in all the research themes.

The scientific staff is in general well-cited, as shown through medium to high h-indices.

The quality of the research of the seniors is also proven by editorships of, for the field, top-journals. Several of the researchers have received prestigious personal research grants. Another indicator for high quality is the extensive collaborations with prestigious universities and institutes internationally and several scientists have affiliation to other prestigious universities.

Relevance to society

The research is highly relevant for society shown in several ways. The focus on the life cycle of materials makes the department's research of high relevance since this area is an enabler for sustainability and many of the research topics show this. The department delivers a large number of educated individuals, both Masters and PhDs, which is also a clear indicator for societal relevance. The department has an extensive collaboration with industry and has even an organised industrial platform assuring that research results are transferred for use in industry. In the report and at the interview many examples on dissemination to society were given. Many of the research areas have important relevance to solving grand challenge problems related to energy and sustainability.

Viability

To develop fundamental knowledge throughout the materials life cycle is timely regarding the challenges related to climate changes and here materials play a key role. Theoretical, computational and experimental research are all included which all are necessary to succeed.

The Committee finds it very positive to see expertise in Artificial Intelligence (AI) and Machine Learning (ML) at the department.

The department operates in a Cooperative Principal Investigator, CPI, model where scientific staff collectively share the responsibility for finances and strategic choices. The Committee welcomes this as a way to get all to contribute forming a more efficient, inclusive working environment, unlike the more traditional hierarchical structure in academia. The CPI model seems to function very well in the department and could be among the best practises of the faculty.

The department seems to have a good balance considering age and gender, and seems to have been successful with recruitments.

The broadening to polymers, composites and polymeric coatings is challenging. There are big differences in the research on metals and polymers and to reach top-level research also in polymers large efforts are needed. From the

perspective of decreasing the strong dependence of the steel industry there are also other possible directions that assumingly have been discussed within the department.

With expertise in theory, experiment, and simulation, the department is very well positioned to continue research in traditional areas and also to move into new areas related to problems in energy transition, circular economy and development of more sustainable materials.

Strong fundamental research and interactions with industry are both important for future viability.

Investments in both physical and computational infrastructure is done regularly which is essential to keep top-level research. On the other hand, the department express the challenge to support infrastructure maintenance and non-fancy, but essential, infrastructure for research in materials science, e.g. LOM.

There is an impressive increase of the number of Master students.

It is good that both research grants and contract research have increased considerably.

The department gives an impression of an inclusive atmosphere.

RECOMMENDATIONS

The Committee recommends the following for the MSE department:

- The gender balance is good: 30% female at all levels except PhD students-40%. The Committee recommends to continuously work with culture and awareness related to gender equality. Do not relax because the numbers are good, this can change rather quickly;
- The proposed PhD timeline is a great idea. The Committee recommends a yearly follow-up and evaluation after 4 years;
- The CPI-model is very interesting and the impression is very positive. It decreases hierarchy and increases inclusion, but it might be a challenge to maintain, for instances since finances are cooperative. The department

head takes all decisions based on the department council but can overrule it, so needs to be benevolent. The committee recommends to anchor how to continue in the long run e.g. when dept head is changed, new persons are recruited. Also, it is important to openly discuss pros and cons with the model to anchor support;

- The department wants to apply fundamental knowledge to another group of materials and is broadening its activities to polymers and composites as a response to industry and students' interest. This would decrease the dependence on the steel industry that in the SWOT analysis is identified as a threat even if the focus on metals is not changed. However, the differences between polymers/composites and metals are substantial and it is not self-evident how the activities benefit from each other. The committee thinks it is important to continue this development slowly to really have time to find and identify synergies to ensure that right areas are targeted. The situation needs continuous attention moving forward;
- The department keeps a close eye on the work load, and discusses this with everyone yearly. The committee thinks that is very positive and recommends to continue with this.

3.5 Research Department of Maritime and Transport Technology (MTT)

Head of Department	Prof. ir. Hans Hopman
Research staff 2018	39.0 Research FTE (excluding PhD)

As mentioned in the self-assessment report, the Department of MTT strives to make a significant contribution to the sustainable development of our society and our economy in the fields of Transportation, Maritime, Offshore and Dredging engineering.

The main research objective of MTT is to improve the competitive position of the Netherlands and European marine, dredging and transport sector by developing more efficient, safe, and sustainable solutions.

MTT consisted of the following research groups at the start of the period considered:

- Transport Engineering & Logistics proposes new tools and methods for design, control, automation, simulation, and optimization of mono- and multi-machine transport systems in terms of sustainability, maintenance, automation, and exchange of information.
- Ship Design, Production & Operation covers research related to design, engineering, production and repair of ships and other floating marine objects including their machinery and electric equipment.
- Ship Hydromechanics & Structures covers research on ship motion; seakeeping; manoeuvring behaviour; the hydromechanics; resistance; propulsion; construction; strength; vibrations related to new building; modification; repair; use of ships and other floating marine objects in the marine environment.
- Offshore & Dredging Engineering covers research on the design and engineering of systems to be used for the exploitation or usage of the seabed like dredging, (deep-)sea-mining, offshore oil- and gas production & offshore renewables.

The four research groups of MTT participate in different areas of industry and society, with different topics, applications, and research requirements set by the industry. To cope with this overlaying research themes across each of the four groups were defined. These four themes are, at the start of the period considered:

1. Intelligent Marine, Transport and Production Processes
2. Design for Service
3. Deepwater Offshore and Dredging
4. Innovative Design of Marine and Transport Concepts

The research staff is composed of 28.3 FTE scientific staff, 10.8 FTE post-docs and 87 PhD-candidates (2018).

