

**Research Review Civil Engineering
Delft University of Technology and
University of Twente**

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Preface

The assessment committee Civil Engineering TU Delft and University of Twente was assigned the task to evaluate the Civil Engineering research and corresponding programmes of the Faculty of Civil Engineering and Geosciences of Delft University of Technology and of the Civil Engineering Department of the University of Twente over the period 2005-2010.

Five experts from three different countries, covering the various disciplines in the research programmes, were invited to join the committee. The committee's assessment is based upon information about the research activities and results supplied by the institutes, key publications, interviews with the programme directors and members of the academic staff, meetings with the faculty boards, visits to the laboratories and meetings with PhD students. Before finalizing the assessment report, a draft was submitted to the faculty boards for comments.

The committee members experienced the discussions during the site visits as open and stimulating, especially because of the enthusiasm of the staff. The committee is pleased to report that the quality of the programmes ranges from good to excellent according to international standards. The societal relevance of the programmes is generally very high, and the research results contribute substantially to innovation in technology and practice.

The review committee would like to thank the institutes for their thorough preparation of this evaluation, as evident from the self-evaluation reports and the interview sessions, from the poster sessions with the PhD students, from the laboratory tours and from the care and arrangements made for the committee.

The committee members are pleased to have participated in this research assessment; it has provided a valuable benchmark of their own research experience and activities with the research at TU Delft and Twente University.

The committee is convinced that this review will contribute to further strengthening of the prominent international role played by Civil Engineering programmes at the Dutch universities.

Prof. Job Dronkers
Chairman of the committee

1. Objective, scope, committee and procedures

Objective and scope of the assessment

The committee was asked to perform an assessment of the research in Civil Engineering at the Delft University of Technology (TU Delft) and the University of Twente (UT). This assessment covers the research in the period 2005-2010.

In accordance with the Standard Evaluation Protocol 2009-2015 for Public Research Organisations (SEP), the committee's tasks were to assess the quality of the institutes and the research programmes on the basis of the information provided by the institutes and through interviews with the management and the research leaders, and to advise how this quality might be improved.

The deans of the participating faculties and the Board of the University of Twente asked the committee to pay extra attention to ways to strengthen the acquisition of external financial resources and to the relevance of the research programmes reviewed and their acknowledgement by society. The committee noted these requests and included their observations regarding these aspects in the assessments at the institute level and for each research programme.

Composition of the committee

The members of the committee were:

- Prof. Job Dronkers, Deltares Delft, chairman;
- Prof. Dominic Reeve, Swansea University, UK;
- Prof. Günter Blöschl, Vienna University of Technology, Austria;
- Prof. Hani Mahmassani, Northwestern University, USA;
- Prof. Mike Kagioglou, Salford University, UK;
- Prof. Giuseppe Mancini, Politecnico di Torino, Italy.

A short curriculum vitae of the committee members is included as Appendix A. Peter van Holten, QANU (Quality Assurance Netherlands Universities), was appointed secretary to the committee.

Independence

All members of the committee signed a statement of independence to ensure that they would assess the quality of the institutes and research programmes in an unbiased and independent way. Any existing personal or professional relationships between committee members and the programmes under review were reported and discussed in the committee meeting. The committee concluded that there were no unacceptable relations or dependencies and that there was no specific risk in terms of bias or undue influence.

Data provided to the committee

The committee received detailed documentation consisting of:

1. Self-evaluation reports of the institutes under review, including all the information required by the Standard Evaluation Protocol (SEP);
2. Key publications of each research program;
3. PhD theses covering the review period (available during the site visits);
4. The 'Civil Engineering Support Campaign' progress report (April 2011).

Remarks about the data provided

The ‘Civil Engineering Support Campaign’ progress report provides insight into the choices that have been made and the plans for the near future at both TU Delft and the University of Twente.

Procedures followed by the committee

The committee proceeded according to the Standard Evaluation Protocol (SEP). Prior to the committee meeting, each research programme was assigned to two reviewers who independently formulated a preliminary assessment. The final assessments are based on the documentation provided by the institutes, the key publications and the interviews with the management and the leaders of the programmes, meetings with PhD students and a tour of the facilities. The interviews took place on February 27 – 29, 2012, at TU Delft and at UT.

In advance of the interviews, the committee was briefed about the research assessment procedure according to SEP. On the same day, it discussed the preliminary assessments. For each programme a number of comments and questions were formulated. The committee also agreed upon procedural matters and aspects of the assessment. After the interviews it discussed the scores and comments. The score overview is included as Appendix B. The contributions to the committee report were drafted at the end of the visit and revised through email exchanges. The completed assessment was presented to the faculties for factual corrections and comments. The committee considered these comments before finalising the assessment report. The final report was presented to the boards of the participating universities and was printed after their formal acceptance of it.

The committee used the rating system of the SEP. The meaning of the scores is included as Appendix B.

A summary of the human resources (in fte research time), funding (in thousands of euros) and productivity (research output in no. of publications) as listed in the self-evaluation reports of TU Delft and UT are included as Appendices C, D and E, respectively.

The abbreviations used are explained in Appendix F.

2. Faculty of Civil Engineering and Geosciences, TU Delft

Assessment at the institute level

Introduction

As a low-lying, densely populated, delta country, the Netherlands poses particular challenges to the field of civil engineering. Without a vast network of civil engineering structures, the country would be uninhabitable. Omnipresent watercourses, soft soil conditions and scarcity of space demand innovative engineering solutions, and the intensive use of public infrastructure calls for durable technologies. This holds also for many other delta countries around the world. The Faculty of Civil Engineering and Geosciences (CEG) is an important breeding ground for the development of innovative engineering technologies that respond to these vital demands.

The Delft Civil Engineering Research Institute focuses on the technological aspects of engineering. As may be expected for a delta country, water-related engineering is a major theme of the institute's research programme. A second important aim is improving the robustness and lifespan of constructions, using new high-performance materials, with special attention being paid to maintenance and recycling issues. A third main theme addresses the issue of transport. Much of the research is carried out in close collaboration with stakeholders and other research institutes worldwide.

Recommendations of the previous assessment committee in 2005 were:

- To participate actively in the interdisciplinary research centers set up at the university level;
- To harmonize the research portfolio with civil engineering in Twente;
- To attract more funding from contract research;
- To share laboratory facilities with other institutes, nationally and internationally;
- To improve the coherence between departments and programmes;
- To increase the number of publications in high-impact, peer-reviewed journals;
- To become more attractive for young talented researchers at the PhD level;
- To promptly replace staff members who are close to retirement;
- To reduce the burden of managerial and educational duties for the research staff.

QUALITY

Leadership and academic reputation

The Delft Civil Engineering Institute ranks among the world's top institutes owing to its broad coverage of civil engineering disciplines and to the excellence of several of its research groups. Not all groups and subgroups have the same very high level, however. All groups are involved in international co-operative research, and most groups participate in European projects funded by the EU.

During the evaluation period, several eminent faculty members retired. The institute has been able to attract highly talented experts as replacements; overall, the quality of the research has remained very good. In fulfillment of a recommendation of the 2005 assessment, the publication policy of the institute has contributed to a significant increase of articles in internationally refereed journals. At the same time, a shift has taken place from an engineering-oriented research approach to a more scientific one. The committee has noted a similar shift in engineering

research institutes in other countries. Applied research related to the integral design of civil engineering works has suffered from this trend.

Several staff members play a prominent role in international scientific organizations. A few groups are world leaders conducting highly innovative research. Other groups have consolidated in their fields, still producing high-quality but less innovative scientific output.

Recommendation: Develop an attitude of a permanent search for innovation and excellence, which is a prerequisite for remaining a world leader. For small groups with a specific focus, it may be more difficult to achieve continuous renewal than for larger groups with a broader focus.

Organization

The institute has successfully implemented several of the recommendations of the previous 2005 assessment through the Renewal Plan, such as the replacement of retiring professors with equally talented staff, increase of contract funding and increase in the number of publications in refereed journals. The previous evaluation already noted that the coherence of the programmes at the institute level is weak. Although there are several examples of collaboration between groups, it appears that groups and subgroups have a strong tendency to maintain their own group identity and culture. The rationale of the present division of the institute into departments and groups has become less transparent as groups have shifted their focus over the course of time. The research fields of some groups now partially overlap (partial overlap of Hydraulic Engineering, Environmental Fluid Mechanics and Water Resources Engineering and partial overlap of Structural Mechanics, Materials & Environment and Structural and Building Engineering), while other fields have become less attractive. The field of Integral Design and Maintenance is in the latter category. It is addressed in the groups of Road and Railway Engineering and Hydraulic Engineering, but clearly less so than in the past. The research field of Integral Design is seen as vitally important to the sector and to society and should therefore be revalued.

