Committee Assessment Report
Mid-Term Research Assessment
Applied Mathematics (DAMUT)
2015-2018

Twente University

April 2019

Preface

The importance of mathematics for society has always been significant. In today's digital society, mathematics has even become indispensable. It is therefore of the utmost importance that the highest level of mathematical research is conducted at Dutch universities. The Department of Applied Mathematics of the University of Twente (DAMUT) plays an important role as a driver of applied mathematics, which often finds its inspiration in modern digital applications. For DAMUT's Mid-Term research evaluation, we happily accepted the role of committee members, in order to gain a better insight into the research that is currently taking place in Twente. Frank den Hollander, Sjoerd Verduyn Lunel and myself — forming the evaluation committee — enjoyed becoming aware of the latest developments in DAMUT.

DAMUT is a very interesting department, with multiple possibilities for the future. We have read and heard about new developments, new opportunities and new challenges, but we have also heard some concerns. We will address these concerns in this evaluation report as well.

The Mid-Term research visitation took place on February 27, 2019. We thank all the discussion partners for their input and for their open attitude. Particularly, we thank professor Stephan van Gils and his team for the preparation of the documents and the ensuing contacts.

On behalf of the evaluation committee,

Kees Oosterlee

Procedure

The Department of Applied Mathematics of the University of Twente (DAMUT) is one of the three departments of the Faculty of Electrical Engineering, Mathematics and Computer Science (EEMCS). Within the department, six research groups ('vakgroepen') are organized into two research clusters: Systems, Analysis and Computational Science (SACS) and Mathematics of Operations Research (MOR). Heads of department in the evaluation period were prof. Richard Boucherie (2013-2016) and prof. Stephan van Gils (2016-2019). Vice Dean Research of the faculty is prof. Vanessa Evers.

Every third year a research evaluation takes place at Dutch universities, in which research lines, progress in research and organizational issues are addressed. Half of these are Mid-Term evaluations. The present DAMUT research Mid-Term evaluation took place on February 27, 2019, and was based on the self-evaluation report 2015-2018, which was delivered at the end of January 2019. The evaluation committee spoke with the Vice Dean Research, with the research directors of the two research clusters SACS and MOR, with tenure-track and junior staff members, as well as with a selection of PhD students. Prior to the visitation, skype interviews with tenure-track and junior staff who could not be present on February 27, 2019, took place.

In 2015, the research volume of the scientific staff amounted to 12 fte (with 30 fte scientific staff). See Figure 1. Approximately 40 PhD students, financed through external funding, are targeted, but currently the number is 31. Next to regular PhD students, there were also quite a few PhDs who were employed elsewhere (FOM, hospitals, etc.), but have a UT promotor. Due to vacancies, the number of fte scientific staff went down from 30 in 2015 to 27 in 2017, but at the end of 2018 most vacancies were filled, resulting in 30 fte scientific staff ultimo 2018. The current age structure in DAMUT is presented in Figure 2.

The self-evaluation report sketched many positive developments within DAMUT during the review period, but also raised some concerns. During the interviews with the management and the scientific staff, the evaluation committee discussed both. The written assessment and recommendation report is a result of the information obtained by the committee from the self-evaluation report and the interviews.

Assessment

During the review period, DAMUT's research was organized into two clusters of chairs: SACS (Systems, Analysis and Computational Science) and MOR (Mathematics of Operations Research). The SACS cluster combines the chairs of applied analysis (van Gils), hybrid systems (Zwart), mathematics of computational science (van der Vegt) and multiscale modelling & simulation (Geurts). The MOR cluster combines the chairs of discrete mathematics and mathematical programming (Uetz) and stochastic operations research (Boucherie). From the end of the review period (December 2018), the MOR

cluster also includes the new chair in Statistics (Schmidt-Hieber). The six group leaders report directly to the Dean.

Unique profile

The mission of DAMUT is to develop state-of-the-art research in computational science and operations research, and to address applications of societal and technological relevance. DAMUT has a unique profile, with sophisticated applied mathematics research being conducted directly within the application areas. The research work forms an excellent example of multi-disciplinarity, with many cooperations outside of mathematics. The ability to connect applied mathematics research to societal relevant themes, such as energy, health, neuroscience, seismics and traffic — supported through an impressive volume of funding via the second and third money streams, and through a strong network of collaborative research institutes, industries and healthcare organizations — is fascinating.

