

ASSESSMENT COMMITTEE REPORT ON RESEARCH
IN
TECHNOLOGY, POLICY AND MANAGEMENT
2010-2015
DELFT UNIVERSITY OF TECHNOLOGY



MAY, 2017

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Colophon

Title

Assessment Committee Report on Research in Technology, Policy and Management 2010-2015,
Delft University of Technology

Editors

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PREFACE

The Assessment Committee was assigned the task of evaluating the research carried out at the Faculty of Technology, Policy and Management at Delft University of Technology over the period 2010-2015.

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

The Committee truly enjoyed the exchange and discussion. This took place in an open and positive atmosphere. We appreciated the major effort that the Faculty invested in preparing for this research assessment. We also appreciated the way in which the Faculty staff responded to the Committee's many additional information requests during the site visit. The Faculty and its members impressed the Committee with its combination of commitment, spirit of collegiality and shared culture.

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

Prof. Dr. Giovanni Azzone
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 three Departments that comprise the Faculty of Technology, Policy and Management at Delft University of Technology. This assessment covers research in the period 2010-2015. 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 research 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. Giovanni Azzone, Committee Chair, Professor of Business Economics and Organisation and Rector Emeritus Politecnico di Milano, Italy.

Prof. Dr. Kay Auxhausen, Professor of Transport Planning, Swiss Federal Institute of Technology in Zurich, Switzerland.

Dr. Jason Blackstock, Senior Lecturer in Science and Global Affairs, University College London (UCL), UK.

Prof. Dr. William (Bill) Crossley, Professor of Aeronautics and Astronautics, Purdue University, USA.

Prof. Dr. Armin Grunwald, Professor of Philosophy and Ethics of Technology, Karlsruhe Institute of Technology, Germany.

Prof. Dr. Sven Ove Hansson, Professor of Philosophy, Royal Institute of Technology (KTH), Sweden.

Prof. Dr. Michael Howlett, Professor of Political Science, Simon Fraser University, Canada and Yong Pung How Professor of Public Policy, National University of Singapore.

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 2004-2009,
- The full publication lists of the Departments of the Faculty of TPM.

The Self-evaluation report together with the interviews and additional information 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). 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, and teaching and administrative staff of the Graduate School and research programmes. Interviews took place on March 29 to 31, 2017 at the Faculty of Technology, Policy and Management in Delft. 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. This briefing also covered the rating system (Appendix C). 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. After each interview, the Committee discussed scores and comments. The committee also offered a separate advice to the TPM Faculty and Executive Board of the TU Delft regarding the core concept of comprehensive engineering of the Faculty and concerning talent recruitment. The Committee presented preliminary general impressions to the Faculty on the last day of the visit.

Following the on-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 TECHNOLOGY, POLICY AND MANAGEMENT FACULTY

2.1 THE FACULTY OF TECHNOLOGY, POLICY AND MANAGEMENT

Research and education in Technology, Policy and Management (TPM) at Delft University of Technology (TU Delft) is carried out within three research Departments: Engineering Systems and Services (ESS), Multi Actor Systems (MAS), and Values, Technology and Innovation (VTI).

The Faculty of Technology, Policy and Management pursues a multidisciplinary research programme at the intersection of the engineering sciences, the social sciences and the humanities. The Faculty has defined an overarching theme for its research programme, called “comprehensive engineering”. The assumption underlying this concept is that sociotechnical systems can only be understood or designed/redesigned with expertise in their technical behaviour, knowledge of the actors involved and of the social values that need to be taken into account in decisions and activities.

The research programme of the Faculty is expected to address “grand challenges” and contribute to solving them. Grand challenges cannot be solved by focusing on just one aspect of reality. In the research, both the analysis of the grand challenges and the design of solutions to them are conducted at a systems level and translated into projects and programmes to research. The technical components and relations that together define a system are taken into account as well as the actors involved, their interests and values, and the underlying institutions.

A core element of the Faculty’s research is the development of three perspectives on sociotechnical systems, where each perspective has both an analytical and a design component.

The three perspectives are:

- 1) The **engineering** perspective, focusing on the characteristics and behaviour of engineered systems. This perspective coincides with the Department of Engineering Systems and Services (ESS);
- 2) The **governance** perspective, focusing on the characteristics and behaviour of actors involved, including underlying institutions. This perspective coincides with the Department of Multi-Actor Systems (MAS);
- 3) The **value** perspective, focusing on values and normative – including moral – questions. This perspective coincides with the activities of the Department of Values, Technology and Innovation (VTI).

2.2 RESEARCH QUALITY

Table 1 shows the demonstrable research output of the Faculty of Technology, Policy and Management for the period 2010-2015.

	2010	2011	2012	2013	2014	2015
Refereed articles	229	190	223	217	231	240
Non-refereed articles	9	9	10	7	2	2
Books	17	17	10	6	7	10
Book chapters	101	76	81	95	123	84
PhD theses	21	23	16	19	23	21
Conference papers	341	305	250	194	162	135
Professional publications	82	89	69	52	52	44
Publications aimed at the general public	44	48	58	20	15	27
Other research output	197	204	305	180	157	178
TOTAL	1041	961	1022	790	772	741

Table 1: Total output Faculty TPM

REMARKS AND RECOMMENDATIONS

TPM shows a consistent level of research output (Table 1) over the period 2010-2015; in general, the quality of publications is very high, such as the number of publications per capita. Key figures in Table 1 show that the Faculty is undergoing a process of evolution, leading towards a more focused publication strategy.

In 2010, conference papers represented in fact 32% of total publications, while refereed articles made up 22%; in 2015 the weight of conference papers decreased to 18%, while refereed articles grew to 32%. In the same period, the share of professional publications and publications aimed at general public decreased from 12% to 10%.

Over the years, the Committee acknowledged an increase in the number of PhD's, and a growing attention to research grants, with the deliberate creation of a portfolio of NWO funding and ERC grants. At the same time, the Faculty decided to reduce the time spent to obtain small-scale contract research.

All these trends show a successful and deliberate process of improvement in academic quality; such a process is consistent with the overall strategy of TU Delft, as described by the Rector during his meeting with the Committee. The Committee also noted that there is still a significant number of professional publications and those directed towards the general public, and that such efforts are consistent with the attention of the Faculty towards real life problems with great societal relevance.

As a whole, the quality of research was found to vary between very good and excellent, with some groups in each Department considered to be truly excellent at a world-class level.

The Committee recommends that the Faculty continues the process of rising academic quality in the future, and to this end warns the Faculty about a possible risk. This is that the growing interest of the society, and of TU Delft itself, in comprehensive engineering could lead to an increase in the pressure on faculty to devote more time to education and towards applied projects rather than academic research. Such pressures must be balanced by additional resources. Otherwise, a lack of resources could negatively influence future research quality and productivity, and detract attention from more fundamental research, particularly among early career faculty.

2.3 RELEVANCE TO SOCIETY

REMARKS AND RECOMMENDATIONS

The Committee has two preliminary remarks, concerning the use of the SEP-protocol to assess TPM:

- 1) Most of criteria used to assess “relevance to society” in the SEP-protocol are not congruent – as far as the Committee is concerned - with the characteristics of TPM. Criteria such as the number of patents or startup companies, for instance, apply to Faculties whose research domain is in “hard” engineering or natural science, rather than to a Faculty operating on comprehensive engineering as does TPM;
- 2) “Relevance to society” is an integral part of the nature of all the problems TPM is involved in and focuses upon; the Committee suggests that it would be more meaningful to assess the real societal *impact* of TPM.