Recommendation: Reinstate Integral Design as a core discipline of engineering research.

Reinforcing research on Integral Design could contribute to strengthening the coherence among the present research themes. The same holds for other integrating research topics of high societal relevance, such as Asset Management and Economics, which are hardly addressed in the present programmes.

Recommendation: Strengthen coherence among the present research themes by considering interdisciplinary research topics, such as Asset Management and Economics.

The present organization of Civil Engineering in Delft is a legacy of the past, which has not followed the evolution of research themes in the last decade. It does not promote potential synergies among research groups and apparently hampers an efficient coverage of the core research fields of civil engineering.

Recommendation: Develop a strategic plan at the institute level addressing these organizational weaknesses. It seems appropriate to reconsider the present group division of the institute, looking for larger, robust groups, with stronger coherence and better opportunities for interdisciplinary integration and innovation.

Human resources

The institute has been successful in attracting top experts to replace several programme leaders who have recently retired. The staff of full professors was rejuvenated, while maintaining or even strengthening the quality and productivity of the programmes.

Several more programme leaders will retire soon, as will quite a number of associate professors. During the assessment period, hardly any replacements were made in this last category. When renewing the staff, the institute should consider the different strategic issues mentioned above.

Recommendation: Prepare a Succession Master Plan at the institute level.

Financial resources

The financial situation of the institute has been brought into balance, in spite of the strong decrease of direct funding. The committee is impressed by the efforts undertaken to attract extramural funding and congratulates the staff of the institute on this achievement. It puts the institute in a favorable position to start the next period as a world leader in civil engineering research. The committee sees opportunities for further growth in the top sector programmes “Logistics” and “Water” and in the European Horizon 2020 programme, which specifically targets research at the interface of science and industry.

Research facilities

The Delft Institute of Civil Engineering possesses world-class research facilities, which are a major asset for achieving scientific excellence. They represent a heavy financial burden, but the Renewal Plan has been successful in alleviating the most urgent financial pressure. The most important facilities have been maintained and tailored to advanced research techniques; a large facility could be decommissioned thanks to an agreement on making the Deltares’ facilities available for academic research programmes.

PhD training

The PhD training programme put in place by the institute is responding to the need to train young researchers in managing their research in the most effective way. Nevertheless, many PhD projects exceed the planned framework.

Recommendation: Put more emphasis in the PhD training programme on the planning of the PhD project and the monitoring of related milestones.

Some programmes indicate that the students’ skills in mathematics and programming are below the required level for PhD research and, consequently, it is difficult to find suitable candidates.

Recommendation: Incorporate training of mathematical and programming skills in the education curriculum of the faculty.

A pertinent indicator for monitoring the quality and reputation of the research institute is to track the employment careers of PhD graduates. At present, no systematic records are kept of alumni.

Recommendation: Monitor and record the employment careers of alumni.

PRODUCTIVITY

In order to stimulate publishing in high-ranking scientific journals, the university has introduced a model for direct funding that greatly depends on scientific output. This strategy has been successful: the number of publications in international, refereed journals has substantially increased. Moreover, several researchers have a high citation score. However, the less academic and more engineering-oriented disciplines have suffered from this funding model. Funding also fluctuates strongly from year to year. Currently, a new model for direct funding is being applied, which will be less dependent on published papers and therefore more stable. The financial impact for the different groups is not yet fully clear. This entails an undesirable uncertainty in the research planning.

SOCIETAL RELEVANCE

The committee is convinced of the very great societal relevance of the research conducted by the Delft Civil Engineering Research Institute. This research is vital for maintaining suitable living conditions for modern society in delta countries like the Netherlands and for adapting to the impact of global change.

The institute has strong links with the private and governmental civil engineering sector. Many research projects are carried out in close cooperation with industrial partners. The large share of

contract research points to a high degree of societal relevance and fitness for use. Programme leaders are influential and are invited onto national advisory committees on societal issues related to their field of expertise. They also appear in the media when societal issues related to civil engineering are at stake. Some groups are major contributors to the development of Eurocodes.

VITALITY AND FEASIBILITY

Strategy

Key features of the Civil Engineering research strategy are:

1. Clearer profiling by way of themes linked to the TU Delft-wide Delft Research Initiatives;
2. Participating in initiatives for new NWO/STW/EU research programmes and knowledge centres;
3. Increased cooperation with the sector;
4. Increased internal cooperation between departments and research groups;
5. Academic entrepreneurship;
6. Facilitating efficiency improvements;
7. Upgrading facilities.

This strategy reflects the recommendations of the 2005 assessment. It has been successful for:

Feature 1: Civil Engineering research groups play a prominent role in the Delft Research Initiatives;

Features 3 and 5: Closer co-operation with public and private organizations in the sector and stronger entrepreneurship have generated a very substantial increase in external research funding;

Feature 6: The structural budget deficit was turned into a small surplus;

Feature 7: An agreement was concluded for the use of facilities at Deltares.

The strategy has not led to substantial improvement of features 2 and 4. The share of funding from NWO/STW research grants has decreased even further. As to the internal cooperation between departments and research groups, the committee still sees much room for improvement.

Assets

Civil Engineering in Delft has a high international profile in technology-oriented engineering science. Several faculties are considered world leaders, and several research groups belong to the world's best. The institute attracts top experts and is popular among PhD students from all over the world; being a graduate or professor of the institute is considered a mark of prestige. The institute has strong international networks and is a preferred partner in international projects. It has unique laboratory facilities at its disposal and access to the research facilities of nearby institutes, such as Deltares. The proximity of big engineering institutes (TNO, Deltares) and the strong personal ties with these institutes provide other benefits also, such as non-tenured faculty, PhD training and coaching, learning from the application of research results in practice, etc. The institute is a breeding place for innovation in fields of great societal relevance. The authority of its faculty on national and international advisory boards on societal matters related to civil engineering is undisputed.

Funding

All research groups maintain tight links with government agencies and industry. The result is a large number of research contracts in the governmental and industrial sectors. The funding from external parties has doubled during the evaluation period. This has compensated for a substantial reduction in academic funding and even resulted in an overall increase in the research budgets. The reduction of academic funding did provide additional incentives to strengthen ties with

industry; these ties have contributed not only to increased funding but also to better interfacing of science and practice. Today, all PhD projects are financed by external parties. The number of PhD students has substantially increased, and this has extended the scope of research. An important drawback of this situation is the heavy burden it places on the time faculty can devote to their own research. Ensuring long-term stability of funding is also an issue of concern.

Pathway to the future

Civil engineering research groups elsewhere in the world are making fast progress, especially in the developing countries, where today the largest infrastructure works are being carried out. A bit surprisingly, the committee has not perceived a coherent and shared strategic research vision for keeping the Delft Civil Engineering Research Institute at the world top. The different research programmes apparently evolve without great interaction. This has resulted in overlaps between different programmes on the one hand, and to weaknesses in the coverage of important topics on the other.

Most of the research programmes are divided into highly specialized subprogrammes led by an internationally renowned expert. These subprogrammes operate independently with a high degree of freedom as to their research orientation. It appears that this strategy has worked well to achieve a high level of excellence in the research field and to attract external research contracts. However, there are also several drawbacks. The size of the subprogrammes is often quite small – just above critical mass. Their existence is therefore vulnerable to the departure of any senior staff member. Often there is no strong coherence between the subgroups; if one of them experiences a temporary disruption, it is difficult for other groups or subgroups to step in. Strengthening the cohesion between groups and subgroups within the institute can provide greater robustness and contribute to increasing the scientific and societal impact of the research further.

The Delft Civil Engineering Institute houses several world-class research groups. However, in the committee's opinion, it could make better use of its wide-ranging and outstanding expertise.

Recommendation: To stay at the top, the Delft Civil Engineering Institute should pursue stronger coherence in its research programme and stimulate stronger co-operation among its research groups and subgroups.

The imminent retirement of some senior faculty members provides an opportunity to repair present weaknesses in the research portfolio and to unite the different research programmes better. This can best be done by establishing a Succession Master Plan at the institute level as recommended earlier and recruiting top-level candidates from around the world.

Assessments per programme TU Delft

The committee assessed the following programmes:

1. Structural Mechanics
2. Materials & Environment
3. Steel, Wood & Composite Structures
4. Concrete Structures
5. Road and Railway Engineering
6. Transport & Planning
7. Hydraulic Engineering
8. Environmental Fluid Mechanics
9. Water Resources Engineering
10. Sanitary Engineering

The detailed assessments per programme are presented on the following pages.