At the level of the university, there are three research institutes in which DAMUT is actively involved: DSI for ICT-related research, MESA+ for nanotechnology, and TechMed for biomedical technology and technical medicine. To facilitate operations research solutions in healthcare, prof. Boucherie co-founded the Center for Healthcare Operations Improvement and Research (CHOIR) in 2008. To further develop this research for society, the spin-off Rhythm B.V was co-founded, with currently 15 employees (a further spin-off in this direction is foreseen). These spin-off activities are impressive and unique in applied mathematics. DAMUT is an active department with impressive numbers of scientific publications in good quality journals.

As a result of the DAMUT strategy, PhD students have many contact points, and there is good funding for research travels to conferences and workshops. Next to collaborative projects in various application domains, the department conducts fundamental research on the foundations of computational science and mathematics of operations research. Naturally, it is the applied mathematics focus that connects the people in the department.

New personnel

In the national context, the department is active in three of the four Dutch Mathematics Clusters: DIAMANT, NDNS+ and STAR. The Department invests significantly in young mathematical talent. Since 2015 five new members have been appointed. The gender balance within DAMUT has improved during the evaluation period. The selection of new candidates aligns with the department's profile, as well as with the national research agenda "Sector Plan" in mathematics. It was mentioned that new tenure-track personnel will receive one PhD position in their starting package, which is highly appreciated. Young staff members are coached in grant proposal writing. Although this has lead to highly ranked proposals, no personal grants were funded during the review period. Not only tenure trackers, but also junior UDs, get a reduction of their teaching load to

facilitate grant writing. These measures should make DAMUT an attractive place for talented young staff members.

Collaboration, data science

The department strives for a closer collaboration with the computer science department. As an example, during the review period data science became much more visible within the faculty, and DAMUT is actively involved in this initiative. DAMUT invested in the new chair in statistics, who will be important for the data science connection and will help to strengthen ties between the different research lines. DAMUT aims for strength in data science, which is strongly supported by the evaluation committee. In the cooperation with computer science, the department has furthermore taken the lead in establishing a research group on smart energy systems, especially on decentralized energy management. At the 4TU level, the group is involved in a broader cooperation of smart-grid related researchers and Netbeheer Nederland. The UT research group has initiated a yearly international workshop `Energy Open', which rotates between the four TUs.

The evaluation committee sees that the availability of large data sets offers new possibilities for the research within DAMUT. Data driven science enables new challenges in inverse problems, uncertainty quantification, model order reduction and dynamical systems, all core topics in the research agenda of DAMUT. Connecting data driven science with the strong research potential in dynamical systems, scientific computing and mathematical systems theory at DAMUT will lead to modern and advanced research. In the MOR cluster the research is traditionally built on data. However, in the value chain "Data, Model, Decisions", the focus will shift towards data aspects and deep learning. The trend will therefore also be on data-driven methods in optimal decision making. The department is in an excellent position to embrace upcoming themes of societal relevance, such as accountability and reliability of mathematical methods, e.g. through uncertainty quantification, algorithms and optimization under uncertainty.

Previous research assessment

The 2015 Research Assessment Committee formulated a number of recommendations:

The department was recommended to continue its path of rejuvenation of staff in both programs and make sure that the hiring of young researchers is consistent with its strategy.

Junior new members in the department were hired in several DAMUT groups, e.g. in numerical mathematics, theoretical foundations of optimization problems connected to smart grids, algorithmic game theory, as well as in healthcare logistics. There are currently job openings in optimization and learning, as well as in statistics (junior level).

The pressure on senior researchers with respect to the high teaching load should be reduced.

Apart from junior staff members, both permanent and temporary, the department attracted teaching staff. The research time of the staff was reviewed, in order to reduce the pressure. This process is ongoing.

The strong interdisciplinary cooperation in areas of major societal relevance should be continued. This recommendation has already been addressed in detail earlier in this report.

With the activities in smart grids DAMUT will be involved in the Top-Sector `Energy'. The cooperation with computer science has lead to the establishment of a research group on smart energy systems. Next to 32 research publications, this has led to the energy management concept TRIANA and an underlying steering mechanism called `profile steering'. In 2018, a team of researchers from this cooperation (UT, TUD and TU/e), in cooperation with researchers from RUG and CWI, has submitted a Zwaartekracht proposal `Digital Energy', where Hurink is one of the Co-PIs. Within the University of Twente, the topic `Sustainability' is chosen as one of the main research areas for the upcoming years. The department is involved in this development at the central level via Hurink, who has become a member of the core team Energy Transition@UT.