Notwithstanding these considerations, the Committee considers the relevance to society of TPM to be excellent. Engagement with societal actors is “in the DNA” (part of the culture) of TPM and is perceived as such by all members of the Faculty, both senior and junior staff. TPM research projects are connected to (and frequently derived from) the needs and interests of a diverse range of societal actors, and the activities of the Faculty have a strong influence at the local and national levels and, in some fields, at a trans-national or international level as well.

Despite such a positive valuation, however, the Committee remarks that the Faculty could do even more in terms of social impact.

A first point concerns the “strategic vision” of the Faculty itself, i.e. “Comprehensive Engineering for Grand Challenges”. Using the phrase “Grand Challenges” does not effectively capture TPM’s contributions which tend to focus on the slightly more prosaic level of significant social problems. Use of the Grand Challenges rubric may invite misinterpretation of how TPM works and what it works upon. The Committee suggests that it would be better to say that TPM “works on real-world problems of great societal importance”.

A second point is that even if societal impact is already very high, its appreciation and visibility can be improved by better codifying and supporting mechanisms that enable these impacts to be measured and monitored. In fact, relevance and impact are in the TPM culture, but not very well documented and articulated. The Committee understands that societal relevance might be so obvious to senior faculty members that it is difficult to see why it needs to be described, but the Committee believes this would be useful both internally (particularly for early career researchers who, when not educated within the Faculty will require some time to fully understand its culture) and externally. In the future, this could become a more explicit model for other Faculties at TU Delft as well.

2.4 VIABILITY

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

	2010		2011		2012		2013		2014		2015	
	#	FTE										
Scientific staff	117	36.7	118	38.2	118	37.6	117	37.3	113	36.6	112	35.8
Post-docs	31	19.8	28	17.4	37	23.3	49	33.5	50	31.9	34	21.9
PhD-students	95		115		119		124		130		144	
Total research staff		56.4		55.6		60.9		70.7		68.5		57.7

Table 2: Staff embedded in the Faculty TPM

TOTAL	2010		2011		2012		2013		2014		2015	
	k€	%										
Direct funding ¹	9957	41	10599	44	9152	48	9152	41	9420	49	9598	45
Research funding ²	1089	4	1301	5	1657	9	2065	9	2842	15	3336	16
Contract research ³	9332	38	8371	35	6513	34	6462	29	5967	31	5007	24
Other ⁴	4103	17	3602	15	1810	9	4390	20	1078	6	3527	15
Total funding	k€ 24481		k€ 23872		k€ 19131		k€ 22068		k€ 19307		k€ 21198	

Table 3: Total funding at level of the Faculty TPM. 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 decreased over the years from €24.48 million in 2010 to €21.20 million in 2015 (Table 3). The percentage of direct funding rose from 41% in 2010 to 45% in 2015. The percentage of funding from research grants increased from 4% in 2010 to 16% in 2015, and the percentage of contract funding decreased from 38% in 2010 to 24% in 2015.

REMARKS AND RECOMMENDATIONS

The assessment of the viability, i.e. the consistency between vision and strategy – on the one side – and available resources, on the other, refer to several different dimensions:

- The overall strategy of TU Delft and its impact on TPM;
- The consistency between TPM's own strategy and available resources;
- The capacity of units within TPM to maintain the quality and quantity of research staff;
- The competence and number of relevant support staff throughout.

Impact of overall TU Delft Strategy to TPM

The role of TPM within TU Delft is relevant today and is expected to increase in the future. The Rector explained to the Committee that the framework of comprehensive engineering is of high value for the university and that the TU Delft Executive Board is encouraging TPM to increase its cooperation – already strong – with other Faculties. While such a trend is very positive, the Committee remarks once again that it must be balanced by the provision of additional resources; if resources remain capped, such activities could induce stress or reduce the time for research and, in the end, research quality itself.

A second general issue pertaining to the overall TU Delft strategy is the emerging focus on a new “PI model” in research strategy, resulting in a growing attention towards large NWO and ERC Grants and following European and North American best practice. Such a trend is consistent with what is taking place in top European Technical Universities, where the number of ERC Grant winners is becoming a more and more important performance indicator. However, the Committee remarks that such a trend, if not properly managed, amounts to another risk for TPM, as the strategic vision of the Faculty is based on multidisciplinary and collaborative research which is somewhat antithetical to more specialized PI-type research. The Committee recommends specifically that TPM senior staff should avoid an *exclusive* emphasis on the PI model activity that could lead to a fragmentation of research effort.

Consistency between TPM strategy and resources

The Committee remarks above all that an explicit research strategy is missing at TPM; the Faculty’s research agenda’s seem to generally emerge from project opportunities and PI interests, and existing priorities and “pilots” do not define an organic set of topics.

Such a bottom up approach, however, nevertheless appears viable, due to:

- Good capacity to get research funding within the general area of “comprehensive engineering for real life problems of great societal impact”;
- Consistent demand for the competences of the Faculties.
- Strong leadership within and across units.

In fact, the set of opportunities arising is large enough to create a portfolio of projects that will keep the Faculty well supported and active, although somewhat splintered. The Committee remarks that while the total amount of indirect funding varies over time – as it happens in most universities – it remains at a comfortable level. As the Committee already noted in the section dedicated to “quality of research”, the Faculty is shifting from small contract grants to larger research contracts, consistent with a general evolution towards increasing the quality of research.

Maintaining quality and quantity of academic staff

The Faculty reported difficulties in recruiting new staff; in general, the average number of applications per position was about twenty, more or less consistent with TU Delft average (even though lower than universities of comparable reputation). For each position, the number of interviews was even more limited, due to the required standards of achievement and excellence for new hires and due to the need to hire people who share the “multidisciplinary and collaborative ethos” of TPM.

Despite these low numbers, the Committee remarks that high standards are generally met by successful hires and junior staff employed are of high quality and talented.

A specific issue, however, due to the implicit nature of the vision and culture of TPM, is the risk of losing tacit knowledge as senior staff retire or move on. This is a key competence within the Faculty and still is not documented. Hence, the Committee believes that an effort to make such knowledge more formal would be worthwhile.

Risk of shortage of support staff

Finally, the Committee remarks that the Faculty is involved in activities – as for instance the production of open source software – that, in the long run, cannot be professionally managed by research faculty alone. Hence, TPM must find support staff able to manage such activities or there is a risk that the quality of these activities will decline over time.

2.5 PHD PROGRAMMES AND TPM GRADUATE SCHOOL

It is the ambition of the 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. The mission of the TU Delft Graduate School is to prepare and train doctoral candidates to become highly qualified, autonomous and leading researchers and skilled professionals and to ensure that the doctoral process is transparent, systematic and effective. Furthermore, the UGS recognises scientific supervision as a pivotal and defining element of the research environment and doctoral training.

REMARKS AND RECOMMENDATIONS

The TPM GS was developed and begun during the assessment period and seems to have found its feet quickly. The involvement of up to four seniors in each PhD is deemed to be productive, as their degree of involvement varies substantially between the daily supervisor, the promotor, the mentor and the advisor on academic integrity. The graduation time has been reduced to be within reach of the four-year target under this system. The desirable, but large number of external PhD students with their external time constraints will make a strict adherence to the target impossible, however.

The committee notes that the distribution of the number of students by promotor and less so by daily supervisor is heavily skewed, which can lead to problems (Figure 1).