Table 17 shows the demonstrable research output of the Department of MTT.

	2013	**2014**	**2015**	**2016**	**2017**	**2018**
Refereed articles	22	24	45	51	74	66
Non-refereed articles	1	1	1	1	3	1
Professional publications	8	5	14		4	1
Publications aimed at the general public	1					
Book chapters	1	6	5	2	2	1
Books	1	3		1		
PhD theses	6	3	6	10	11	11
Conference papers	90	63	84	72	66	73
Other research output	5	2	6	4	10	4
Total	**135**	**107**	**161**	**141**	**170**	**157**

Table 17: Total output of the Department of MTT

The composition of the research staff of MTT is found in Table 18.

	2013		2014		2015		2016		2017		2018	
	#	FTE	#	FTE	#	FTE	#	FTE	#	FTE	#	FTE
Scientific staff	27	24.8	28	24.6	30	26.5	31	26.7	31	26.4	34	28.3
Post-docs	4	3.3	6	3.5	9	4.8	14	7.3	16	9.2	20	10.8
PhD-students	53		69		76		94		89		87	
Total research staff	84	28.0	103	28.1	115	31.2	139	34.0	136	35.6	141	39.1

Table 18: Staff embedded in the Department of MTT

The total funding of MTT is found in Table 19.

TOTAL	2013		2014		2015		2016		2017		2018	
	k€	%	k€	%	k€	%	k€	%	k€	%	k€	%
Direct funding[1]	3034	56%	3340	45%	3391	40%	3584	33%	4095	43%	4295	43%
Research funding[2]	170	3%	450	6%	936	11%	1290	12%	1698	18%	1952	19%
Contract research[3]	1545	29%	3005	40%	3518	42%	4568	42%	3208	34%	2449	24%
Other[4]	636	12%	637	9%	534	6%	1533	14%	474	5%	1405	14%
Total funding	**k€ 5385**		**k€ 7433**		**k€ 8379**		**k€ 10975**		**k€ 9474**		**k€ 10100**	

Table 19: Total funding at level of the Department of MTT. All amounts in k€.

1. Direct funding by the University, obtained directly from the University, and financial compensation for educational efforts.
2. Research funding obtained in national and international scientific competition (e.g. grants from NWO, KNAW, EU/ERC, ESF).
3. Research contracts for specific research projects obtained from external organisations, such as industry, government ministries, the European Commission, and charity organisations.
4. Funds that do not fit the other categories.

RESEARCH QUALITY

The department shows a very positive development in the number of refereed articles and PhD thesis and has fulfilled its targets for this review period, even though the level of publications on some of the professor level is still fairly low. The research funding has increased from 3% to 19% indicating the successful efforts to increase the research activities on the fundamental scientific topics.

The committee was also happy to hear the good success during 2020 to achieve new EU funded projects (4), NWO funding and one ERC grant.

One drawback is still the fairly long time needed to finish the PhD thesis. As discussed above, this might need some new actions also on the faculty level.

RELEVANCE TO SOCIETY

The Committee considers the relevance to society to be very high through its close connection to societal and industrial partners. A number of projects has been initiated and launched and the research has resulted in new design methods, concept for operation and models for supporting decision making. A number of examples on impact to society by the use of research products were given in the report.

VIABILITY

MTT covers well all the important elements of maritime and transport technology. The research is organised through research groups, and research topics have been updated in 2017 including 7 themes having all fundamental importance for the future development: Submerged Seabed Systems, Future Ships & Complex Flows, Safe Autonomous & Complex Ships, Reliable Large Floating Systems, Impact less Material Handling System, Coordinated Multi-Machine Transport Logistics, Sustainable Drive Energy Systems.

Younger PIs have been activated to take further responsibility in building their own research themes and groups. The committee was delighted to hear that the co-operation in the department was based on a matrix approach. The department

has a number of younger professors and their part will increase due to some soon coming retirements.

The research facilities have high international level including also two new interesting openings: Research Laboratory for Autonomous Shipping and new Mega-Hexapod investment.

The department has a very close relation to the strong and innovative Dutch maritime sector, which is considered positive by the Committee.

Some staff members feel only loosely connected to the overall department, because of type of research and because of working at different locations.

RECOMMENDATIONS

The Committee recommends the following for the MTT department:

- Increase the efforts to shorten the PhD graduation time;
- Include and activate younger staff to take part in developing problems solving for grand challenges;
- Make solid long-term plan to motivate female staff to join the department;
- Plan the actions needed to cover the high retirement number of experienced professors;
- The high increase in the activities should achieve a steady state phase, this should be analysed further, i.e. what is the right level? The department has selected 7 themes having all fundamental importance for the future development of the maritime and transport field. The committee recommends that the department will do a long-term plan what is the critical mass needed in each sector and how to co-operate with the other departments of the faculty for the successful future;
- Initiate a broad and open discussion through all the layers of the department to set up a strategy for increasing the cohesion within the department. Have regularly meetings of PhD's within the research groups.

3.6 Research Department of Precision and Microsystems Engineering (PME)

Head of Department	Prof.dr.ir. Just Herder
Research staff 2018	30.4 Research FTE (excluding PhD)

As mentioned in the self-assessment report the Department Precision and Microsystems Engineering (PME) aims to advance the understanding and designing of the working principles and processes for manufacturing, sensing, and positioning with high precision to impact bio-health, agro-food and a sustainable high-tech society.