A further recommendation was that the university leaders should consider establishing a Project Development Office (PDO) similar to TU Eindhoven, or as a joint activity in 4TU.AMI. The department and the faculty have taken measures to professionalize the development and support of new research projects. Prof. Litvak coordinates the development of personal grants (Veni-Vidi and ERC) within the faculty. In addition, the faculty attracted professional support for the preparation of proposals and consortia. Further steps towards a PDO are being developed at the UT level.

Recommendations

In terms of a SWOT-analysis, the evaluation committee sees the following opportunities for DAMUT:

International aspect

Use the DAMUT research strength to show international leadership and to become more visible in Europe. Basically, there is only one section in the report on the cooperation of DAMUT with China. "Who are we in the larger world?" is a relevant question for the next research evaluation. We recommend to prioritize and become more pro-active in acquiring EU research funding, like in the Marie Curie calls. There are calls where excellence in industrial cooperation is highly beneficial, like the European Industrial Doctorate (EID) program, where DAMUT should have excellent chances. There should further be opportunities within the Dutch-German region to build consortia. Inter-regional networks, like those with

German universities, could be very helpful in establishing such a funding focus. Funding from Europe may give extra flexibility. Long-term international visitors will strengthen the international focus and the collaboration with international networks. International funding will further increase the international visibility of DAMUT, and may give rise to scientific and funding resilience. Inviting top foreign researchers, for example, to spend their sabbatical leave at DAMUT, is a suggestion in this direction. Such a stay should be very interesting for international staff, given the presence of young and talented research staff at DAMUT.

Funding aspects

The active cooperations that were mentioned earlier under DAMUT's successes are excellent and important. However, they are demanding for the personnel, and sometimes also for the PhD students. Moreover, the teaching load for senior staff is still substantial and competes with their research activities, in particular, with grant writing and establishing new research collaborations. Success with individual grants has been modest for DAMUT, which is mentioned in the SWOT-analysis in the self-evaluation report. At the same time, there is considerable success and funding within NWO-Shell, STW and other calls, in which applied mathematics offers important support for applications, such as healthcare logistics and power networks. DAMUT should be proud of these achievements!

From the interviews it became clear that obtaining an individual research grant is very beneficial for the research career in DAMUT. Also the Vice Dean Research explained that the Executive Board places emphasis on securing personal grants. This is even included in job profiles and is a condition for promotion. The evaluation committee's advice is to embrace all funding opportunities and successes equally in the assessment of research staff!

The department should try to match excellently rated proposals that were not funded with a PhD student and more generally should compensate the substantial teaching load of some of the staff with more `eerste geldstroom' PhD students. It was mentioned that, instead, it is common practice to support such proposals with a post-doctoral position. However, for young staff supervising a PhD researcher is probably more rewarding (for their CV and to show their supervision qualities). There are opportunities for PDEng within EEMCS, which are positions funded by the industry for 2 years. These form an extension of the MSc studies. Upon successful completion of this period, the faculty is prepared to upscale the PDEng position to a PhD position, which would then only last 2 years. The committee is enthusiastic about this procedure. This may also provide opportunities for young staff to supervise a PhD student and to act as a co-supervisor. Nowadays, the supervision of PhD students is a requirement for obtaining personal grants.

Connection with computer science

The connection between DAMUT and computer science was, for the evaluation committee, a topic of specific interest, especially because DAMUT will focus more

on data science and neural networks research in the near future. We recommend to work this connection out in a `data science & big data plan'. The committee considers it important to invest more time in developing such a plan, in order to sharpen the department's mission, vision and objectives. This is particularly crucial for the development of common themes in the data sciences cluster together with computer science.

The committee advises DAMUT to consider recruiting a top senior scientist in one of the areas of data science. This would further strengthen the connection with computer science. Within SACS a difference in age between the current chair holders and the new generation of researchers is noticed. A senior top scientist may help to bridge the difference in age, which may be particularly beneficial for future contacts to the Dean and the Rector.