Programme TUD1: **Structural Mechanics**
Programme director: Prof. dr. ir. L.J. Sluys
Research staff 2010 (fte): 6.52 tenured; 21.9 total

Assessment	Quality:	Excellent (5)
	Productivity:	Very Good (4)
	Relevance:	Very Good (4)
	Vitality and feasibility:	Very Good (4)

Short description

In the Structural Mechanics programme, research is performed into the analysis of solids and structures relevant to civil engineering. The research strategy is to provide mechanics-based solutions to civil engineering challenges. Novel computational and analytical techniques are developed for a more reliable, efficient and effective analysis of materials and structures. There is a specific interest in new and innovative civil engineering structures and high-performance materials and in dynamic, impact and environmental loading problems. Research within the programme is split into four subprogrammes:

- Computational Mechanics of Materials;
- Mechanics of Infrastructure Materials;
- Wave Mechanics;
- Computational Modelling of Structures.

The research addressed in the programme is broad in the mechanics scope, but also has an in-depth approach. The research work is fundamental and applied in nature and has a mono-, multi- or trans-disciplinary character.

Quality

The group produces high-quality output that receives international recognition. It has undoubtedly gained a top international reputation and can be considered a world leader. The leadership of the group has been excellent in developing and implementing an effective research strategy for the four different fields. Some 30% of the staff of the group is tenured, and the number of PhD students has increased over the past 3 years and now exceeds 50% of total research staff. The PhD students remain in academia or join large companies like Shell. The funding of the group showed some variation during the period under review, averaging € 1.7 million per year, which is adequate for the research of a group with a theoretical and numerical character.

Productivity

The productivity of the group in terms of refereed articles averages 28 articles per year and was relatively stable in the period under review, apart from a peak of 41 articles in 2008. The number of PhD theses is increasing and is now in better proportion to the number of PhD students. The number of conference papers dropped in the last year, in line with a reduction in the overall number of publications.

Societal relevance

There is clear evidence that the research output is highly relevant for industry and semi-governmental organizations, both in the short and medium term; the research subprogrammes on 'Computational Mechanics of Materials' and 'Mechanics of Infrastructure Materials' attracted 22 PhD students from all over the world.

Vitality and feasibility

At present, the group is organized into four research subgroups related to Computational Mechanics of Materials, Mechanics of Infrastructure Materials, Wave Mechanics and Computational Modelling of Structures. The group recently obtained a number of large national and international research grants offering the basis for a robust research programme with several new research subjects, e.g. in the field of structural integrity and reliability of novel, high-performance materials, computational environmental engineering and noise generation by offshore wind power generators. The common denominator of the different subgroups is mechanics, and close interaction is strongly recommended, particularly at the level of non-tenured staff and PhD students.

Despite a number of relatively young staff members, rejuvenation of this group requires an adequate succession plan to guarantee continuity of the high level of research.

Programme TUD2: **Materials and Environment**
Programme director: Prof. dr. ir. K. van Breugel
Research staff 2010 (fte): 6.42 tenured; 40.32 total

Assessment	Quality:	Very Good (4)
	Productivity:	Good (3)
	Relevance:	Very Good (4)
	Vitality and feasibility:	Very Good (4)

Short description

The Materials and Environment programme has as its mission statement: “The development, gaining and supply of knowledge in the fields of chemical, physical and mechanical properties of materials which are used, or have potentials for usage, for architectural and civil engineering applications under consideration of the total life cycle of structures, including the reuse of materials through recycling and/or upcycling processes.”

Apart from scientific interest in designing improved and new materials and innovations in recycling technology, due attention is paid to predictions of the long-term performance of structures as an inherent part of sustainable concepts used in the building sector.

Quality

The group has a top international reputation and produces research results that have been acknowledged as excellent by the academic community. The leadership and structuring of the organization into three sections: ‘Materials modeling, design and engineering’, ‘Resource engineering and recycling’, ‘Service life, durability, maintenance and repair’, have resulted in high-level, integrated research products. The group operates and maintains an advanced micro-mechanics laboratory.

The number of research staff of the group, i.e. tenured and non-tenured staff as well as PhD students, has increased substantially over the years under review, from 9.08 fte in 2005 to 40.32 fte in 2010. The funding shows a substantial increase as well, from €947.000 in 2005 to €3.183.000 in 2010. These numbers seem adequate to support the research programmes of the different sections and to maintain the current good level of the research.

The nature of the different funding sources also supports the research objectives of the group well.

Productivity

The productivity of the group is good, with a significant increase of refereed articles in the last two years; the number of conference papers has remained constant over the period under review. The number of PhD theses is low compared to the number of PhD students. The overall number of publications remains at a good level on average.

Societal relevance

There is considerable evidence that the research outcome contributes significantly to a sustainable future with respect to building materials. In particular, the research results on recycling of demolition waste are highly relevant for the environmental impact of the construction sector. Another important outcome for society is the regular appearance of the group in the public debate about the dissemination of knowledge regarding sustainability issues.

Vitality and feasibility

The group focuses on large research programmes (FP7 and STW perspective projects). The size of the group has more than tripled during the evaluation period, due especially to a successful strategy of cooperation with industry. The share of fundamental research is assured by limiting the share of 100% industry-funded projects within the group programme to less than 10%. The group collaborates with other groups of TU Delft like the Concrete Structures group and the Mathematics Faculty, and with foreign universities, like Ghent, Donai and Rome.

Programme TUD3: **Steel, Wood & Composite Structures**
Programme director: Prof. ir. F.S.K. Bijlaard
Research staff 2010 (fte): 2.58 tenured; 8.85 total

Assessments:	Quality:	Good (3)
	Productivity:	Good (3)
	Relevance:	Very Good (4)
	Vitality and feasibility:	Good (3)

Short description

The mission of the research programme of the Steel, Wood & Composite Structures group can be described as: The development of models and techniques, with a spin-off that proposes structural design rules to describe the static and fatigue behaviour of structural components of structures made of steel, timber, composite steel-concrete and fibre-reinforced plastics. These models and techniques enable industry to develop innovative products and structural concepts in a competitive market.

Quality

In general, there were convincing examples of very good work during the review period, but they were not considered at the cutting edge. The work appears to be carried out within segregated disciplinary groups, except for one example of timber fibers in hybrid structures. There is good work under development, and there is an opportunity for some high-quality and novel work in the future, provided the capacity issues are resolved. The work on static and fatigue behavior of structural components can provide significant improvements in engineering technology in the future.

Productivity

The productivity of the group in terms of refereed articles has remained fairly constant over the period apart from a peak in 2010 when it has almost doubled. The reduction of the number of conference papers in favour of other publications was seen as positive. In some ways retaining the same level of publications with less staff is good but sporadic and perhaps not sustainable in the long term.

Societal relevance

There was clear evidence that the work of the group is highly relevant, and it has been applied across a number of settings, making a valuable contribution to a variety of stakeholders at both the national and European level. The significant societal relevance results mainly from the implications for the lifespan of structures, which can be considerably increased.

Vitality and feasibility

The group has shrunk in size in real terms, i.e. not counting PhD candidates, over the reporting period. At the same time there has been a parallel reduction in funding received, with the expenditure remaining the same. Although the group can dispose of significant material resources, it is evident that the above changes will potentially have a negative impact on the robustness and stability of the group in the future. The strategy suggests that changes have to be made, but how this should happen is not yet specified. A potential scenario that can be considered is the integration with other groups, such as the structures group, where both economies of scale and critical mass can be created to utilize the existing facilities and the potential of the group.

Programme TUD4: **Concrete Structures**
Programme director: Prof. dr. ir. J.C. Walraven
Research staff 2010 (fte): 1.7 tenured; 7.5 total

Assessments: Quality: Very Good (4)
 Productivity: Good (3)
 Relevance: Excellent (5)
 Vitality and feasibility: Good (3)

Short description

The Concrete Structures research programme has defined the following aims:

- To support and stimulate developments in the concrete building industry which have a direct impact on the needs and demands of society. Major goals are to improve safety, serviceability and durability of concrete structures;
- To disseminate knowledge via teaching programmes, seminars for practising engineers and building codes;
- To educate MSc students in such a way that they develop both a scientific and a practical attitude. To this end, they are confronted with topics with a highly innovative character and great relevance to society;
- To give young researchers the opportunity to become research professionals by letting them participate in challenging research programmes and international activities.

Quality

The group has clearly developed some internationally competitive work in their field with evident scientific relevance. The leadership provided in the group was very good and fundamental to its development. The group is very well known both nationally and internationally and plays an important role in its field. It has limited capacity at the tenure level but has increased its PhD capacity over the years. The funding for the group has decreased dramatically, and the combination of the reduction in tenured fte's, funding and productivity rate is a concern. The research facilities and laboratories are of a high standard.