PME develops methods and devices in the cross-disciplinary fields of Mechanical Engineering and Thermodynamics, Electrodynamics, Optics and Micro/Nanoscience. They focus both on systems operating at small length scales (enabling-nano) and on systems and devices where the small scale is decisive for their functioning and performance (nano-enabled). The nature of the research ranges from fundamental exploration to application-inspired, involving mechanics, micro/nanotechnology, mechatronic system design as well as their associated computational modelling and design methodologies.

The research activities within PME are organised around four research themes and corresponding research groups:

- Structural Optimization and Mechanics aims at developing (computational) analysis and design methods, and applying them to the design of novel (nano)mechanical devices, high-tech production equipment and structured (meta) materials.
- Mechatronic System Design focuses on the synergistic integration of mechanisms, sensors, actuators and control to perform complex tasks in a multi-physical environment.
- Micro and Nano Engineering exploits basic nanoscientific and microtechnology knowledge for its engineering research on instrumentation, processing and manufacturing.

- Dynamics of Micro and Nanosystems focuses on exploiting and understanding dynamics of micro and nanomechanical systems to engineer technologies that enable new products in the fields of instrumentation, consumer electronics, agro-food, biology and healthcare.
- A 5th theme has been added just recently, which is Micro-optics and Opto-mechatronics, which combines optics with the above topics.

The research staff is composed of 19.7 FTE scientific staff, 10.7 FTE post-docs and 46 PhD-candidates (2018).

Table 20 shows the demonstrable research output of the Department of PME.

	2013	**2014**	**2015**	**2016**	**2017**	**2018**
Refereed articles	28	31	54	45	68	52
Non-refereed articles						1
Professional publications	1	5	5	2	5	6
Publications aimed at the general public			1			
Book chapters	3	1	2	1	2	
Books		1				
PhD theses	9	2	8	11	6	3
Conference papers	47	46	40	29	23	35
Other research output	4	19	7	14	7	7
Total	**92**	**105**	**117**	**102**	**111**	**104**

Table 20: Total output of the Department of PME

The composition of the research staff of PME is found in Table 21.

	2013		**2014**		**2015**		**2016**		**2017**		**2018**	
	#	FTE	#	FTE	#	FTE	#	FTE	#	FTE	#	FTE
Scientific staff	16	15.1	20	14.0	19	16.7	19	17.3	20	19.0	22	19.7
Post-docs	8	5.6	10	7.9	12	8.2	13	6.6	13	9.2	15	10.7
PhD-students	57		50		49		42		41		46	
Total research staff	81	20.6	80	22.0	80	24.8	74	23.9	74	28.2	83	30.4

Table 21: Staff embedded in the Department of PME

The total funding of PME is found in Table 22.

TOTAL	2013		2014		2015		2016		2017		2018	
	k€	%	k€	%	k€	%	k€	%	k€	%	k€	%
Direct funding[1]	2691	56%	3126	39%	3134	41%	3473	49%	3696	60%	3959	61%
Research funding[2]	742	15%	2027	25%	1655	22%	911	13%	913	15%	1487	23%
Contract research[3]	1005	21%	2497	31%	2475	33%	2102	30%	1279	21%	1012	16%
Other[4]	393	8%	307	4%	332	4%	571	8%	239	4%	50	1%
Total funding	**k€ 4831**		**k€ 7957**		**k€ 7595**		**k€ 7057**		**k€ 6126**		**K€ 6508**	

Table 22: Total funding at level of the Department of PME. All amounts in k€.

1. Direct funding by the University, obtained directly from the University, and financial compensation for educational efforts.
2. Research funding obtained in national and international scientific competition (e.g. grants from NWO, KNAW, EU/ERC, ESF).
3. Research contracts for specific research projects obtained from external organisations, such as industry, government ministries, the European Commission, and charity organisations.
4. Funds that do not fit the other categories.

RESEARCH QUALITY

All five themes have published very well as quantified by standard normalised metrics. The aim that each PhD candidate produces at least 4 journal publications is considered by the Committee as quite ambitious, especially if the design aspect is also satisfactorily covered. This, might make the PhD last longer than necessary.

The high research quality is also demonstrated by the significant funding that the department is able to achieve from industry.

Relevance to society

The department has a very strong focus on societal relevance with a clear vision including energy and healthcare.

Exploring the limits of engineering towards the small is relevant for society in many aspects, from research enabling new products to new applications, that are at the interface with neighbouring disciplines, like biology at the cellular level.

PhD candidates are encouraged to publish early on, to give them the flavour of publishing.

Viability

Organisation of research

Since the writing of the assessment report a new section with the topic of Micro-optics and Opto-mechatronics has been added to the original 4 on Mechatronics System Design, Dynamics of Micro- and Nanosystems, Micro and Nanoengineering, Structural Optimization and Mechanics

The department currently has 27 faculty members, close to half of it are young assistant professors. This makes the faculty very dynamic, makes it possible to distribute the teaching load and pick-up new topics.

The department is clearly organised in these coherent research areas. The topics covered show a nice balance between fundamental and curiosity driven research on the one hand and applied research, often pursued together with industry. In particular for this department strong links exist to bridge towards physics and biology and their applied aspects. New topics like 3D printing or atomistic modelling of small structures are embedded in these existing sectors, thereby they are mutually benefitting from each other.

Funding

The department has a very strong funding record, that includes many contracts from industry. The department have used recent special funding schemes to make excellent investments into infrastructure and equipment, like chemical

labs, optics labs, 3D printer labs, … The large proportion of industry funding with full economic costing also helps them in funding their expensive infrastructure including technicians.