DAMUT's organizational structure

The self-evaluation report mentions that the recent developments in data science will have a major impact on future research agendas of both the SACS and the MOR clusters. The corresponding plans were sketched in the respective roadmaps of SACS and MOR, where the committee noticed a considerable overlap. As far as cohesion within different groups is concerned, the new staff appears to cross cluster borders easily, and to discuss and cooperate with each other whenever suitable.
According to the committee, the organizational structure of the institute could be simplified. With data sciences as an overarching theme, it is advised to grow towards a single institute, which communicates with the Dean as a whole rather than as seven chairs. One aim could be to develop a single roadmap for all of DAMUT, instead of roadmaps for the two clusters. From the discussions during the interviews the committee got the impression that this recommendation received a positive feedback from the two clusters.

This concludes the evaluation report of the 2015-2018 research activities. In summary, it is clear that DAMUT can be proud of its past and present achievements. The recommendations and opportunities for DAMUT described above may inspire the department to further strengthen its activities.

CV's

Prof. dr. ir. **Cornelis W. Oosterlee** is part-time full professor at Delft University of Technology in Applied Numerical Mathematics. He is also senior scientist at CWI – Centrum Wiskunde & Informatica — and member of the management team. Currently, he is Chair of the Dutch-Flemish Society for Computational Sciences (SCS), which has 400 members. He has been coordinator of various EU Marie Curie projects. His research focus is on developing novel, robust and efficient algorithms, with a particular interest in computational finance. He has written two textbooks and 140 research articles.

Prof. dr. **Sjoerd Verduyn Lunel** is full professor at Utrecht University in Applied Analysis. He was the head of both the Mathematical Institute and the Leiden Institute of Advanced Computer Science at Leiden University, Dean of the Faculty of Science at Leiden University, and Scientific Director of the Mathematical Institute at Utrecht University. Currently, he is Chair of the National Platform for Mathematics in the Netherlands (PWN) and Secretary of the European Mathematical Society. His research interests are in delay differential equations and applications at the interface of operator theory and dynamical systems theory. Applications include control theory to stabilize delay equations and perturbation theory for differential delay equations. He is co-author of two influential books on differential delay equations, and 90 research articles.

Prof. dr. **Frank den Hollander** is full professor at Leiden University in Probability Theory. He was Scientific Director of EURANDOM in Eindhoven, and has served in many national and international advisory roles. He is member of KNAW — Royal Netherlands Academy of Sciences — where currently he is Chair of the Advisory Council for the Natural Sciences. His research lies at the interface of probability theory with statistical physics, population genetics and complex networks, with a focus on disordered systems and phase transitions. He is the author of three monographs and 170 research articles,

and co-PI of the Zwaartekracht-project NETWORKS.

Appendix

In this appendix we collect some figures regarding the research staff, the corresponding fte's, the current age structure of the DAMUT personnel, the background of the DAMUT PhD students, the activities alongside the core research of the DAMUT personnel, and the acquired research funds during the evaluation period. Also the agenda for the research evaluation day on 27/02/2019 is attached.

Research Staff and FTE

Total	2015		2016		2017	
	#	FTE	#	FTE	#	FTE
Scientific staff	30	10,41	28	9,56	27	9,38
Researchers (incl.postdoc)	6	2,42	10	3,00	12	5,51
PhD candidates (employed)	25	16,05	21	12,77	18	10,45
PhD candidates (not employed)	28		27		22	
Visiting fellows (> 3 months)						
Total res. Staff	**89**	**28,88**	**86**	**25,33**	**79**	**25,34**

MOR	2015		2016		2017	
	#	FTE	#	FTE	#	FTE
Scientific staff	16	5,64	15	4,97	14	4,75
Researchers (incl.postdoc)	2	0,15	3	0,37	4	1,95
PhD candidates (employed)	13	8,68	12	7,40	12	6,63
PhD candidates (not employed)	15		16		12	
Visiting fellows (> 3 months)					0	
Total res. Staff	**46**	**14,48**	**46**	**12,74**	**42**	**13,34**

SACS	2015		2016		2017	
	#	FTE	#	FTE	#	FTE
Scientific staff	14	4,77	13	4,59	13	4,62
Researchers (incl.postdoc)	4	2,27	7	2,62	8	3,56
PhD candidates (employed)	12	7,37	9	5,37	6	3,81
PhD candidates (not employed)	13		11		10	
Visiting fellows (> 3 months)						
Total res. Staff	**43**	**14,40**	**40**	**12,59**	**37**	**12,00**