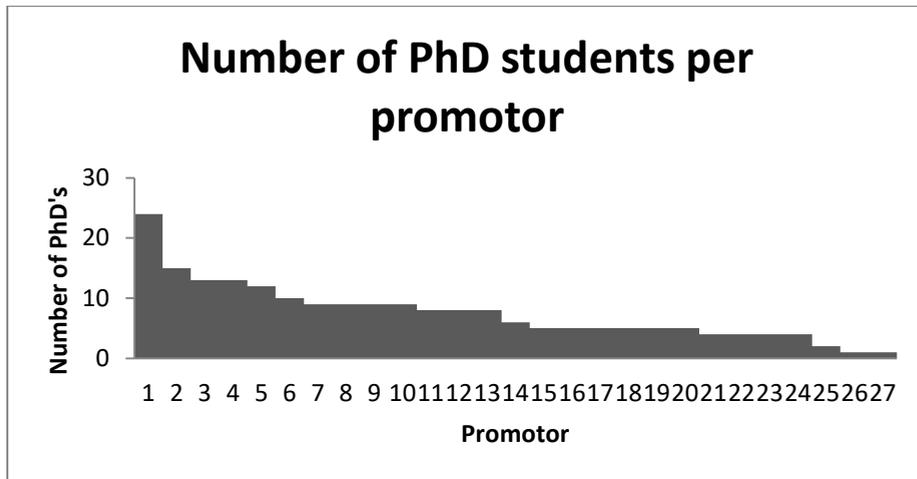


Figure 1 Number of PhD students per promotor

However, this may be dealt with by the upcoming change in Dutch law allowing associate professors to act as promotors. But the Committee found that the social and organisational implications of this change had not been discussed at length by the Faculty and many were unaware of this initiative.

The Committee shares the view of the Faculty that the unfavourable ‘exchange rate’ between ETCS and Graduate School credits limits the students in their choice of classes. Even with the programmes of all the Doctoral Schools to which TPM belongs, there will be gaps, which only regular courses can fill. Given the specific ethos of TPM, a stronger introductory class for students would be desirable. The PhD day and the ‘Grand Challenges’ class are a start, but a different format might be better.

The attrition rate of PhD students, including the rate low number of ‘No go’ decisions after 12 months is in the expected range for programmes of this type. It speaks also of a good recruitment process. The structure of the programme was seen as helpful by both students and staff. The ‘resit’ option at the ‘Go/No go’ stage reduces the pressure, but the Faculty will have to observe its use in the coming years in order to assess its long-term utility.

With about 50% of the total intake, the share of external students is impressive. The Committee urges that supervisors make sure that these students also have a chance to enter the spirit of the place and are fully integrated into the programme and activities. The committee welcomes the engagement of many students with the policy environment, as both supportive of TPM's mission and as a good opportunity for the students to reflect their theory and work in practice.

2.6 RESEARCH INTEGRITY

TU Delft has articulated its ideals, values, principles and responsibilities in the Code of Ethics TU Delft. The Code provides guidelines for everyone who is part of the TU Delft community: the academic staff, support staff, guests and students. The Code of Ethics has been expressly designed as a 'living document' that can be continually updated in response to new insights or topical issues.

REMARKS AND RECOMMENDATIONS

The Committee learned that TU Delft has a committee for research integrity and an ethics committee. Ethical permits for research involving human subjects are decided by the ethics committee. In the last three years, a campaign has been conducted to ensure that researchers send in applications when that is required. The research integrity committee deals reactively with cases submitted to it. The most common type of cases are those concerning intellectual authorship (mostly inventions, in some cases texts). The committee advises the Executive Board on potential measures and remedies. There is also a national committee to which appeals can be made. Plagiarism by PhD and staff are dealt with by the committee; while plagiarism by students is dealt with by their respective dean. New PhD students and new academic staff take part in training sessions that include research ethics. The general impression of the Committee is that adequate structures and procedures are in place to deal with problems concerning research ethics. However, while the Board is aware of the new and emerging issues around data archiving, TPM should be more proactive in this area as it affects many of its programmes and projects.

2.7 DIVERSITY

Encouraging diversity has been an implicit goal of TPM. Compared to other faculties at TU Delft, TPM attracts a relatively high proportion of female students for its education programmes and roughly one third of PhD candidates are female. Further, TPM has been an active proponent of the prestigious TU Delft Female Fellowships and was successful in hiring two excellent researchers under this scheme. One of the three heads of department is female, and one quarter of the management team of each department is female. However, while TPM has always encouraged and embraced diversity, there was no formal TPM diversity policy with explicit targets during the current review period. A more proactive approach and a formal diversity policy will be a primary focus in the coming period and this is strongly encouraged by the Committee.

REMARKS AND RECOMMENDATIONS

The committee remarks that Diversity is a complex subject with at least three different dimensions: gender, ethnic, and national disadvantaged groups, among others. The University has a proactive strategy for gender but no specific strategy for other disadvantaged groups other than the disabled. TPM adheres to the general TU Delft strategy, with better results than average across engineering disciplines in terms of gender. This should not lead to complacency, however. Given TPM's focus on societal issues, it is doubly important for it to develop a broader diversity strategy. The multi-national origin of students and younger faculty members is high; but less so for senior faculty members. This is in part a generational problem common in many universities that will eventually change with recruitment and promotion of staff. The Committee recommends however that the Faculty considers "improved diversity" also as a research opportunity, given the focus of TPM on social problems viewed from multi stakeholder perspectives.

2.8 FACULTY'S EXTRA QUESTIONS

QUESTION 1: "THE CORE CONCEPT OF THE FACULTY: COMPREHENSIVE ENGINEERING AND ITS COMBINATION OF SYSTEMS, GOVERNANCE AND VALUES. MORE SPECIFICALLY, PLEASE COMMENT ON THE APPROPRIATENESS AND POTENTIAL EFFECTIVENESS OF THIS COMBINATION IN ADDRESSING THE GRAND CHALLENGES THAT FACE SOCIETY".

The committee noticed throughout all interviews that the ethos or culture of Comprehensive Engineering (CE) is pervasive throughout TPM. It is internalised by young faculty and increasingly acknowledged by other faculty as well. It also became apparent that CE was embodied through practice (some formal; most informal) rather than articulated as theory. Soft mechanisms in place that act to reinforce the CE culture are joint supervisions of PhDs, criteria for promotion, and the project orientation of the Faculty. The committee also sees a strong opportunity to articulate, and further develop, the concepts underpinning CE for a much wider (global) audience. This is already strongly supported within TU Delft, as articulated by the Rector of the University. Also, other universities are recognising the importance and building their own TPM-like programmes. The Committee does, however, see some potential risks. (1) CE does not obviously align with "Grand Challenges" language (versus "addressing real-world problems of great importance to society"); (2) If CE is not carefully managed or taken too far, single-investigator PI awards might undermine this ethos; and (3); the question arises whether the concept of CE is clear for international partners.

QUESTION 2: "TALENT RECRUITMENT IN LINE WITH THE COMPREHENSIVE ENGINEERING CONCEPT. MORE SPECIFICALLY, PLEASE PROVIDE RECOMMENDATIONS OF HOW THE DEPARTMENTS CAN BETTER ATTRACT TALENT WITH MULTI-DISCIPLINARY BACKGROUNDS THAT COMBINE THE TECHNICAL SCIENCES WITH SOCIAL SCIENCES AND/OR HUMANITIES, CITING EXAMPLES OF OTHER RELEVANT INTERNATIONAL APPROACHES IF POSSIBLE".