The department does a lot of things jointly, e.g. within the NERI initiative. This is a focus for the whole department. It identifies the long-term challenges, then looks for industry who might be interested in this. Over the last three years they have had significant industry funding for this initiative - e.g. metamaterials. It is planned to increase EU funding, including ERC's in phase 3 of the NERI plan.

The sharing of the expensive equipment as well as the computational facilities benefits all.

Out of the many assistant professors recently hired only two have left, one for industry, one for a start-up company. They are active in acquiring projects. The problem of enough co-financing was mentioned by PME as an explicit point of concern, especially with respect to the funding of projects of the young faculty. This co-financing problem applies to the whole Faculty of 3mE, but was in the general discussions (including the discussion with the Management team) not regarded as a limiting factor,

The department also has a strong educational record. The teaching load seems to be high, due to the recent increase in student numbers. PhD students also contribute and assist in Masters courses, guest lectures and practical aspects of education. The department has also hired a full-time teaching staff member. The Committee learned that the topic of Mechanics is not only covered within the PME department, but taught by members of all departments.

The PhD education starts early on with an early publication to get them up to speed. This is a relatively recent policy and does not show yet in the term figures of the self-assessment report. Accordingly, it should be monitored closely whether this is a suitable action plan to bring the length of the PhD in line with the faculty goals.

RECOMMENDATIONS

- The areas the Committee recommends considering for the future are High Tech, Bio Health, Micro-optomechatronics and Agrofood;
- Continue the good practices mentioned above;
- Within the context of globalisation, a large share of manufacturing of larger structures has been moved to China. It might happen that this trend is going to be reversed, such that a need for building up this capacity again in the western world might become essential. High precision, structural optimisation and optics will also be important in this context and could be a new field for the department, where the available competences come together;
- The relatively rigid four publication guideline could be handled in a more flexible way in order to bring the length of the PhD in line with the faculty and university goals. For example, in an experimental research theme more time might be required to come up with a high-class publication as compared to a computational one.

3.7 Research Department of Process and Energy (P&E)

Head of Department	Prof. Dr. Ir. Bendiks Jan Boersma
Research staff 2018	44.2 Research FTE (excluding PhD)

As mentioned in the self-assessment report, the Department Process & Energy (P&E) aims to enable the energy transition by educating future (mechanical) engineers and by developing novel processes and equipment for the production and consumption of synthetic fuels, chemicals and materials. Research is performed in the fundamentals (thermodynamics and fluid dynamics) and in technologies (energy technology and storage, process intensification and multiphase systems). The research and education of P&E is based on three domains: Energy, Flow and Processes. These domains, which emerged from a previous section-based organisational structure, are very much interconnected and working together.

The common denominators for the research in P&E are continuum 'fluids' (gas or liquid or a combination, with or without solids), either used as process material, carrier or solvent, or as a medium through which a transport process, separation process or chemical conversion is carried out. In terms of length scales considered, the research covers the range from full equipment scale down to the molecular scale.

The research themes covered by the P&E department are broadly divided over the topics 'Energy', 'Flow' and 'Processes':

- The Energy domain studies and develops energy conversion and storage systems both on a system and a component development level.
- The Flow domain investigates the fundamentals of (among others) turbulence, transport phenomena (mass, heat, momentum), micro and nanofluidics, granular materials, multiphase flows, interfaces (interactions), cavitation, biological flows and complex fluid systems (e.g., fluidised beds).
- The Processes domain studies systems and components aimed at reduced energy consumption and improved sustainability regarding resources

utilisation and emission reduction by intensification of reaction systems (using, for example, electricity powered plasma and application of external fields) and their inherent separation operations for targeted product quality.

The research staff is composed of 21.1 FTE scientific staff, 23.2 FTE post-docs and 79 PhD-candidates (2018).

Table 23 shows the demonstrable research output of the Department of P&E.

	2013	**2014**	**2015**	**2016**	**2017**	**2018**
Refereed articles	107	114	112	85	98	123
Non-refereed articles	1			5		
Professional publications	4	7	4	4	5	2
Book chapters	4	14	5	7	5	3
Books		1	2	2	1	
PhD theses	8	13	16	13	11	9
Conference papers	47	30	37	23	45	23
Other research output	21	29	18	13	15	11
Total	**192**	**208**	**194**	**152**	**180**	**171**

Table 23: Total output of the Department of P&E

The composition of the research staff of P&E is found in Table 24.

	2013		**2014**		**2015**		**2016**		**2017**		**2018**	
	#	FTE	#	FTE	#	FTE	#	FTE	#	FTE	#	FTE
Scientific staff	25	22.8	24	19.6	20	18.2	20	18.1	22	21.3	22	21.1
Post-docs	24	14.4	21	15.1	21	11.2	28	13.9	31	21.1	31	23.2
PhD-students	90		85		76		81		79		79	
Total research staff	139	37.2	130	34.7	117	29.3	129	32.0	132	42.4	132	44.2

Table 24: Staff embedded in the Department of P&E

The total funding of P&E is found in Table 25.

TOTAL	2013		2014		2015		2016		2017		2018	
	k€	%	k€	%	k€	%	k€	%	k€	%	k€	%
Direct funding[1]	2968	33%	3812	29%	4036	37%	4035	38%	4425	42%	4459	36%
Research funding[2]	1515	17%	1950	15%	1581	14%	1808	17%	2165	20%	2424	20%
Contract research[3]	2914	32%	5933	46%	4333	39%	4053	39%	3729	35%	4802	39%
Other[4]	1635	18%	1266	10%	1029	9%	610	6%	276	3%	645	5%
Total funding	**k€ 9031**		**k€ 12961**		**k€ 10979**		**k€ 10505**		**k€ 10596**		**k€ 12330**	

Table 25: Total funding at level of the Department of P&E. All amounts in k€.