Productivity

The general productivity of the group was stable over the period under review. The productivity in terms of refereed articles is relatively low (apart from a peak in 2009). The same applies to PhD theses, although we noted an increase in PhD registrations to almost double that in the initial review period. It is worth mentioning that the peak in 2009 relates to a reduction in conference publications, which could mean that the results are endemic to the strategy being followed, and if this was orientated differently, higher numbers of journal publications could be produced.

Societal relevance

There was clear evidence that the work is highly relevant and that significant contributions have been made. The results will have great societal and economic consequences for years to come, for example, in relation to Eurocodes and also to the national strategy for bridge design and maintenance.

Vitality and feasibility

In general, the group has achieved some significant outputs, and there is a stream of activity that is still ongoing around the testing of ageing bridge designs and concrete resilience. However, the

retirement of the programme director and the already declining number of tenured staff (from 2.2 to 1.5 fte) over the evaluation period should be a point for concern. Although the retired programme director still supervises his PhD students, there is a risk concerning his future replacement. His successor will very much determine the future of this group, notwithstanding the significant contributions that other faculty and PhD students are making.

Programme TUD5: **Road and Railway Engineering**
Programme director: Prof. dr. ir. A. A. A. Molenaar
Research staff 2010 (fte): 2.8 tenured; 20.45 total

Assessments: Quality: Very Good (4)
Productivity: Good (3)
Relevance: Excellent (5)
Vitality and feasibility: Satisfactory (2)

Short description

The mission of the Road and Railway Engineering Section is to be a leading group, on both the national and international level, in fundamental and applied research into the performance of road and railway structures including materials, design, and maintenance.

Quality

The group's performance over the past review period reveals a continuous and productive research effort, addressing important problems affecting the quality, durability and serviceability of roadway pavements, especially asphalt concrete pavements, and of railway track structure and performance. The research carried out on road pavements is on par with the highest quality work at the international level in that area, and is disseminated actively in professional and research venues, including journals and conferences. The research on railway track structure addresses specific problems experienced in the field, and is of great use to its industry stakeholders (dissemination in academic fora is more limited given the less well-defined international academic expertise in this area).

The quality of the programme in road pavement engineering is highly regarded in the corresponding international academic community. The programme leader is a prominent member of that community. The work of the group is well in sync with the developments that take place in that field around the world, with clear evidence of cross-fertilization. The quality of the programme is also well recognized by industry in the Netherlands and in Europe, as well as by professional organizations abroad, for example in South Africa. It is more difficult to assess the railroad engineering activity from that standpoint given the absence of a full-time faculty member in that chair.

The group has continued to experience considerable success in generating extramural funding for its research activities and for the operation of its excellent laboratory facilities, thereby reducing its vulnerability to fluctuations in internal funding. This success has been directly manifested in the increase in the number of PhD researchers. Nonetheless, the maintenance and upkeep of world-class laboratory facilities require the sustained investment of internal funds.

As noted, the group's activities and reputation are heavily centered on the key role of its leader—and his departure due to retirement as well as the absence of a visible “heir apparent” pose a real threat to the continuation of the activities of the group at this level of quality.

Productivity

The group appears to have reoriented its productivity strategy in the last review period, placing greater emphasis on the production of PhD theses as well as on dissemination in academic-oriented journal articles, without sacrificing its long-standing commitment to disseminate knowledge using professional fora, targeting the practice-oriented engineering community. This strategy appears to have been successful, especially in the road pavements engineering area,

where PhD thesis production has increased, as have journal publications over the review period, while continuing to supply conference presentations and other outlets targeting the professional practice stakeholders of interest and the agencies sponsoring the research.

Societal relevance

The group's contribution to road and railway engineering practice is substantial, and the research actively translates into methods and tools used by the industry. These methods and tools contribute to the quality and safety of the transportation systems used by society. Accordingly, the societal relevance of the work of this group is very high.

Vitality and feasibility

This group is facing critical challenges with regard to staff renewal and continuity. The departure of key staff, the vacancy of the Railroad Engineering chair since 2006, and the imminent retirement of the Road Engineering chairholder and overall leader of the group together create uncertainty about the continuation of the research activities of the present group and the planning of its future prospects. The present group has built an enviable reputation in the expertise areas of design, construction and maintenance of asphalt concrete pavements, using excellent facilities and networks of clients and collaborators. Continuation of the research and maintenance of the facilities in this area are important for the institute and for the stakeholders it serves. By the same token, recruitment of new leadership creates an opportunity to realign the group's profile and collaboration network. Moreover, it is an opportunity to broaden the scope of research activities to include new developments in materials technology, modern technologies for pavement quality assessment and structural condition, sustainability in design and operation principles, as well as better positioning of and closer alignment with the system aspects of the road and railway infrastructure. Finally, it is an opportunity to face the challenges that arise in connection with the management of road and railway infrastructures. The committee recommends that the institute develop a comprehensive, long-term succession plan for the replacement of key personnel.

Programme TUD6: **Transport & Planning**
Programme director: Prof. dr. ir. B. van Arem
Research staff 2010 (fte): 6.27 tenured; 27.86 total

Assessments: Quality: Excellent (5)
 Productivity: Excellent (5)
 Relevance: Excellent (5)
 Vitality and feasibility: Excellent (5)

Short description

The mission of the Transportation Planning and Traffic Engineering (TTE) programme is to achieve top-level fundamental research that contributes to a more efficient and robust design and reliable operation of transportation systems that meet the mobility demands and respect scarce resources of land, environment and people. Part of this mission is to produce and disseminate new insights and tools to support professionals in transportation planning and management practice (planners, designers, authorities, infrastructure managers, transport and traffic operators). Equally, the mission includes the contribution to top-level MSc and PhD education in transportation. From this statement it follows that the research is predominantly knowledge-driven with a clear perspective on society-driven applications using a multidisciplinary approach. The primary target audience is the scientific community; the professionals and policymakers form a second important target group.

Quality

The group has maintained and improved its already strong reputation for high-quality research. It ranks among the world's best programmes in traffic modeling and applications to system management, and has a well-regarded presence in international research and academic circles. It has built a unique capability for field observation and measurement of traffic and transport processes, from the network level to the individual particle level, which enables the development of fundamental descriptions and mathematical models of underlying phenomena at multiple levels of resolution. This also includes experimental apparatus and virtual environments for the study of human behavior in traffic situations.

Research generated by this group finds its way into the most prestigious peer-reviewed journals in the field, and researchers actively disseminate their results at scientific and professional venues, where it has become renowned for high quality in conceptualization, execution and presentation. Another indication of quality is the placement of PhD graduates, who are increasingly gaining recognition for their scholarship and creativity.

Leadership in the group comes from established faculty with international “star”-level recognition and from a new addition to the group with a proven track record in advanced transport technologies; several junior members are rapidly rising in terms of international recognition and prominence.

The committee recommends targetting future additions and/or replacements to the strategic multimodal planning area, including emerging approaches for demand and travel behavior modelling, in addition to freight and logistics. Moreover, a stronger connection to the physical infrastructure aspects of transport is recommended.

The group has very successfully weathered the decline in internal funds for research over the past few years through an increase in extramural funding; the value of research contracts has increased

more than fourfold since 2005, allowing the group to maintain its momentum and growth in the face of a decline in direct funding.

Productivity

The group has pursued a successful production strategy, centered around the fostering of first-rate PhD students and their dissertations, coupled with active publication in high-quality journals and dissemination through scientific and professional venues. The number of PhD graduates is excellent, sustained at about 5 per year on average, especially considering the high quality of their dissertations.

Societal relevance

The topics addressed by the group are of considerable relevance to society. Mobility, sustainability, reliability of travel and congestion are critical quality-of-life dimensions. The group engages in the active application and dissemination of its fundamental research results through agencies and engineering consultancies. Several members also engage in outreach to the general public through the broader media. There is no doubt that the problems addressed by this group will be with us for a long time to come, and hence the societal relevance of these problems will remain and are likely to gain further in prominence.

Vitality and feasibility

This group has succeeded in managing the rejuvenation of its human resources, especially key faculty, while retaining continuity in excellence and its international reputation in key areas of traffic flow modelling and system management. It attracts an increasingly diverse doctoral research population from different disciplinary backgrounds including mathematics, psychology, and economics in addition to engineering, which infuses the group with new ideas and promotes an attitude for innovation in ideas and methods. While the group is facing some personnel retirements, the core will remain in place and is very well positioned to take advantage of personnel replacement to further invigorate and diversify the group's skills and research portfolio.