During the visit, the assessment committee inquired about the experience other Faculties at TU Delft have regarding applications for open positions. While the committee was not given exact numbers for understandable reasons of protecting information about specific hiring opportunities, the committee did learn that it is not unusual across the university to have 20 applications for an open position. The committee also learned that there is considerable variance around this number. A reasonable conclusion that can be derived from this is that the concept of comprehensive engineering and the mission of the Faculty of Technology, Policy and Management is not the sole reason for the difficulty the Faculty has had in attracting a large number of applicants.

Members of the assessment committee have been involved in searches for potential faculty members who would fit the spirit of TPM's comprehensive engineering; these members are aware of the difficulty in writing an advertisement that is open enough to capture a large number of candidates while also specific enough to attract candidates with the proper mix of strong disciplinary focus and multidisciplinary experience and attitude. The committee reviewed an announcement for a currently open position in TPM, concluded that the language was appropriate, and did not have any major suggestions for improvement.

One approach that two members of the assessment committee have used to find appropriate candidates for comprehensive engineering-related positions is an intentional effort to track promising PhD candidates and to look for colleagues who would be attracted to and benefit from working in the "ethos of comprehensive engineering" found at TPM. The scientific staff of TPM would need to feel empowered to always look for these potential applicants, even when

there is no active search underway. Conferences provide an opportunity to see PhD students present work and networking with colleagues to ask which of their advisees have high promise and would work well in the TPM are other tactics. At the institutions of some of the assessment committee members, the university or college host visits for “future faculty members” as a way to bring PhD students and Post-Doctoral Students to campus. Leveraging research or graduate seminars to bring colleagues to TU Delft is a model that has also worked at other institutions. Based on the committee’s experience, meeting the TPM staff and students in person and to be immersed in the ethos of comprehensive engineering for a short period of time by having potential candidates visit campus informally – well before they apply for a position – could help convince these potential candidates to apply for a position when one is open.

While these ideas are perhaps already employed by TPM, the committee hopes that including these ideas in the assessment report will help reinforce that these do work but also require conscientious effort if they are to succeed.

3. ASSESSMENTS OF INDIVIDUAL RESEARCH DEPARTMENTS

The Committee assessed the three research Departments of the Faculty of Technology, Policy and Management of Delft University of Technology. These are the Department level assessments:

<i>Research Department</i>	<i>Research quality</i>	<i>Relevance to society</i>	<i>Viability</i>
Engineering Systems and Services	1-2	1	2
Multi Actor Systems	1-2	1	2
Values, Technology and Innovation	1-2	1	2

Given the committee’s interpretation of the assessment criteria, the split ranking of 1-2 for research quality reflects that the research is very good across the department and is world leading in some areas.

The detailed assessment of each Department follows.

3.1 RESEARCH DEPARTMENT ENGINEERING SYSTEMS AND SERVICES (ESS)

Head of Department	Prof. dr. ir. Paulien Herder	
Research staff 2015	15.4 Research FTE (excluding PhD)	
Assessments	Research quality	1-2
	Relevance to society	1
	Viability	2

As mentioned in the self-assessment report, ESS focuses on the Engineering perspective.

The mission of the Department Engineering Systems and Services is to develop theories, methods, tools and insights that will improve the understanding of and ability to shape complex engineering systems and services. The department employs four interrelated perspectives, reflecting a system lifecycle.

The research programme is rooted in the idea that there is co-evolution between (i) bottom-up emerging technological innovations and user and system behaviours, and (ii) top-down mechanisms and institutions that attempt to anticipate and influence, in real-time, such innovations and behaviours. The department has structured its research programme, analogous to the four perspectives, into four research lines, overlaying their main application areas:

- A. Choice behaviour analysis
- B. Complex system behaviour analysis
- C. Complex system design
- D. Complex system evaluation

The department consists of the following research groups: Energy & Industry (E&I), Transport and Logistics (TLO) and Information and Communication Technology (ICT).

The research staff is composed of 10.4 FTE scientific staff, 5.0 FTE post-docs and 52 PhD-candidates (2015).

Table 4 shows the demonstrable research output of the Department of ESS.

	2010	2011	2012	2013	2014	2015
Refereed articles	95	79	94	96	107	116
Non-refereed articles	3	6	7	0	1	1
Books	1	6	2	0	1	1
Book chapters	23	15	22	26	23	12
PhD theses	6	10	9	9	13	13
Conference papers	142	146	103	87	64	69
Professional publications	27	25	19	9	14	12
Publications aimed at the general public	9	25	21	3	4	0
Other research output	41	39	71	40	32	42
TOTAL	347	351	348	270	259	266

Table 4: Total output of the Department of ESS

The composition of the research staff at level of ESS is found in Table 5.

	2010		2011		2012		2013		2014		2015	
	#	FTE										
Scientific staff	31	9.2	30	9.6	32	10.2	32	10.4	32	10.3	33	10.4
Post-docs	10	5.6	13	7.9	12	7.3	20	14.1	13	9.1	8	5.0
PhD-students	45		54		57		58		52		52	
Total research staff		14.8		17.6		17.5		24.5		19.4		15.4

Table 5: Staff embedded in the Department of ESS

The total funding of ESS is found in Table 6.

TOTAL	2010		2011		2012		2013		2014		2015	
	k€	%										
Direct funding ¹	2795	39	2902	39	2297	44	2297	35	2736	45	2841	46
Research funding ²	536	7	576	8	518	10	343	5	487	8	692	11
Contract research ³	3219	45	3074	42	2056	40	2382	37	2123	35	1295	21
Other ⁴	649	9	832	11	325	6	1469	23	758	12	1356	22
Total funding	k€ 7199		k€ 7385		k€ 5196		k€ 6490		k€ 6104		k€ 6184	

Table 6: Total funding at level of the Department of ESS. 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 research quality from the department of Engineering Systems and Services is very high; it also has high visibility. The committee notes that there is a consistent production of peer-refereed journal articles – usually around 100 per year. The quantitative data about the research publications and their impact reinforces the impression that this work is of high quality.

The five selected publications cited in the Faculty's self-assessment report all received high accolades (high citation rates, etc.). In particular, the work on random regret has opened a new avenue in choice modelling that is critical for engineering systems in many domains – especially transportation. This particular example is clearly world leading.

RELEVANCE TO SOCIETY

By definition, the projects undertaken by ESS have high societal importance; the rating of 1 for this assessment category is obvious.

The members of the ESS scientific staff, however, also are on many important committees. Many of the research projects discussed involve collaborations with public and private entities and the models and tools developed by ESS to address these high societal relevant problems have reached others outside of TU Delft to help guide their decision-making. Insights and suggestions provided by ESS researchers have also guided decisions that influence society.

As described elsewhere in this report, the focus of the Faculty of TPM on real-world problems of great importance to society suggested to the assessment committee that *societal impact* likely holds more importance to ESS than *relevance to society*. To that end, the assessment committee would like to recommend that ESS continue to extend their societal impact by continually demonstrating how the research products and outcomes directly influence important societal decisions. The committee sees high impact in the Netherlands and encourages ESS to extend their relevance and impact to the international level.