1. Direct funding by the University, obtained directly from the University, and financial compensation for educational efforts.
2. Research funding obtained in national and international scientific competition (e.g. grants from NWO, KNAW, EU/ERC, ESF).
3. Research contracts for specific research projects obtained from external organisations, such as industry, government ministries, the European Commission, and charity organisations.
4. Funds that do not fit the other categories.

Research quality

The quality and quantity of research are extremely strong, and in multiple areas can be considered world leading. The department is leading in terms of experimentation across a range of areas and problems. Although the quality of numerical research in the department is excellent, the Committee felt that this could be an area of greater consideration and potential expansion in the future.

Relevance to society

The PhD graduates are in strong demand, and much of the research in areas concerning energy and environmental issues is of strong relevance to the future of society. Faculty hiring is forward thinking in bringing in new fundamental expertise that can address Grand Challenge problems in energy and sustainability. The committee believes that the hiring policy of P&E allows them to be flexible to address new problems and Grand Challenges as they arise.

The department focuses on fundamental research with questions provided by societal challenges. The group indicated they are downscaling combustion research. The research addresses important fundamental objectives and appears well organised among the areas covered. New objectives aimed at water resources are relevant and fit well with P&E expertise and facilities. Also, it is notable that the research includes not only fundamental studies but also studies directly related to industry needs.

VIABILITY

P&E responds well to the shifting societal landscape, which ensures long term viability. The department has done an outstanding job at obtaining funding for fundamental research as well as maintaining strong ties to industry. Their facilities are top quality, and some are unique in the world. Their distribution of faculty (full professors to tenure track) suggests they will be able to sustain their mode of operation well into the future.

The P&E group has many collaborations within the 3mE faculty but also outside the 3mE faculty. The examples provided make sense, and the Committee thinks they are making good use of the diverse knowledge present at TUD. Further, the formation of the three domains within P&E seems to increase cross-domain research. Various of the novel cross-domain research topics (successfully) attempt to tackle large societal issues mainly focused on a sustainable future.

The model of supporting technicians within the department will aid the success of both faculty and students in both short and longer term.

The P&E model of operation including regular informal and formal interactions across all staff promotes not only a healthy climate, but also creativity, and productivity.

Although the department appears to support an open and inclusive culture, no proactive strategy seems in place to support women and people from underrepresented groups in achieving shorter- and longer-term success.

In distributing teaching load, junior staff are given the smaller master classes while senior staff are given the bachelor courses. The Committee thinks this is a great initiative to support the tenure trackers. Each course has at least two staff members, in order to distribute the load and always have a teacher available (even if one is away at a conference).

RECOMMENDATIONS

The Committee recommends the following for the P&E department:

- Continue supporting large facilities useful across multiple applications;
- Continue interdepartmental collaborations aimed at Grand Challenge problems;
- Continue efforts to develop and support the success of a diverse faculty and department;
- A minor suggestion of the Committee is to consider the option of more research proposals with one experimental PhD-student supported by a numerical PhD-student as a way to include numerical research.

Appendix A Curricula Vitae of the Committee members

Professor A.J. (Arjan) van der Schaft, Committee Chair, received the undergraduate degrees (cum laude) in Mathematics from the University of Groningen, the Netherlands, and was awarded the Ph.D. degree at the same university in June 1983 under the supervision of prof. Jan C. Willems. In 1982 he became assistant professor, in 1987 associate professor, and in 2000 full professor in Mathematical Systems and Control Theory; all at the University of Twente, NL. Since 2005 he is full professor in Mathematics at the Bernoulli Institute of the University of Groningen. His honors include: Fellow of the Institute of Electrical and Electronics Engineers (IEEE) since 2002, Fellow of the International Federation of Automatic Control (IFAC) since 2016, Recipient of the 3-yearly awarded Certificate of Excellent Achievements of the IFAC Technical Committee on Nonlinear Systems (2013), Invited semi-plenary speaker at the International Congress of Mathematicians (2006), Co-recipient of the SICE Takeda Best Paper Prize (2006). His research interests include: geometric modeling of multiphysics systems for control, robust nonlinear control, mathematical systems theory, energy systems and dynamical distribution networks.

Professor A.C.P.M. (Ton) Backx has worked in the field of applied research on model based process control and process optimization in the past 40 years both in industry and at the university. He initiated and built up an industry – university network that has been involved in many national and European R&D projects. Ton Backx received his MSc degree in Electrical Engineering (Cum Laude) from Eindhoven University of Technology in 1977. In 1987 he received his PhD on contributions to the identification based modeling of MIMO industrial processes. He was appointed part-time professor at Eindhoven University of Technology in 1990 in the field of modeling and model based control of industrial processes. After having worked in Telecom research (1977-1981) and within Philips (1981- 1988) he started his own company ('IPCOS') in model based control for the process industries. He held management positions in Setpoint and

AspenTech (1993-1998). He started a new company in 1998 ('IPCOS Technology') in model-based control focusing on chemical processing, steel and glass manufacturing. He went to Eindhoven University of Technology full-time in 2006 as Dean of the Faculty of Electrical Engineering (2006-2016). He was appointed Vice-Rector of Eindhoven University of Technology with special responsibility for strengthening the collaboration between the university and industry (2010-2016). In 2016 he became Vice-President International Relations. From 2016-2020 Ton Backx was responsible for research and development of Integrated Photonic Circuits and Systems at Eindhoven University of Technology. He started the Institute for Photonic Integration in April 2016. He also is initiator and president of Photon Delta –an eco-system for Photonic materials, photonic integrated circuits and photonic systems related companies and R&D institutes. In January 2020 he retired from the university.