Programme TUD7: **Hydraulic Engineering**
Programme director: Prof. dr. ir. M.J.F. Stive
Research staff 2010 (fte): 3.35 tenured; 44.05 total

Assessments: Quality: Very Good (4)
 Productivity: Very Good (4)
 Relevance: Excellent (5)
 Vitality and feasibility: Very Good (4)

Short description

In the Hydraulic Engineering programme, research is performed in coastal engineering, hydraulic structures and probabilistic design, dredging engineering, port and waterways, river engineering and offshore engineering. The research within these areas is unevenly distributed, with an emphasis on the problems of controlling coastal erosion and flooding. The programme uses computer models to analyse the morphological systems and laboratory experiments to understand the performance of hydraulic structures. Research is applied to problems around the world.

Quality

Within the group the quality of the research varies from excellent to good. The coastal engineering group is internationally recognized as being a leader in understanding and managing coastal morphological problems. The flood risk group is very well established nationally and has an international presence, but its visibility is limited. The research on ports and offshore engineering is nationally recognized. The committee noted the move away from traditional engineering design to more process- and science-oriented research, which is in line with university policy and international trends. Engineering design does not appear to be accounted for in the evaluation of research quality. There is scope for closer collaboration between the subgroups of the programme. The available laboratory facilities seem to be used efficiently. PhD training seems to be well managed, and the system that was introduced seems to be working well.

Productivity

There is a very good output in refereed journal articles. There is a disproportionately high output in non-refereed conference proceedings. It is recognized that conferences are an important platform to engage with practitioners, but the group may want to reconsider their publication strategy to optimize their impact with respect to journal publications. Due to their involvement in the educational programme, the PhD graduation numbers lag significantly behind the enrollment numbers. The core target for PhD students is being exceeded.

Societal relevance

The societal relevance of the research in this group is excellent. The coastal morphology research is contributing to major innovative solutions to coastal defense. The flood risk research contributes to improved design concepts of flood defense structures and to issues of societal relevance at the international level. The programme has excellent contacts with industry in the area of dredging and coastal consultancy.

Vitality and feasibility

Hydraulic Engineering is a well-established group with several senior members due to retire shortly. There are plans to replace them, but the long-term feasibility of the group requires successful appointments to be made. There is a large number of PhD students compared to the permanent staff, which will require close attention in the future to ensure a consistently high

quality of supervision. There is a strong dependence on contract income. The sustainability of the group will rely on a diversified portfolio of income.

Programme TUD8: **Environmental Fluid Mechanics**
Programme director: Prof. dr. ir. W.S.J. Uijtewaal
Research staff 2010 (fte): 3.63 tenured; 11.18 total

Assessments: Quality: Very Good (4)
 Productivity: Very Good (4)
 Relevance: Excellent (5)
 Vitality and feasibility: Very Good (4)

Short description

In the Environmental Fluid Mechanics programme, research is performed into understanding surface wave propagation, open channel hydraulics and sediment transport. There is a strong emphasis on maintaining and developing the wave models SWAN and SWASH as a way to synthesise knowledge on these processes. Insights are provided by laboratory and field experiments as well as computer modelling. Research is applied to problems around the world.

Quality

The quality of the group is very good. There is a good balance between peer-reviewed journal publications and other output, and the group seems to be aware of how best to spend their efforts to maximize the science impact. Innovative research is devoted to new process representations of the SWASH model and linking it to the SWAN model. The programme leader has a very good international reputation. There is a good number of PhD students enrolled which is consistent with the number of supervisory staff. The group management seems to perform very well, and the PhD students are highly motivated. However, not all PhD candidates graduate within four years, and attention should be paid to completion rates. The total funding has only increased marginally over the past six years, with a large proportion of contracts, but they have helped to stabilize the financial basis of the group. The decommissioning of the wave tank has provided space for a range of new, smaller experimental facilities to be deployed in a more flexible way.

Productivity

The group has a measured approach to productivity. There are some very strong papers in high-impact journals, and there is a significant upward trend. The SWAN and SWASH software products developed by the group have an impressive international reach and range of users. During the past six years 10 releases of the SWAN model were published, and the first version of the SWASH model was released.

Societal relevance

The societal relevance of the research in this group is excellent, mainly due to the SWAN wave model. The research of the group has fed into the development of other models such as Delft 3D, which is used by consultants and contractors such as Deltares.

Vitality and feasibility

This is a well-established group with several senior members due to retire shortly. There is room for succession and also the opportunity to set the future course for the group. The options include numerical modelling, a detailed process focus or a broader system perspective. One possibility would be to merge this group with hydraulic engineering to create a critical mass across the broad spectrum of coastal engineering and science, but the synergies and benefits would have to be identified first.

Programme TUD9: **Water Resources Engineering**
Programme director: Prof. dr. ir. H.H.G. Savenije
Research staff 2010 (fte): 5.04 tenured; 25.43 total

Assessments: Quality: Excellent (5)
 Productivity: Very Good (4)
 Relevance: Very Good (4)
 Vitality and feasibility: Very Good (4)

Short description

In the Water Resources Engineering programme, research is performed into understanding water availability and water use. The research strategy is to provide a scientific basis for decision-making in water-related issues such as flood control, drought mitigation, water quality management and ecosystem management. The programme has developed novel measurement methods such as Distributed Temperature Sensing, new remote sensing data analysis methods and flexible modelling approaches for processes related to water availability and water use. Research within the programme is performed in two closely interacting groups: Hydrology and Water Resources Management. The research is performed both in Europe and overseas (especially Africa), where managing water resources reliably is of particular societal impact.

Quality

This programme is a world leader that is particularly recognized for innovative methods in the measurement, monitoring and modelling of water availability. The Distributed Temperature Sensing method is one of the world-renowned innovations that originated in this programme. Similarly, the research on moisture recycling and the concept of rainsheds is very innovative and has received much attention worldwide. While there is substantial overlap between the areas of the two chairs of Hydrology and Water Resources Management, there was limited evidence in the self-evaluation report on the interactions between the two groups. The PhD students seem to be very highly motivated, so the management of the groups seems to work very well. The number of PhD students who have graduated in the past six years is relatively large (38 graduates). The group leaders enjoy an excellent reputation internationally, as indicated by prestigious awards and numerous invitations to speak at conferences and user meetings. They are sought-after reviewers. The programme has been very successful in acquiring funding, tripling its income over the past six years. The research facilities (field instrumentation) developed by the group are world class.

Productivity

The programme has been very productive over the past six years. The output of more than 70 refereed journal papers per year is excellent. The productivity strategy is well matched with the faculty model, with a stress on many journal publications and relatively less focus on non-peer-reviewed output such as conference proceedings.

Societal relevance

The societal relevance of understanding water availability and water use is very clear. In particular, the focus on developing countries that are more vulnerable to floods and droughts gives the group a very valuable international presence in addition to the involvement in the Netherlands. While the societal relevance of the research is clear, the direct input to policy-making at various levels is less obvious.

Vitality and feasibility

This is a young group that has made very good progress during the past six years. The strategy for future management of the group is a zero growth one in response to the rapid growth in the

past years. It involves strengthening the network at both the national and international level as well as building on strong partnerships with the water industry and water management agencies. This will require some time to re-evaluate the priorities to provide opportunities to adjust to changed funding situations. There is a good balance in the income of the hydrology and water resources management groups, which is felt to enhance the robustness to fluctuations in funding opportunities.

Programme TUD10: **Sanitary Engineering**
Programme director: Prof. dr. ir. J.B. van Lier
Research staff 2010 (fte): 2.74 tenured; 15.65 total

Assessments: Quality: Very Good (4)
 Productivity: Very Good (4)
 Relevance: Very Good (4)
 Vitality and feasibility: Very Good (4)

Short description

In the Sanitary Engineering programme, research is performed into water treatment and transport. The particular strength of the group is membrane technology as used in drinking water and waste water treatment. The overarching goal of the research is to underpin the sector technology in providing high-quality water at acceptable cost, collection and conveyance of used urban water, and adequate treatment of polluted water to stringent criteria. The programme uses a combination of refined laboratory methods and on-site testing to ensure the feasibility of the technologies developed. The research is a balance of fundamental and applied aspects.

Quality

The quality of the group is very good. The membrane technologies are innovative, and although much of the research is fundamental, there is always a clear application in mind. The new technologies are applied in a creative way to a range of engineering problems. The programme leader has a very good international reputation. The group management seems to perform very well, with the PhD students being highly motivated. There are many PhD students, but most of them have not graduated yet. Clearly, the programme is in a transition phase of substantially increasing its PhD research. The total funding has doubled over the past six years, with a large proportion of contracts. However, a greater input from research grants could be targeted. The research facilities are first class. The group has considerable expertise as a result of developing laboratory equipment. The up-scaling of the research results from the laboratory to real world water treatment facilities is a high priority in the group to ensure the smooth transition of the technologies to practice.