VIABILITY

The assessment committee feels that ESS has good leadership. During the visit, the committee observed the ESS leadership team's good communication and interaction with each other. The support from the leadership team of the scientific staff is also good. Based upon interactions with junior faculty, the committee saw that these members of the scientific staff also understand and participate in the ethos of comprehensive engineering. This indicates that these junior faculty members (associate and "tenure-trackers") provide a good base for continuing the research work in Engineering Systems and Services.

The department's base funding (from the first money stream) appears to be tight. The committee recognizes that this provides little or no opportunity for growth or additional support. As one example noted during the visit, if ESS wants

software produced by researchers to become regularly used tools by others outside of TPM as part of the department's strategy to have societal impact, keeping this software updated and supported will likely require additional support that does not exist currently.

The committee feels that the strategy of the department could use more clarity and targets that are more precise. The discussion in the self-assessment report and during the on-site visit indicate only that ESS seeks to continue doing "good work" and lists some specific tasks to pursue.

RECOMMENDATIONS

Overall, the committee believes the research from the Department of Engineering Systems and Services is good. The following recommendations echo some points made in the preceding discussion of ESS.

The committee recommends that ESS seek to extend their **societal impact** by demonstrating how the models and tools produced as well as insights and suggestions gained from the research efforts directly influence important societal decisions. ESS research work might be having this impact now; if so, the assessment committee recommends making this more visible to those outside of TPM. Similarly, some of the research projects in ESS have international components; the committee recommends that ESS seek to extend their international reach for societal impact. Finally, the committee believes that the department can strengthen its strategy moving forward by including more of a "we will be known for ..." perspective. If the department can agree upon and codify a few specific issues and approaches for which ESS wants TU Delft, national and international recognition, this will provide a strong rationale for the "good things" that the Faculty of ESS will do moving forward.

3.2 RESEARCH DEPARTMENT MULTI ACTOR SYSTEMS (MAS)

Head of Department	Prof. mr. dr. Hans de Bruijn	
Research staff 2015	22.5 Research FTE (excluding PhD)	
Assessments	Research quality	1-2
	Relevance to society	1
	Viability	2

As mentioned in the self-assessment report, research at the Multi-Actor Systems Department (MAS) deals with the governance component of comprehensive engineering.

The research mission of the MAS department is to contribute to smart governance in and of sociotechnical systems.

The research at MAS addresses the question of how decision-making, change and coordination of and in sociotechnical systems happen. These processes are (1) described empirically, (2) modelled and analysed, and (3) improved by the intervention arrangements that are designed, varying from IT-based system solutions to strategies for individual actors.

The core of the Department's research is comprised of the following elements:

- 1) From a strong empirical orientation: understanding of real-world decision-making processes in sociotechnical systems, with all of their interdependencies.
- 2) From a strong analytical orientation: the development of methods and techniques to support decision making.
- 3) From a strong model-based orientation: the tools to model the properties of systems and relationships between these properties for the purpose of design. Within each orientation, design solutions are a key focus, with models, algorithms, metrics, technology and tools to explore the emergent relationships.

The department consists of three research groups: Policy Analysis (PA), Policy, Organisation, Law and Gaming (POLG) and Systems Engineering (SE).

The research staff is composed of 11.8 FTE scientific staff, 10.7 FTE post-docs and 55 PhD-candidates (2015).

Table 7 shows the demonstrable research output of the Department of MAS.

	2010	2011	2012	2013	2014	2015
Refereed articles	76	51	66	65	71	60
Non-refereed articles	1	0	2	2	1	6
Books	9	8	6	4	3	3
Book chapters	44	31	21	32	31	18
PhD theses	5	6	5	6	4	6
Conference papers	124	120	99	78	73	52
Professional publications	40	23	32	28	15	11
Publications aimed at the general public	1	5	3	5	0	4
Other research output	56	69	56	27	33	35
TOTAL	356	313	290	247	231	195

Table 7: Total output of the Department of MAS

The composition of the research staff of MAS is found in Table 8.

	2010		2011		2012		2013		2014		2015	
	#	FTE										
Scientific staff	42	13.4	43	13.7	41	12.5	40	12.2	41	13.1	38	11.8
Post-docs	12	7.5	9	5.3	15	9.0	16	10.5	18	11.7	16	10.7
PhD-students	25		33		32		38		46		55	
Total research staff		20.9		19.0		21.5		22.7		24.9		22.5

Table 8: Staff embedded in the Department of MAS

The total funding of MAS is found in Table 9.

TOTAL	2010		2011		2012		2013		2014		2015	
	k€	%										
Direct funding ¹	3163	42	3566	46	2898	44	2898	39	3408	48	3435	41
Research funding ²	93	1	149	2	233	4	385	5	880	12	1473	17
Contract research ³	3169	42	3219	41	2660	40	2692	36	2460	35	2465	29
Other ⁴	1117	15	885	11	827	12	1542	21	308	4	1106	13
Total funding	k€ 7541		k€ 7819		k€ 6618		k€ 7517		k€ 7056		k€ 8479	

Table 9: Total funding at level of the Department of MAS. 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

MAS continues to produce high quality work of international standard. This quality is vouched for by the growth of research funding over the review period and the success of Faculty in winning highly competitive Dutch and international research funding competitions. Outputs are also of very high quality with a new focus on ISI journal articles over the review period bearing fruit in terms of quantity and percentage of publications. In addition, Faculty and research groups are involved in many consultations and provide advice to user groups on a regular basis. While there is clear excellence in these areas, some aspects of the governance theme have received less attention than others; such as questions about non-governmental actors and the role of Public Administration and Public Management in their assessment. Also, while many geographical and topical foci (e.g. Smart Cities in China) emerge bottom up; there is an opportunity to develop a more strategically-informed landscape of cases.

RELEVANCE TO SOCIETY

MAS engages in problem-centred research and its research programmes are of high relevance to society and government. This is attested to by the continual interactions of faculty with stakeholder groups, industry and governments and the prizes and recognition awarded to units such as Gaming and Simulation, Participatory Systems and Cyber Security. Exploratory modelling work on deep uncertainty is also at leading edge worldwide and of great interest to governments in many countries

VIABILITY

The programmes and courses offered by MAS are in high demand by students while there is also high demand for research results from user groups. Programmes, culture and practices, and leadership are excellent. Management is rightly concerned with recruitment and retention issues however as the number of applications for positions is low in absolute terms and senior faculty are often recruited by other institutions. In relative terms with other units at TU Delft, these problems are no worse than in many others, however steps should be taken to deal with them nonetheless.

There is also considerable tacit knowledge in the culture and practices of the Department, which if not codified and passed down, risks being lost due to generational replacement of experienced staff and senior leadership. Codification can also help with more transparency of practices and procedures around research and teaching. It would also be very helpful for better articulating the Department culture when hiring candidates and with new hires, and for guiding future priority setting and hiring.

RECOMMENDATIONS

Codification of tacit knowledge is needed and will help with hiring and retention and long-term growth. There is also an opportunity to develop a more coherent strategy around geographic distribution of case studies (e.g. smart cities).

There is also an opportunity to better identify/expand how currently excellent innovations in governance methods fit within more standard governmental (public administrative) tool kits.

Hiring issues could be improved by taking a 'targeted candidate' approach to hiring and development (for example, by identifying potential external candidates early; inviting them to spend time in the unit and learn about its culture, orientation and work).

3.3 RESEARCH DEPARTMENT VALUES, TECHNOLOGY AND INNOVATION (VTI)

Head of Department	Prof. dr. ir. Ibo van de Poel	
Research staff 2015	19.8 Research FTE (excluding PhD)	
Assessments	Research quality	1-2
	Relevance to society	1
	Viability	2

As mentioned in the self-assessment report, VTI focuses on the value dimension of comprehensive engineering.