Professor A. (Annika) Borgenstam is professor in Micro and Nano structures in Alloys at KTH Royal Institute of Technology in Stockholm, Sweden. She received her M.S in 1991 from KTH and was awarded her Ph.D. in Materials Science at the same university in 1997. She is Head of the Department of Materials Science and Engineering at KTH since 2015. She is Director for two research centres, the Competence Centre Hero-m 2 Innovation and Center for Mechanics and Materials Design. Her work is on the structure of metallic materials from nano- to micro level, focusing on how a structure is formed and how it can be modified. The emphasis is on the theoretical and experimental with particular focus on the link between thermodynamic and kinetic properties and transformation mechanisms. She is Member of the Royal Swedish Academy of Engineering Sciences, Chair for the steering committee for Advanced Metallic Systems Centre for Doctoral Training, University of Manchester and University of Sheffield, and Responsible at the ITM-school at KTH for Gender equality, diversity and equal opportunities.

Professor A.M.J. (Anthony) Bull has been Head of the Department of Bioengineering at Imperial College London since 2012. Prior to that he was Deputy Head of Department and Director of Courses. Originally a Mechanical Engineer, Anthony's conversion to Bioengineering was cemented through his work in orthopaedics and, latterly, in trauma; he holds leadership positions in both. He is Director of the Centre for Blast Injury Studies and the Musculoskeletal Medical Engineering Centre and is an active fundraiser at the institutional level as

co-director of the £125million Michael Uren Biomedical Engineering Research Hub. Anthony's work and leadership has been recognised through his election to the World Council of Biomechanics (limited to 40 members worldwide), Fellowship of the Royal Academy of Engineering and the American Institute for Medical and Biological Engineering. He has over 200 peer review publications, several granted patents and currently holds approximately £13m of research grants as PI. Professor Bull's research is focused on the basic mechanics of joints (including the tissues of joints and the mechanics of joints within the whole musculoskeletal system) and the application of this knowledge and technologies developed to clinical practice, including the diagnosis and treatment of pathologies, improving performance, and ageing.

Professor J. (Jürg) Dual has been Full Professor of Mechanics and Experimental at the Institute of Mechanical Systems at ETH Zurich since October 1, 1998. He was President of the Planning Commission of ETH Zurich 2000-2004, President of the University Assembly from 2008 to 2012 and Head of the Department of Mechanical and Process Engineering from 2014 to 2016. Jürg Dual studied mechanical engineering at ETH Zurich. He then spent two years on a Fulbright grant at the University of California in Berkeley, where he graduated with a M.S. and a M. Eng. degree in mechanical engineering. He then received his Dr. sc. techn. degree at the ETH Zurich under the guidance of Prof. Dr. M. Sayir at the Institute of Mechanics. For his dissertation he was awarded the Latsis Prize of the ETH Zurich in 1989. After one year as visiting assistant professor at Cornell University, Ithaca, NY, he returned to the ETH Zurich as assistant professor. He is a Fellow of the ASME, member of the SATW (Swiss Academy of Technical Sciences), Honorary Member of the German Association for Materials Research and Testing and Member of the Board of the International Congress of Ultrasonics (ICU) and the Acoustofluidics Conference Series. His research focuses on wave propagation and vibrations in solids as well as micro- and nanosystem technology. In particular he is interested in both basic research and applications in the area of sensors (viscometry), nondestructive testing, ultrasonic manipulation of cells and particles and gravitational interaction of vibrating systems. In his research, experimentation is central, but must always be embedded in corresponding analytical and numerical modeling. As mechanics is a very basic science, it is particularly attractive for him to interact with

neighbouring disciplines like bioengineering, materials science or micro- and nanosystem technology.

Ir. T. (Thijs) Hazenberg obtained his master's degree at Eindhoven University of Technology (TU/e) in 2019. As part of the master's program, he did his internship at Rolls-Royce Deutschland, where he worked on the development of fuel injectors of aerospace engines. Afterward, he started his graduation project under the supervision of Jeroen van Oijen. His master thesis is about model development for metal flames. This work was awarded the NVV combustion award for the best master thesis in the field of combustion. Directly after graduation, Thijs joined the Power and Flow group as a Doctoral Candidate. In this position, he is now working on model development for plasma-assisted combustion.

Professor P. (Pentti) Kujala studied Naval Architecture at the Helsinki University of Technology and was awarded D.Sc degree from the same university at 1994. He has been working also at Lloyd´s Register of Shipping in London (1981-1982) as a research engineer, VTT in Finland (1982-1989) as research scientist and Aker Yards in Finland (2003-2006) as a project manager and short-term visiting professor at DTU, Memorial University of Newfoundland and TUHH. Since 2006, he has been a professor of marine technology (safety) at the Aalto University, School of Engineering. Since 2012, he has been the head of the Marine Technology research group and from May 2017 he has been also Vice Dean of Research for the School of Engineering. He is chairing a center of Excellence for Arctic shipping and operations (CEPOLAR) funded by Lloyd's Register Foundation 2013-2021. His honors include: A Fellow at the Royal Institution of Naval Architects (Since 2017), Achievements in Teaching: Shipbuilder's Portfolio, School of Engineering, Aalto University (2012), Aalto Education Impact Award (2018). The main research interests have been devoted to the safety and risk analysis of marine operations both in open water and in ice and development of innovative structural solutions for various types of ships.