Productivity

There is a very good output in refereed journal articles. The number of non-refereed conference publications is relatively high, and the group may want to reconsider their publication strategy to optimize their impact with respect to journal publications.

Societal relevance

The group maintains very good contacts with the industry, and the technology they develop clearly finds its way into industrial applications. The programme is interdisciplinary, but there was limited evidence of research into the socio-economic aspects of water treatment and transport. There is a lot of scope of how to internationalise most effectively the technologies the group develops.

Vitality and feasibility

This is a young group with a good age distribution. The management strategy is well matched to the faculty model. The group puts a lot of emphasis on both national and international collaboration. The 0.2 fte of the programme leader at the UNESCO-IHE is an important contribution to internationalisation and is expected to bear fruit in the near future. There is a reasonable balance in the income for the water supply and water treatment themes, which is a good way of mitigating the risk of variations in funding for the group as a whole. The group is

rather small, so it is important that it does not shrink over the next years. There is a large number of PhD students relative to the permanent staff, and this situation will require close attention in the future to ensure a consistently high quality of supervision.

3. Department of Civil Engineering, University of Twente

Assessment at the Institute level

Introduction

The research at the Department of Civil Engineering (CE) focuses on the human dimension of civil engineering and, more particularly, on management and governance issues related to the development and use of infrastructural works. This focus is shared by the three civil engineering research groups of the Department and acts as a common basis for co-operation among them. The human dimension of Civil Engineering has become an increasingly important field, responding to societal trends of democratization, individualization, mobility and environmental awareness. It is a new and well-chosen research niche, which nicely complements the more technology-oriented research at TU Delft. The previous assessment in 2005 already concluded that the cultural differences underpinning the Civil Engineering research programmes of TU Delft and UT should be fostered.

Other recommendations of the previous assessment of 2005 were:

1. To strengthen the alumni network;
2. To harmonize the research portfolio;
3. To improve the research output, especially in terms of publications.

QUALITY

Leadership and academic reputation

The Civil Engineering Department in UT is much smaller than its equivalent in Delft, but because of the particular focus on human and societal factors in civil engineering, the CE&M research programme is complementary rather than competing with the research programme of civil engineering at TU Delft. At a national level, CE&M has a unique position and leadership. The CE research groups were successful in attracting research grants from STW and NWO and play a leading role in some national programmes such as AIDA and PSIB. The groups have participated in several European research projects, but not in a leading role. Internationally, there are few other university groups with a similar focus, which makes benchmarking difficult. The international visibility of the water footprint studies is very high; other research topics make a very valuable contribution in their field. It is the committee's opinion that the Department does not have the status of a world leader of excellence in its field yet, but has taken significant steps in this direction.

The research staff of the CE Department is still fairly young and entering its most productive years. This holds the promise of further steps towards an internationally leading position, which is crucial for attracting and retaining top academic talent. To reach such a position, a permanent search for excellence is required.

Recommendation: Persistence of research programmes should not be taken for granted. The staff should be capable of assimilating new, promising developments in their field and generating corresponding incentives for renewal within their group.

Methodology

Operating at the interface of the engineering and social sciences is a main characteristic of many PhD projects carried out at CE&M. Its research approach differs in this respect from the more

technology-oriented approach of most civil engineering research institutes. The methodological framework for interdisciplinary science is, in general, less well-developed than for the constituent disciplinary sciences. The presence of a sound methodological framework is essential, however, also for interdisciplinary studies, to make results more generally applicable and to establish a firm body of knowledge for subsequent studies. The committee is of the opinion that the methodological foundation of the approaches used in the interdisciplinary studies should be addressed in a more systematic way.

Recommendation: The further development and improvement of what one might call “the science of interdisciplinarity” should be a common focus of the three research groups and eventually become a key expertise of CE&M.

Research facilities

The policy of CE&M to use external laboratory facilities has worked out very well. The costs of having access to laboratory facilities do not represent a structural financial burden for the Department, while the financial burden for the external facility owners is reduced. The policy generates great flexibility since most external laboratory facilities are not fully occupied. Besides, the use of the laboratory facilities of other institutes often stimulates co-operation with research groups of these institutes.

PhD coaching and training

A solid PhD training programme has been put in place. Only 11% of the PhD students drops out, and 56% graduates in less than 5 years. This is a good score, to which the PhD training programme has contributed. At the poster session, the committee got a favorable impression from the PhD students regarding the way they were coached.

A pertinent indicator for monitoring the quality and reputation of the research institute is the employment of graduates. At present, no systematic records are kept of their employment.

Recommendation: To monitor the career of PhD students after graduation.

PRODUCTIVITY

The publication policy of the institute has contributed to a substantial increase of articles in international, refereed journals. There are hardly any high-ranking, interdisciplinary, scientific journals in the field of civil engineering. Therefore, many interdisciplinary studies were submitted to the ‘nearest discipline’ journals. The articles were accepted in high-ranked journals and generally well-appreciated. The quantity and quality of the scientific output meet high international standards. The number of completed PhD theses is stable at a high level.

The committee values the incentive to publish in high-ranked journals. However, the number of papers produced should not be the only criterion for assessing quality, to avoid the risk that background documentation (e.g. data reports) and dissemination to professionals and the general public will be neglected.

Recommendation: To further improve the quality and productivity of the output so it reaches both the non-academic as well as academic stakeholders. This requires the implementation of a carefully tailored strategy.

SOCIETAL RELEVANCE

The CE Department staff is well aware of the societal relevance of their research. Several research projects focus on optimizing the human use of data, information and knowledge in practice. There are intensive contacts and connections with stakeholders: governmental

organizations, private institutions (e.g. hospitals) and industries. In some cases, part of the research work is carried out externally in stakeholder organizations; vice versa, experts of stakeholder organizations sometimes participate in the research work at the university. The committee noted many examples of the successful application of research results in practice and is convinced of their high societal value.

VITALITY AND FEASIBILITY

Strategy

The Civil Engineering Department formulated 5 main objectives for the 2005-2010 period:

1. To gain international recognition for the quality of research by giving priority to publishing in high-ranking journals;
2. To further expand international collaboration with leading institutes all over the world;
3. To further increase funding for long-term and comprehensive research projects;
4. To strengthen the cooperation with industry;
5. To improve the quality of staff and non-tenured researchers.

To achieve these goals, several measures were undertaken:

- Applying strict norms for publications and research grants;
- Imposing tough selection criteria for new staff members;
- Developing and implementing improvement plans for underperforming staff;
- Offering PhD researchers mentorship support and encouraging them to write their theses on the basis of publications and to collaborate internationally.

This strategy has been successful in several ways: the quantity of high-quality scientific output has substantially increased, new international collaborations have been initiated, and the funding from industry has substantially increased. The staff of the Construction and Water groups has remained stable. The Transport group suffered from the departure of two important leaders but was able to make a new start by attracting high-quality replacements.

Assets

The CE Department has several strategic assets that provide good opportunities for growth towards a highly visible and valued position in the world of Engineering Science. A major strength of the CE Department is the well-chosen focus on interdisciplinary research, linking Engineering Sciences and Social Sciences. Other strengths include the relatively young age of the staff and the healthy funding coming from both academia and industry sources. The good atmosphere in the Department, the openness to collaboration and the inspirational enthusiasm of the researchers are conditions that contribute to creativity and innovative science. The laboratory strategy is one of limited own infrastructure while making use instead of laboratory facilities of research institutes in the Netherlands and abroad. This strategy works very well and contributes to a more efficient use of existing laboratory facilities, while at the same time stimulating collaboration and flexibility.

The peripheral location of Twente in the Netherlands is not necessarily a weakness. In fact, UT is more centrally located in Europe than TU Delft, and the civil engineering research institutes in northwestern Germany are as close as those in Holland. This asset is not yet fully exploited by the Department.

Recommendation: By further strengthening co-operation with its German neighbours, the CE Department could play a valuable liaison role between Dutch and German civil engineering research institutes.

Funding

Thanks to a strategy of close co-operation with industry, the opportunities for external funding are sufficiently abundant to enable the selection of projects that fit the research strategy of the Department. Therefore, a coherent research line can be maintained, with due attention paid to fundamental scientific questions. Increasing the size of the research groups will require more external funding. This may come from industry, as long as it remains possible to select projects with sufficient scientific added value. CE&M is also searching for opportunities for Dutch government funding and European funding.

Recommendation: In the Netherlands, the Department should strive for active participation in the key national programmes “Water” and “Logistics”. In Europe, the Horizon 2020 programme is particularly interesting for the Department, as it aims at strong support for scientific collaboration between universities and industry.