= not registered

Figure 1: DAMUT's research staff and corresponding fte numbers.

age structure DAMUT

	HL		UHD		UD		TT		Totaal	
Leeftijd	#	FTE	#	FTE	#	FTE	#	FTE	#	FTE
21-30	0	0	0	0	0	0	0	0	**0**	**0**
31-40	1	1	0	0	5	5	3	3	**9**	**9**
41-50	2	2	1	1	3	3	0	0	**6**	**6**
51-60	7	5,42	1	0,21	2	1,11	0	0	**10**	**6,74**
61-67	4	3,21	2	1,39	1	1	0	0	**7**	**5,6**
Totaal	**14**	**11,63**	**4**	**2,6**	**11**	**10,11**	**3**	**3**	**32**	**27,34**

Figure 2: Current age structure within DAMUT.

MSc background of current PhD students at DAMUT

		2019
MOR PhD	MSc at UT	8
	other NL University	5
	foreign MSc diplom	2
SACS Phd	MSc at UT	7
	other NL University	0
	foreign MSc diplom	6

Figure 3: Background of current PhD students in DAMUT.

Activities

Type	2015	2016	2017
Publication peer-review and editorial work -			
Editorial work	22	25	26
Membership -			
Membership of committee	9	12	13
Participating in or organising an event -			
Organising a conference, workshop, ...	12	12	13
Visiting an external institution -			
Visiting an external academic institution > 1week	2	4	4
Hosting a visitor -			
Hosting an academic visitor > 1 week	1	3	7

Figure 4: Activities and duties of DAMUT personnel.

Research funds

	2015		2016		2017		Average 2012-2017	
Funding	k€	%	k€	%	k€	%	k€	%
Direct Funding	6216	78%	6586	84%	6934	84%	6579	82%
Research grants nat.	849	11%	624	8%	663	8%	712	9%
Research grants inter.	185	2%	63	1%	104	1%	117	1%
Contract Research	753	9%	571	7%	536	7%	620	8%
Other	0	0%	0	0%	0	0%	0	0%
Total Funding	**8003**	**100%**	**7844**	**100%**	**8237**	**100%**	**8028**	**100%**
Expenditure	k€	%	k€	%	k€	%	k€	%
Personelle Costs	5240	86%	4841	86%	5035	88%	5039	86%
Other Costs	878	14%	805	14%	678	12%	787	14%
Total Expenditure	**6118**	**100%**	**5646**	**100%**	**5713**	**100%**	**5826**	**100%**

Figure 5: Research funds acquired in the evaluation period.

MIDTERM VISITATION DAMUT

VISITATION COMMITTEE:

- Prof.dr.ir. C.W. (Kees) Oosterlee (Chairman) - CWI
- Prof.dr. W.T.F. (Frank) den Hollander – Leiden University
- Prof.dr. S.M. (Sjoerd) Verduyn Lunel - UU

DATE: 27th of February 2019
LOCATION: Zilverling 2126 & Ravelijn 1501

PROGRAMME:

09.00 – 09.30	Committee meeting with Prof. Vanessa Evers (Vice Dean Research)
09.30 – 09.45	break to note findings
09.45 – 10.45	Committee meeting with OR. OR is represented by: Prof. Richard Boucherie, Prof. Marc Uetz, Prof. Johannes Schmidt-Hieber
10.45 – 11.00	break to note findings
11.00 – 12.00	Committee meeting with SACS. SACS is represented by: Prof. Stephan van Gils, Prof. Jaap van der Vegt and Prof. Hans Zwart
12.00 – 12.15	break to note findings 12.15 – 13.00 LUNCH break
13.00 – 14.00	Committee meeting with Tenure Track and young staff TT and young staff represented by: Dr. Dietmar Gallistl (UD-MACS), Dr. Jasper Goseling (TT-OR), Dr. Aleida Braaksma (TT-OR), Dr. Alexander Skopalik (OR)
14.00 – 14.15	break to note findings
14.15 – 15.15	Committee meeting with PhD candidates
15.15 – 16.00	Committee works on report
16.00 – 16.15	Committee presents their conclusions at RA 1501
16.15	Drinks in Ravelijn