Professor E.K. (Ellen) Longmire is currently Associate Dean for Academic Affairs in the College of Science & Engineering at the University of Minnesota. She received an A.B. in physics (1982) from Princeton University and M.S. (1985) and Ph.D. (1991) degrees in mechanical engineering from Stanford University. She

has taught and directed research in the Department of Aerospace Engineering and Mechanics at the University of Minnesota since 1990. Professor Longmire uses experimentation and analysis to answer fundamental questions in fluid dynamics that affect industrial, biomedical, and environmental applications. Her research interests include single- and multi-phase transitional and turbulent flows, interfacial effects in multi-fluid flows, and development of measurement and analysis techniques. She is a Fellow of the American Physical Society and received the UM Distinguished Women Scholars Award, the McKnight Land-Grant Professorship, and the NSF National Young Investigator Award. She currently serves as an Editor-in-Chief for Experiments in Fluids. She previously served as Chair of the American Physical Society Division of Fluid Dynamics, as a member of the US National Committee on Theoretical and Applied Mechanics, and as an Associate Editor for Physics of Fluids.

Professor J. (Jan) Swevers received the M.Sc. degree in electrical engineering and the Ph.D. degree in mechanical engineering from the KU Leuven, Belgium, in 1986 and 1992, respectively. He is full professor at the Department of Mechanical Engineering of KU Leuven, member of the DMMS core lab of Flanders Make, and coordinating the research team MECO: Motion Estimation, Control and Optimization. His research focuses on motion control and optimization: robust and iterative learning control design methodologies for (non-)linear multi-variable systems, identification and control of robot manipulators, modeling and compensation of friction in mechatronic systems, dynamic and embedded optimization for motion control systems. He is member of the International Scientific Advisory Board of LINK-SIC - Linköping Center for Sensor Informatics and Control, Sweden, and was Laureate of the Belgian Royal Academy for Fine Arts, Letters and Sciences, in 1988, and won the Kitakyushu Mechatronics Award, Contribution to Studies on Mechatronics through an excellent paper presentation at Mechatronics ’98, Japan, and the best paper award at the 15th International Workshop on Advanced Motion Control, 2018, Tokyo, Japan. Jan Swevers teaches master and bachelor courses at the KU Leuven, on systems and control theory and system identification.

APPENDIX B ONLINE SITE VISIT PROGRAMME

- All meetings were on-line using the 'Zoom' application

Wednesday October 28			
time NL	*activity*	*assessors*	*participants 3mE*
13.30	Prep. time	All	-
13.45	**Context site visit**	All	Prof. Dr. Ir. T.H.J.J. (Tim) van der Hagen (Rector) Prof. Dr. Ir. T.S. (Theun) Baller (Dean)
14.15	Wrap-up	All	-
14.45	Break		
15.15	Preparation	All	-
16.00	Interview **MT-3mE** *Participants start with 5-minute presentation*	All	Prof. Dr. Ir. T.S. (Theun) Baller Prof. Dr. Ir. B.J. (Bendiks Jan) Boersma Prof. Dr. Ir. B. (Bart) De Schutter Dr. A.R. (André) Groenhof Prof. Dr. Ir. J. (Hans) Hellendoorn Prof. Dr. Ir. J.L. (Just) Herder Prof. Ir. J.J. (Hans) Hopman M.J.P. van Laarhoven Prof. Dr. Ir. J. (Jilt) Sietsma Prof. Dr. H.E.J. (DirkJan) Veeger Drs. A. Vervoort
17.00	Wrap-up	All	-
17.30	Break		
18.00	Preparation BMechE, DCSC, MTT	Assessors in breakout rooms	
18.30	Interview **BMechE** *Participants start with 5-minute presentation*	Prof. Dr. A.M.J. (Anthony) Bull (1st) Prof. Dr. J. (Jürg) Dual (2nd)	Prof. Dr. Ir. H. (Heike) Vallery Prof. Dr. H.E.J. (DirkJan) Veeger (head of department) Prof. Dr. Ir. A.A. (Amir) Zadpoor
18.30	Interview **DCSC** *Participants start with 5-minute presentation*	Prof. Dr. Ir. A.C.P.M. (Ton) Backx (1st) Prof. Dr. J. (Jan) Swevers (2nd)	Prof. Dr. Ir. B. (Bart) De Schutter (head of department) Prof. Dr. Ir. T. (Tamas) Keviczky Prof. Dr. Ir. J.W. (Jan-Willem) van Wingerden

18.30	Interview **MTT** *Participants start with 5-minute presentation*	Prof. Dr. P. (Pentti) Kujala (1st) Prof. Dr. A. (Annika) Borgenstam (2nd)	Prof. Ir. J.J. (Hans) Hopman (head of department) Dr. Ir. S.A. (Sape) Miedema Prof. Dr. R.R. (Rudy) Negenborn
19.00	Wrap-up	Assessors in break-out room	
19.10-19.30	Sharing impressions	Entire committee	