Pathway to the future

The size of the separate programmes is fairly small; it is generally just above critical mass. This makes the groups vulnerable to the eventual departure of staff members. Growth in size of the research groups is also necessary to further enhance their impact in the scientific world, to increase their visibility on the international scene and to rank in the world top of civil engineering research institutes (for instance, comparable to Imperial College in the UK).

Recommendation: Ways should be explored to increase the budget of the CE Department. Plus a long-term research vision is needed. The present research programmes have successfully produced results with a high international impact. Now the pathway to future success should be established.

In summary, the prospects of the CE Department look sunny if full advantage is taken of the opportunities that exist and those that are on the horizon. The national research scope has become too narrow for the Department. The potential is there to become an international top player.

Assessments per programme at University of Twente

The committee assessed the following programmes:

1. Construction Management & Engineering
2. Centre for Transport Studies
3. Water Engineering & Management

The assessments per programme are presented on the following pages.

Programme UT1: **Construction Management & Engineering**
Programme director: Prof. dr. G. P. M. R. Dewulf
Research staff 2010 (fte): 4.11 tenured; 17.15 total

Assessments: Quality: Very Good (4)
 Productivity: Very Good (4)
 Relevance: Very Good (4)
 Vitality and feasibility: Very Good (4)

Short description

The research mission of the Department of Construction Management & Engineering (CME) encompasses all aspects of the construction process related to the definition, appraisal, design, and delivery of projects. It deals with the interests of the different stakeholders, as well as with those of the construction business in its broadest sense. For this reason, the starting point for the research programme is an interdisciplinary perspective focused on the integration of technology and management for the purpose of producing innovative solutions for the built environment. The design-oriented approach, the close cooperation with the industry, and the emphasis on the integration of disciplines are major distinctive features of this programme.

The objective is to improve performance in the construction industry by:

- Carrying out high-quality research – fundamental as well as applied – pushing for rigour and relevance, much in the spirit of Engaged Scholarship;
- Deepening our understanding of the dynamics of change and innovation in the industry by studying construction processes and value chains at the level of the stakeholders, within legal, market and institutional contexts;
- Developing effective and innovative solutions to the problems of construction process management.

Quality

There was clear evidence of high-quality publications in top-rated journals that cut across disciplines. This demonstrates that the group is making contributions to a variety of disciplines (it both borrows knowledge from and contributes back to them), but these contributions need to be made more explicit. The real value of interdisciplinary work for the Engineering discipline has to be made specific, while demonstrating excellence within its domains. This is particularly relevant to the PhD candidate work, where research methodologies have to be robust and defensible both within and across disciplines.

Productivity

There is convincing evidence of an increase in journal publications, PhD completions and other outputs across the board. This is a clear sign of a group that is highly productive, and the challenge in the future will involve maintaining high quality as well as quantity.

Societal relevance

There is convincing evidence of the societal relevance of the work undertaken within the group, and the interaction with industry is particularly good and noteworthy.

Vitality and feasibility

The group has grown in size, especially non-tenured staff and PhD candidates. It has coped very well with changes in funding over the years, and in real terms it has increased its funding budget and is confident about the future. The focus of interdisciplinary work runs through its leadership, and it is evident in the publications and the PhD work. However, looking to the future, the work

needs to be more clearly connected to the core Engineering disciplines to ensure that it remains relevant to the Engineering community.

Programme UT2: **Centre for Transport Studies**
Programme director: Prof. dr. ir. E. C. van Berkum
Research staff 2010 (fte): 2.46 tenured; 10.55 total

Assessments: Quality: Good (3)
 Productivity: Good (3)
 Relevance: Good (3)
 Vitality and feasibility: Very Good (4)

Short description

The mission of the Centre for Transport Studies (CTS) is “to carry out research for connected and sustainable mobility”. To a large extent, the programme also reflects the university’s motto, i.e. “high tech, human touch”.

The main objective of the research at CTS is to acquire knowledge that helps make transport systems more sustainable by connected mobility. Examples include connecting travellers by the latest ICT, connecting stakeholders, connecting cars, or cars and roadside traffic management systems, connecting land use and transport and connecting transport modes. The focus lies on the development of measures that optimize transport networks and that change the behaviour of individuals. This research is almost always multidisciplinary and multi-objective, justified by the multifaceted nature of sustainability and transport. The objectives of CTS are:

- To conduct high-quality fundamental and applied research in the area of connected mobility;
- To provide a stimulating and supportive environment for researchers, students and guests;
- To be involved in national and international research networks to strengthen cross-fertilisation of research ideas, approach and output;
- To disseminate research output through publications in scientific and professional journals and at national and international conferences.

Quality

Given the disruptive events noted and the rapidly changing cast of researchers during the review period, it is not clear that an assessment of either quality or productivity over that period is particularly meaningful. Overall, the group’s output has been somewhat inconsistent in the review period but has recently begun showing some signs of rebound (but not yet in PhD production). The group has defined a road map of important multidisciplinary research for the next few years, which builds on previous work (primarily in the areas of intelligent transport systems, driver behavior and multimodal networks) but significantly expands its intellectual scope.’

The group conducts research work that is of good quality; it probably cannot be characterized as a world leader at this stage, but it could well be described as a world contributor. World leadership would require moving, over time, from incremental towards more fundamental contributions and greater innovation in ideas and methods.

The group leadership displays a determined effort to see the group succeed in the long run, and appears to be effective at promoting a collegial, inclusive atmosphere in which to conduct research.

The funding stream shows a high percentage of extramural funding, itself a measure of success and the impact perceived by sponsors. This is likely to continue in the near future, though developing and maintaining world-class facilities and resources require a predictable infusion of direct funding.

Productivity

As noted, the productivity strategy and its outcomes cannot be meaningfully assessed for the review period. The stated strategy of emphasizing journal publications is in principle good but should not be rigidly implemented in a one-size-fits-all manner.

Societal relevance

The group has defined important research questions and identified opportunities that lie at the interface of behavioral science, technology (especially information technology) and society. Accordingly, the societal relevance of its scope of research activities is high. Growing engagement with operating agencies is an important development for the group to position itself.

Vitality and feasibility

The group has experienced several disruptive events over the review period, particularly in terms of continuity and renewal of research personnel and leadership. Accordingly, there were concerns about its ability to weather these disruptions, regroup, rejuvenate and redefine a viable path forward for a renewed core of researchers.

The review conducted by the panel reveals that there have been significant positive developments indicating that the steps taken in the past couple of years are already beginning to show success and deliver on the promise and potential of this group. In particular, the recruitment of two new enthusiastic associate professors with complementary backgrounds, along with the full-time confirmation of the group leader, are very positive signs in that direction. The group has formulated a clearly articulated vision and strategy that uniquely define its contribution and potential, and align it with higher-level university initiatives. Recent successes in securing competitive extramural funding, and the corresponding rebuilding of the PhD population, portend well for the group's viability over the medium and long term.

Programme UT3: **Water Engineering and Management**
Programme director: Prof. dr. S.J.M.H. Hulscher
Research staff 2010 (fte): 4.07 tenured; 16.73 total

Assessments: Quality: Very Good (4)
 Productivity: Very Good (4)
 Relevance: Excellent (5)
 Vitality and feasibility: Very Good (4)

Short description

In the Water Engineering and Management programme, research is performed in two areas. The first deals with understanding coastal and river systems through fundamental research. The second deals with water management and the awareness of efficient water use in society. Coastal research has a creative and innovative research agenda including topics such as biomorphodynamics and multiscale modelling. The work on water management revolves around the water footprint concept, with numerous international applications.

Quality

The Coastal and River Systems group is very good. Most of the research funding obtained is competitive. The creativity of the research is reflected in the international quality of the journals in which articles are published. The Water Management group takes a more pragmatic approach by exploiting the water footprint concept in various ways. This includes contracts with large water users and a number of governmental and non-governmental bodies. There is little innovation apparent in the Water Engineering and Management group; it seems to be building on a single concept developed years ago. We suggest pursuing new avenues to complement the existing work. The publication outlets are consistent with the applied nature of the research. The programme has made a strategic decision of not operating their own facilities and acquiring experimental expertise through collaborations. This strategy has been pursued successfully during this assessment period. PhD training seems to follow a well-planned format that is implemented in a consistent way. There is a respectable number of PhD students in relation to the number of permanent staff.

Productivity

The productivity of the programme is very good. The Coastal and River Systems group publishes in top journals, implementing their strategy of focused publishing. The Water Management group is also very productive, although in a more practitioner-oriented way. The publication output has increased over the past six years.