The research mission of the VTI department is to contribute to responsible innovation by:

- (a) Identifying, analysing and increasing awareness of the value and responsibility dimensions of governance, engineering and technology from a sociotechnical systems perspective;
- (b) Studying the institutional design of large sociotechnical systems, innovation processes and systems, and the role of entrepreneurship in innovation with a focus on their value dimension, with the aim of identifying opportunities to make innovations and innovation processes more responsible.
- (c) Developing, applying and empirically testing theories, methodologies, methods, approaches, tools and conceptualisations for, or contributing to, responsible innovation.

The VTI department has three research themes: ‘Design for Values’, ‘Management of Responsible Innovation’ and ‘Responsible Risk Management’ and consists of three research groups that cut across the three themes: Economics of Technology & Innovation (ETI), Ethics & Philosophy of Technology (EPT), and Safety & Security Science (3S).

The research staff is composed of 13.6 FTE scientific staff, 6.2 FTE post-docs and 37 PhD-candidates (2015).

Table 10 shows the demonstrable research output of the Department of VTI.

	2010	2011	2012	2013	2014	2015
Refereed articles	73	73	76	78	69	83
Non-refereed articles	5	3	1	5	0	1
Books	7	4	2	2	3	8
Book chapters	43	31	45	40	69	58
PhD theses	10	7	2	4	6	2
Conference papers	87	66	56	41	37	25
Professional publications	25	41	20	18	23	21
Publications aimed at the general public	34	18	34	12	11	23
Other research output	107	112	178	112	98	102
TOTAL	391	355	414	312	316	323

Table 10: Total output of the Department of VTI

The composition of the research staff of VTI is found in Table 11.

	2010		2011		2012		2013		2014		2015	
	#	FTE										
Scientific staff	44	14.0	45	14.9	45	14.9	45	14.7	40	13.1	41	13.6
Post-docs	9	6.6	6	4.2	10	7.1	13	8.9	19	11.1	10	6.2
PhD-students	25		28		30		28		32		37	
Total research staff		20.7		19.0		22.0		23.6		24.3		19.8

Table 11: Staff embedded in the Department of VTI

The total funding of VTI is found in Table 12.

TOTAL	2010		2011		2012		2013		2014		2015	
	k€	%										
Direct funding ¹	3999	41	4131	48	3957	54	3957	49	3276	53	3322	51
Research funding ²	461	5	576	7	906	12	1337	17	1476	24	1171	18
Contract research ³	2944	30	2078	24	1796	25	1387	17	1383	22	1247	19
Other ⁴	2338	24	1884	22	657	9	1379	17	13	0	795	12
Total funding	k€ 9742		k€ 8669		k€ 7316		k€ 8061		k€ 7398		k€ 6535	

Table 12: Total funding at level of the Department of VTI. 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 sections of the department have (at least) very good quality in terms of scientific output. One of them, namely philosophy, satisfies the very stringent criteria for being classified as excellent, namely that they are world-leading in their field. In general, the number of refereed publications is high, even in areas such as philosophy in which this number is typically lower. There are joint publications with other parts of VTI and also with other faculties at Delft, showing that the department has excellent capacity to disseminate its comprehensive approach to engineering to other parts of TU Delft and beyond. Concepts such as Value Sensitive Design and Responsible Research and Innovation that were developed at VTI have become “trademarks” with worldwide recognition.

RELEVANCE TO SOCIETY

The department as a whole has excellent visibility to the public. It contributes to society not only through its research but also through participation in public debates, not least in pressing issues of new technology. The department is also deeply involved in providing policy advice. The department has many projects, including PhD projects, in common with industry. This is remarkable for disciplines that usually lack such industry involvement. These projects contribute to broadening industry's perspectives in ethical and societal issues in useful ways. However, most of these valuable outreach activities are based on individual initiatives by VTI members. A joint strategy for their continuation and further development would contribute to ensuring the future of this valuable work.

VIABILITY

The department as a whole (which was founded only in 2013) has very good viability. Internal cooperation is developing, and there is an excellent mix of applied research and research in more fundamental issues. The strong worldwide recognition of the concepts of Value Sensitive Design and the Responsible Research and Innovation makes VTI very attractive to PhD students and researchers from other parts of the world. The increased demand within TU Delft for service teaching is a great opportunity, provided that adequate funding is provided. However, if funding is inadequate, increased teaching tasks can lead to a regrettable decrease in the resources and time available for research. The committee also notes that funding is insufficient for a most desirable increase in the number of PhD students.

RECOMMENDATIONS

The notion of “comprehensive engineering” needs to be filled with substance, and its meaning should be further clarified. As part of this, the similarities and differences with other approaches such as Constructive Technology Assessment need to be made explicit. The philosophy section is eminently suited to take the lead in such work.

Diversity should be a major issue in the further development of this department. Due to its study area, this is not only important in terms of equality of opportunity but also in terms of the department's ability to understand society from different perspectives, an ability that is crucial for its research quality in the future.

APPENDIX A CURRICULA VITAE OF THE COMMITTEE MEMBERS

Professor Giovanni Azzone, Committee Chair, is Professor of Business Economics and Organisation at the Department of Economics, Management and Industrial Engineering at Politecnico di Milano, since 1994. He is Member of the Swiss Accreditation Council and of SIBAC-Seoul International Business Advisory Council and Project coordinator for the National Program on Risk Prevention of the Italian Presidency “Casa Italia”. He was Rector of Politecnico di Milano from 2010 to 2016. During such period he was President of T.I.M.E. Network (2013-2015), President of Alliance 4 Tech (2016) and Member of the Heads Board of Idea League (2016), three of the most important strategic partnerships between European Technical Universities. He was also Member of the Board of École Centrale Paris (2012-14), Vice President of the National Committee for the Evaluation of Universities (Comitato Nazionale per la Valutazione del Sistema Universitario) of the Ministero dell’Istruzione, Università e Ricerca (2004-2010). He is author of 10 research books and more than 60 refereed articles, in the fields of technology valuation, sustainable strategies and performance measurement and management of complex organisations.

Professor Kay Auxhausen is Professor of Transport Planning at the Eidgenössische Technische Hochschule (ETH) Zürich (Swiss Federal Institute of Technology) since 1999. He holds his post in the Institute for Transport Planning and Systems of the Department of Civil, Environmental and Geomatic Engineering. Before his appointment at ETH he worked at the Leopold-Franzens Universität, Innsbruck, Imperial College London and the University of Oxford. He holds a PhD in Civil Engineering from the Universität Karlsruhe (now KIT) and an MSc from the University of Wisconsin – Madison. He has been involved in the measurement and modelling of travel behaviour for the past 35 years contributing especially to the literature on stated preferences, micro-simulation of travel behaviour, valuation of travel time and its components, parking behaviour, accessibility impacts and travel behaviour measurement. One strand

of his current work focuses on the micro-simulation of daily travel behaviour and long-term mobility choices. This work is supported by analyses of mobility tool ownership on the one hand and their dependence between activity spaces and the traveller's personal social network on the other hand. The second strand of his work is dedicated to the evaluation of transport projects. He led the effort for the new Swiss cost-benefits guideline (SN 640 820ff) and of the recent German value of time study. Current work is on the one hand testing the possibility to replace complex models by simpler direct demand models and on the other hand tracing the long term implications of accessibility by modelling its change over the centuries. He was the chair of the International Association of Travel Behaviour Research (IATBR) and is editor-in-chief of *Transportation* and earlier of *DISp*, both ISI indexed journals.