Thursday October 29			
time NL	*activity*	*assessors*	*participants 3mE*
14.00	Preparation PME, P&E, CoR	Assessors in breakout rooms	-
14.30	Interview **PME** *Participants start with 5-minute presentation*	Prof. Dr. J. (Jürg) Dual (1st) Prof. Dr. A.M.J. (Anthony) Bull (2nd)	Prof. Dr. Ir. J.L. (Just) Herder (head of department) Prof. Dr. Ir. A. (Fred) van Keulen Prof. Dr. P.G. (Peter) Steeneken
14.30	Interview **P&E** *Participants start with 5-minute presentation*	Prof. Dr. E.K. (Ellen) Longmire (1st) Prof. Dr. P. (Pentti) Kujala (2nd) Ir. T. (Thijs) Hazenberg (3rd)	Prof. Dr. Ir. B.J. (Bendiks Jan) Boersma (head of department) Prof. Dr. Ir. W. (Wiebren) de Jong Prof. Dr. Ir. J. (Jerry) Westerweel
14.30	Interview **CoR** *Participants start with 5-minute presentation*	Prof. Dr. J. (Jan) Swevers (1st) Prof. Dr. Ir. A.C.P.M. (Ton) Backx (2nd)	Prof. Dr. Ir. D.A. (David) Abbink Prof. Dr. Ir. J. (Hans) Hellendoorn (head of department) Prof.dr.ir. M. (Martijn) Wisse
15.00	Wrap-up	Assessors in break-out room	
15.10	Sharing impressions	Entire Committee	-
15.30	Break		
16.00	Prep.time	Assessors in breakout rooms MSE, JBMC, DISC, GS	-

16.30	Interview **MSE** *Participants start with 5-minute presentation*	Prof. Dr. A. (Annika) Borgenstam (1st) Prof. Dr. E.K. (Ellen) Longmire (2nd)	Prof. Dr. Ir. J.M.C. (Arjan) Mol Prof. Dr. M.J. (Maria) Santofimia Prof. Dr. Ir. J. (Jilt) Sietsma (head of department)
16.30	Interview **JMBC** *Participants start with 5-minute presentation*	Prof. Dr. A.M.J. (Anthony) Bull (1st) Prof. Dr. J. (Jürg) Dual (2nd)	Prof. Dr. Ir. G.J.F. (GertJan) van Heijst (Scientific director of JMBC) Prof. Dr. Ir. C. (Christian) Poelma
16.30	Interview **DISC** *Participants start with 5-minute presentation*	Prof. Dr. J. (Jan) Swevers (1st) Prof. Dr. Ir. A.C.P.M. (Ton) Backx (2nd)	Prof. Dr. H. (Henk) Nijmeijer (Scientific director of DISC) Dr. J.W. (Jan Willem) Polderman
16.30	Interview **Graduate School** *Participants start with 5-minute presentation*	Ir. T. (Thijs) Hazenberg (1st) Prof. Dr. P. (Pentti) Kujala (2nd)	Prof. Dr. Ir. J. (Hans) Hellendoorn (Director of the Graduate School at the Faculty) M.P.I. (Mascha) Toppenberg Ir. H.M.A. (Eline) Kolken (member PhD Council)
17.00	Wrap-up	Assessors in break-out room	
17.10	Sharing impressions	Entire Committee	-
17.30	Break		
18.00 – 19.00	Discussing and writing preliminary judgments (committee only)	Committee	-

Friday October 30			
time NL	*activity*	*assessors*	*participants 3mE*
14.00	Prep. time	Assessors Plenary and Breakout room	-
14.30	Interview **PhD**	Ir. T. (Thijs) Hazenberg (1st) Prof. Dr. E.K. (Ellen) Longmire (2nd)	M.P. (Maarten) Klapwijk MSc. (M&TT) Ir. H.M.A. (Eline) Kolken (BmechE) J. (Junaid) Mehmoom MSc. (P&E) Ir. L. (Leonoor) Tideman (DCSC) A. (Alvaro) Serra Gomez MSc. (CoR) L. (Lidan) Zhang MSc. (PME) V. (Vibhor) Atreya MSc. (MSE)
14.30	Interview **TT**	Prof. Dr. J. (Jan) Swevers (1st) Prof. Dr. A.M.J. (Anthony) Bull (2nd)	Dr. A. (Angelo) Accardo (PME) Dr. P. (Poulumi) Dey (MSE) Dr. L. (Laura) Ferranti (CoR) Dr. Ir. J.W. (Willem) Haverkort (P&E) Dr. B. (Bilge) Atasoy (M&TT) Dr. P. (Peyman) Mohajerin Esfahani (DCSC) Dr. Ir. T. (Tim) Horeman (BMechE)
14.30	Interview **Tenured**	Prof. Dr. A. (Annika) Borgenstam (1st) Prof. Dr. Ir. A.C.P.M. (Ton) Backx (2nd)	Dr. F. (Farbod) Alijani (PME) Dr. M. (Manuel) Mazo Espinosa (DCSC) Dr. V. (Vera) Popovich (MSE) Dr. Ir. D.L. (Dingena) Schott (M&TT) Dr. Ir. A.C. (Alfred) Schouten (BMechE) Dr. Ir. R. (Riender) Happee (CoR) Dr. R. (Rene) Pecnik (P&E)
15.00	Wrap-up	Assessors in break-out rooms	
15.10	Sharing impressions + break	Committee	-
15.30	Discussing and writing preliminary judgments (committee only)		
16.30	Available timeslot for extra interview	*Depended*	
17.00	Wrap-up	*Depended*	-

December 1 and December 15			
time NL	*activity*	*assessors*	*participants 3mE*
1 hour	Prep.time	Committee	
30 minutes	Concluding meeting with MT 3mE	Committee	
30 minutes	Wrap-up	Committee	-
30 minutes	Break	Committee	-
30 minutes	Prep.time	Committee	-
30 minutes	Presentation first impressions	Committee	All

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