Dr. Jason Blackstock, Senior Lecturer in Science and Global Affairs, University College London (UCL), UK. With a unique background spanning research physics, Silicon Valley technology development, public policy, and global governance, Dr Jason Blackstock is an internationally respected scholar, educator and policy adviser on the interface between science and public decision-making. Dr Blackstock joined University College London in 2013 to help establish the globally unique Department of Science, Technology, Engineering and Public Policy (UCL STEaPP). As Head of this innovative new department, Dr Blackstock is leading the strategic development of STEaPP's rapidly expanding research, education and policy engagement programmes, all aimed at delivering on STEaPP's socially-oriented mission to explore, experiment with, and improve the mobilisation of scientific and engineering knowledge in support of better public decision-making around the World. Prior to joining UCL, Dr Blackstock taught and directed policy-engaged research at leading universities and think tanks, including Harvard, Oxford, the Centre for International Governance Innovation (Canada), and the International Institute for Applied Systems Analysis (Austria). For the past seven years, Dr Blackstock's scholarly and policy work has focused on the complex interactions between the scientific, political and global governance dimensions of our planetary climate and energy challenges. He has co-authored 10 patents and over 40 publications; given dozens of invited policy briefings and academic presentations across six continents; organised numerous

international academic and policy conferences; and participated in or led five policy-oriented international science assessments. In 2010 Dr Blackstock was elected an Associate Fellow of the World Academy of Art and Science. Dr Blackstock obtained his BA in English Literature (Queen's, 2000) and his Masters and PhD in physics (Edinburgh, 2001; Alberta, 2005), followed by a Graduate Certificate in International Security (Stanford, 2006) and Master of Public Administration (Harvard, 2008). From 2003 to 2007, Dr Blackstock worked as a Research Associate of Hewlett Packard Lab's Quantum Science Research Group. In addition to his UCL position, Dr Blackstock is an Adjunct Associate Professor of the School of Environment, Enterprise and Development (SEED) at the University of Waterloo.

Professor William (Bill) Crossley is a professor of Aeronautics and Astronautics at Purdue University, where he has been a faculty member since 1995. His teaching and research interests are in design optimization for aerospace systems and for system-of-system design problems. Bill is an author of over 150 peer-reviewed journal and conference papers and has been the major advisor for 43 MS and Ph.D. theses. Bill received the School of Aeronautics and Astronautics' Elmer Bruhn Teaching Award in 2000, 2003, 2006, 2009 and 2012 and the W. A. Gustafson Award in 1998, 1999, and 2001; the Engineering Professional Education Distance Teaching Award in 2008; and the College of Engineering A.A. Potter Best of Engineering Teaching Award in 2007. He was inducted into the Purdue University Book of Great Teachers in 2013 and received the 2016 College of Engineering's Leadership Award. Bill is an Associate Fellow of the American Institute of Aeronautics and Astronautics and a past Chair of the Aircraft Design Technical Committee. He is currently Past-Chair of the Council of Engineering Systems Universities. He is a Member of the International Council on Systems Engineering, the Institute for Operations Research and Management Science, and the International Society for Structural and Multidisciplinary Optimization. Prof. Crossley initiated the System of Systems Signature Area in Engineering at Purdue, and he is part of the Purdue Systems Collaboratory leadership team. Bill is the director of PEGASAS (Partnership to Enhance General Aviation Safety, Accessibility and Sustainability), the FAA's Center of Excellence for General Aviation.

Professor Armin Grunwald currently is a full professor of Philosophy and Ethics of Technology at KIT (Karlsruhe Institute of Technology). He received his PhD in Philosophy at the Marburg University in 1998. He has been serving as a Director of the Office of Technology Assessment at the German Bundestag (TAB), Berlin, since 2002. Since 1999, he has been Director of the Institute for Technology Assessment and Systems Analysis (ITAS) at KIT. Armin is Member of the National Academy of Engineering Sciences since 2010; since 2014 member of its executive board. He also was Guest Professor, Klagenfurt University, Austria, in 2011 and Member of MASIS Expert Group on the 'Science in Society' Programme (EC) 2008/2009. He served as Chair of the International Advisory Board of the Programme "Responsible Innovation" of Netherlands Science Foundation 2008 – 2010, in 2012 and in 2016. He was Chair of the Scientific Advisory Board of the Institute of Technology Assessment at the Austrian Academy of Sciences 2008 - 2012. Armin also was Member of the Science Committee of Future Earth International 2014 – 2016.

Professor Sven Ove Hansson is professor in philosophy at the Department of Philosophy and History, Royal Institute of Technology, Stockholm. He is editor-in-chief of *Theoria* and of the two book series *Philosophy, Technology and Society* (Rowman & Littlefield International) and *Outstanding Contributions to Logic* (Springer). He is member of the editorial boards of the journals *Synthese*, *Philosophy & Technology*, *Studia Logica*, and *Journal of Philosophical Logic*, and area editor of the book series *Logic, Argumentation & Reasoning*. His research areas include philosophy of science and technology, fundamental and applied moral theory, value theory, epistemology, and logic. He is the author of well over 300 articles in international refereed journals. His most recent books are *The Ethics of Risk* (Palgrave Macmillan 2013), *Norms in Technology* (Springer 2013, edited with Marc J. de Vries and Anthonie W.M. Meijers), *Social and Ethical Aspects of Radiation Risk Management* (Elsevier 2013, co-edited with Deborah Oughton), *The Role of Technology in Science: Philosophical Perspectives* (Springer 2015, edited) and *The Argumentative Turn in Policy Analysis. Reasoning about Uncertainty* (2016, co-edited with Gertrude Hirsch-Hadorn). He is member of the

Royal Swedish Academy of Engineering Sciences (IVA) and Past President of the Society for Philosophy and Technology.

Professor Michael Howlett, is Burnaby Mountain Chair in the Department of Political Science at Simon Fraser University and Yong Pung How Chair Professor in the Lee Kuan Yew School of Public Policy at the National University of Singapore. He specializes in public policy analysis, political economy, and resource and environmental policy. Professor Howlett taught at Queen's University (1986-1988) and the University of Victoria (1988-1989) before coming to SFU and was Visiting Professor at the Lee Kuan Yew School of Public Policy of the National University of Singapore (2009-2010 and 2013-2017) and the Università degli studi di Cagliari (2012). Dr. Howlett was founding member and Secretary-Treasurer (1995-2006) of the British Columbia Political Studies Association and co-editor of its Proceedings. He was editor of the POLCAN listserv (1995-1997) and currently edits the CAN-POL Maillist (2008-present). He was also English language co-editor of the Canadian Journal of Political Science (2002-2006), co-editor of the World Political Science Review (2003-2014), Associate Editor of the Journal of Natural Resources Policy Research, (2011-2013) and administrative editor of the Canadian Political Science Review (2007-2010). He is currently organiser of the Policy Design Lab and editor of the Annual Review of Policy Design and Policy Sciences, and is co-editor of the Journal of Comparative Policy Analysis (Book Review Editor 2001-2006), Policy & Society, the University of Toronto Press Series in Comparative Political Economy and Public Policy, the Policy Press International Library of Policy Analysis, Cambridge Studies in Comparative Public Policy and Cambridge Elements of Public Policy. He is the current chair of Research Committee 30 (Comparative Public Policy) of the International Political Science Association and sits on the organising committee of the International Conference on Public Policy.

APPENDIX B SITE VISIT PROGRAMME

Tuesday March 28th, 2017

Time	Activity	Participants
17.30 – 18.30	Welcome reception	Committee+ <ul style="list-style-type: none"> • Prof. ir. Karel Luyben, Rector Magnificus DUT • Prof.dr. Theun Baller • Prof.mr.dr. Hans de Bruijn • Prof.dr.ir. Ibo van de Poel • Prof.dr.ir. Paulien Herder • Dr. Martijn Blaauw
18.30 - 20.00	Dinner	Committee (private)
20.00 - 21.00	Formal committee kick-off	Committee (private)

Wednesday March 29th, 2017

Time	Activity	Participants
9.00 - 12.00	Preparation of interviews	Committee (private)
12.15 - 12.45	Interview Executive Board, Delft University of Technology	<ul style="list-style-type: none"> • Prof.ir. Karel Luyben • Prof.dr.Theun Baller
13.00 - 13.30	Lunch	Committee (private)
13.45 - 14.30	Interview Management Team TPM	<ul style="list-style-type: none"> • Prof.dr. Theun Baller • Prof.dr.ir. Paulien Herder • Prof.mr.dr. Hans de Bruijn • Prof.dr.ir. Ibo van de Poel • Dr. Martijn Blaauw • Olivie Beek • Hans Jager

14.45 - 15.30	Interview MT Engineering Systems and Services (ESS)	<ul style="list-style-type: none"> • Prof.dr.ir. Paulien Herder • Prof.dr.ir. Caspar Chorus • Prof.dr.ir. Marijn Janssen • Dr.ir. Zofia Lukszo • Drs. Jolien Ubacht
15.45 - 16.45	Interview invited tenured staff ESS	<ul style="list-style-type: none"> • Dr. Amineh Ghorbani • Dr.ir. Emile Chappin • Dr.ir. Mark de Reuver • Dr. Jafar Rezaei
17.00 - 18.00	Discussing and writing preliminary judgments	Committee (private)
19.00-21.00	Working dinner	Committee (private)

Thursday March 30th, 2017

Time	Activity	Participants
9.00 - 9.45	Interview MT Multi-Actor Systems (MAS)	<ul style="list-style-type: none"> • Prof.mr.dr. Hans de Bruijn • Prof.dr. Frances Brazier • Dr.ing. Bram Klievink • Prof.dr. Bartel van de Walle • Dr. Leslie Zachariah
10.00 - 11.15	Interview invited tenured staff MAS + Lab Tour	<ul style="list-style-type: none"> • Prof.dr. Michel van Eeten • Dr. Heide Lukosch • Dr.ir. Jan Kwakkel • Prof.dr. Martin de Jong • Dr. Martijn Warnier <p>Lab tour</p> <ul style="list-style-type: none"> • Prof.dr.ir. Alexander Verbraeck
11.30 - 13.00	Interview invited TPM tenure track researchers	<ul style="list-style-type: none"> • Dr.ir. Sander van Cranenburgh • Dr. Helle Hansen • Dr. Hadi Asghari • Dr. Yilin Huang • Dr. Filippo Santoni de Sio • Dr.ir. Wolter Pieters

13.15 - 14.15	Lunch with invited TPM PhD candidates	<ul style="list-style-type: none"> • Yashar Araghi • Clara Maathuis • Esther Park Lee • Samaneh Tajalizadehkhoob • Sharlene Gomes • Selma Causevic • Jonas Feltes • Christine Milchram • Yamin Huang • Rolf van Wegberg (president of the Dutch National PhD Network (PNN))
14.15 - 15.00	Interview MT Values Technology and Innovation (VTI)	<ul style="list-style-type: none"> • Prof.dr.ir. Ibo van de Poel • Prof.dr. Sabine Roeser • Prof.dr.ir. Pieter van Gelder • Prof.dr. Cees van Beers
15.15 - 16.15	Interview invited tenured staff VTI	<ul style="list-style-type: none"> • Prof.dr. Jeroen van den Hoven • Prof.dr. Genserik Reniers • Prof.dr. Rolf Künneke • Dr.mr.ir. Neelke Doorn
16.30 - 17.00	Interview TPM Graduate School (GS) Board	<ul style="list-style-type: none"> • Prof.dr. Michel van Eeten • Dr. Leslie Zachariah • Janine Drevijn • Dr.ir. Leon Hermans • Dr.ir. Behnam Taebi • Dr.ir. Maarten Kroesen • Binod Koirala MSc • Olivie Beek
17.15 - 17.45	Interview Scientific Integrity	<ul style="list-style-type: none"> • Prof.dr. Theun Baller • Dr. Martijn Blaauw • Prof.dr. Catholijn Jonker (Scientific Integrity Council, TU Delft)
19.00-21.00	Working dinner	Committee (private)

Friday March 31th, 2017

Time	Activity	Participants
9.00 - 10.00	Summarising findings and first conclusions	Committee (private)
10.00 - 10.30	Concluding meeting with Management Team TPM	<ul style="list-style-type: none"> • Prof.dr. Theun Baller • Prof.dr.ir. Paulien Herder • Prof.mr.dr. Hans de Bruijn • Prof.dr.ir. Ibo van de Poel • Dr. Martijn Blaauw
10.30 - 11.30	Writing preliminary judgements	Committee (private)
11.30 - 12.00	Presentation of first impressions by the committee chair	All faculty members invited
12.00 - 12.30	Refreshments	All faculty members invited
12.30 -14.30	Farewell lunch	Committee and TPM Management Team

Between each interview, time is reserved for a *wrap up* by the Committee. To improve the readability, this activity is omitted from the table.

APPENDIX C EXPLANATION OF THE SEP SCORES

	Meaning	Research quality	Relevance to Society	Viability
1	<i>World leading/ excellent</i>	<i>The research unit has been shown to be one of the few most influential research groups in the world in its particular field.</i>	<i>The research unit makes an outstanding contribution to society.</i>	<i>The research unit is excellently equipped for the future.</i>
2	<i>Very good</i>	<i>The research unit conducts very good, internationally recognised research.</i>	<i>The research unit makes a very good contribution to society.</i>	<i>The research unit is very well equipped for the future.</i>
3	<i>Good</i>	<i>The research unit conducts good research.</i>	<i>The research unit makes a good contribution to society.</i>	<i>The research unit makes responsible strategic decisions and is therefore well equipped for the future.</i>
4	<i>Unsatisfactory</i>	<i>The research unit does not achieve satisfactory results in its field.</i>	<i>The research unit does not make a satisfactory contribution to society.</i>	<i>The research unit is not adequately equipped for the future.</i>

Quality is seen as the contribution that research makes to the body of scientific knowledge. The scale of the unit's research results (scientific publications, instruments and infrastructure developed by the unit, and other contributions to science) are also assessed.

Relevance to society is seen as the quality, scale and relevance of contributions targeting specific economic, social or cultural target groups, of advisory reports for policy, of contributions to public debates, and so on. The point is to assess contributions in areas that the research unit has itself designated as target areas.

Viability is seen as the strategy that the research unit intends to pursue in the years ahead and the extent to which it is capable of meeting its targets in research and society during this period. It also considers the governance and leadership skills of the research unit's management.

The categories in this SEP and the descriptions differ from the scores in prior SEPs and are therefore not comparable.



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