Societal relevance

The societal relevance of the research in this programme is excellent. The Coastal and River Systems group has developed close links with internationally leading consulting firms. The Water Management group has developed the international Water Footprint Network together with main players in the water sector. This network seems to be a vehicle for acquiring contracts and significantly enhances the public visibility of the group.

Vitality and feasibility

Each of the two groups is managed well. There has been a consistent income over the past few years which will likely continue in the future. As a programme there is a diverse income stream, but the groups are more specialized. It does not seem that synergies between the two groups are being explored, and it is not clear in what way they could be realized.

Appendices

Appendix A: Curricula vitae of the committee members

Prof. dr. J. Dronkers

Job Dronkers is an internationally renowned expert in hydrodynamics and morphodynamics of coastal and marine systems. He started his professional career in these fields in 1976 when he joined Rijkswaterstaat, the Dutch governmental agency in charge of public works, road transport and water management. He conducted hydrosedimentary and environmental studies related to the construction of the Eastern Scheldt storm surge barrier and studies that laid the foundation of a new Dutch coastal policy. He was successively director of the advisory branch and the research branch of the National Institute of Coastal and Marine Management of Rijkswaterstaat. In these functions he was in charge of the development of new policies for combating marine pollution and for ecosystem-based management of the marine environment. In 1992 he was appointed part-time professor at Utrecht University for lecturing and research in the physics of coastal systems. His research and his practical experience are synthesized in “Dynamics of Coastal Systems”, a monograph that provides a global overview of the functioning of coastal systems. Recently he has been involved in the legislative aspects of developing and managing public infrastructure and is contracted by Rijkswaterstaat as advisor in this field. In the past decade Job Dronkers initiated coastal networks in many European countries for sharing knowledge and experience, across national boundaries and across disciplines, with a major focus on knowledge transfer between science and practice.

Prof. dr. D.E. Reeve

Dominic Reeve is Professor of Coastal Engineering in the College of Engineering at Swansea University. He has over 25 years experience in maritime research and consultancy, latterly employed by Halcrow Group, where he worked on port, harbour and coastal projects. He was the recipient of the 1995 PIANC International Gustav Willems prize. He was a member of the UK Government’s National Flood Risk Assessment 2008 Review Panel, and is a member of the Editorial Board for the ICE Maritime Engineering and the ASCE Journal for Waterway, Port, Coastal and Ocean Engineering. His current research focuses on the development and application of numerical techniques to improve our understanding of the long-term behaviour of beaches and their interaction with coastal structures. In particular, he is supervising active projects on the development of methods for: forecasting long term coastal and estuarine morphodynamics; statistical analysis of coastal morphology; the stochastic modelling of coastal processes; direct numerical simulation of wave overtopping of seawalls. He has published over 150 peer-reviewed research papers and is the Editing author of ‘Coastal Engineering: Processes, Theory and Design Practice’ (2004, 2011), author of ‘Risk and Reliability: Coastal and Hydraulic Engineering’ (2009), and co-author of ‘Hydraulic Modelling - An Introduction: Principles – Methods – Applications’, (2009) – published by Spon Press. Dominic Reeve is a Chartered Mathematician and Fellow of the Institution of Civil Engineers, the Royal Meteorological Society and the Institute of Mathematics and its Applications.

Prof. dr. G. Blöschl

Günter Blöschl is a Professor and Chair of Hydrology and Water Resources Management at the Vienna University of Technology (TU Wien). He is also the Director of the Centre for Water Resource Systems and Head of the Institute of Hydraulic Engineering and Water Resources Management at TU Wien. Günter Blöschl graduated in Civil Engineering, took a Doctorate (1990) and a Habilitation in Hydrology (1997) at TU Wien. His international experience includes appointments at universities in Vancouver, Canberra and Melbourne. His research interests cover a wide spectrum of topics including flood processes, droughts, soil moisture, and water resources adaptation strategies to climate change. He has published more than 300 scientific publications. 115 of them are ISI journal papers. He has been cited more than 3000 times in 40 different

disciplines with an H-index of 33. Günter Blöschl has been elected Fellow of the American Geophysical Union and the German Academy of Science and Engineering. Recently he has been awarded the prestigious Advanced Grant of the European Research Council (ERC). Günter Blöschl has been elected President of the European Geosciences Union. Günter Blöschl is the Director of the Vienna Doctoral Programme on Water Resource Systems, a multi-year interdisciplinary PhD programme at TU Wien on water, focusing on connecting biogeochemical and ecological processes impacting on water quality.

Prof. dr. H.S. Mahmassani

Hani Mahmassani holds the William A. Patterson Distinguished Chair of Transportation at Northwestern University, where he is Professor in Civil and Environmental Engineering, and in Industrial Engineering and Management Science, McCormick School of Engineering and Applied Science, Professor (courtesy) in Managerial Economics and Decision Sciences, Kellogg School of Management, and Director of the Northwestern University Transportation Center. He has over 30 years of professional, academic and research experience in the areas of intelligent transportation systems, multimodal systems modeling and optimization, pedestrian and crowd dynamics and management, traffic science, demand forecasting and travel behavior, information technology and mobile social networking, dynamic system management, and real-time operation of logistics and distribution systems. Hani Mahmassani received his PhD from the Massachusetts Institute of Technology in transportation systems and his MS in transportation engineering from Purdue University. He has served as principal investigator on over 130 funded research projects sponsored by international, national, state, and metropolitan agencies and private industry.

Prof. dr. M. Kagioglou

Mike Kagioglou is the Head of School of the School of the Built Environment (SoBE), University of Salford, a permanent position within the College of Science and Technology. He is also Academic Director for the Engineering and Physical Sciences Research Council (EPSRC) funded interdisciplinary IMRC in Health and Care Infrastructures Research and Innovation Centre (HaCIRIC) and PI for Salford University. Partners include Imperial College, Salford, Loughborough and Reading Universities. Mike Kagioglou is Professor of Process Management at the School of the Built Environment, member of the University Management Group, College Executive, School Executive (Chair), College Research Committee, project board for research and innovation, University Senate. He is also director of the EPSRC funded Salford Centre for Research and Innovation (SCRI) in the built and human environment (July 2008) and theme leader for the University's theme of the Built and Human Environment, an inter- and multi-disciplinary theme that cuts across the University activity with more than 120 academics. Further Mike Kagioglou is director of Protocol Lab, a spin out company resulting from the Process Protocol Research and Fellow of the Higher Education Academy.

Prof. Eng. G. Mancini

Giuseppe Mancini is full professor of Structural Design and Bridge Design at the 1st Engineering Faculty of Politecnico di Torino and member of the teaching body of PhD Schools in Structural Engineering. He is also professor at the Master of Università of Milano and Roma 3 and professor at the International PhD of Rose School di Pavia; Giuseppe Mancini is Partner and President of the Board of Directors of Engineering Society Sintecna srl in Turin. He was design leader of more than 150 railways and road bridges. He has been the Honorary President of Federation International du Beton (Fib) between 2004 and 2006. Giuseppe Mancini took his degree at Politecnico di Torino in Turin in 1972. Giuseppe Mancini is also chair of the project team for Eurocode EN1992-2 Concrete Bridges, of the SC2 Commission - Concrete Structures - TC250 of European Community (between 2005 and 2011) and of the CIS-UNI n° GL9

Commission – Bridge Design. He is member of the Science Academy of Turin (Founded by Lagrange) and of the American Society for Civil Engineering (ASCE).

Appendix B: Score Overview

Research Programme name	Quality	Productivity	Relevance	Vitality and feasibility
TUD1: Structural Mechanics	5	4	4	4
TUD2: Materials & Environment	4	3	4	4
TUD3: Steel, Wood & Composite Structures	3	3	4	3
TUD4: Concrete Structures	4	3	5	3
TUD5: Road and Railway Engineering	4	3	5	2
TUD6: Transport & Planning	5	5	5	5
TUD7: Hydraulic Engineering	4	4	5	4
TUD8: Environmental Fluid mechanics	4	4	5	4
TUD9: Water Resources Engineering	5	4	4	4
TUD10: Sanitary Engineering	4	4	4	4
UT1: Construction Mgt & Engineering	4	4	4	4
UT2: Centre for Transport Studies	3	3	3	4
UT3: Water Engineering & Management	4	4	5	4

Explanation of the SEP-scores

<i>Excellent (5)</i>	Research is world leading. Researchers are working at the forefront of their field internationally and their research has an important and substantial impact in the field.
<i>Very Good (4)</i>	Research is considered nationally leading. Research is internationally competitive and makes a significant contribution to the field.
<i>Good (3)</i>	Research is internationally visible. Work is competitive at the national level and makes a valuable contribution in the international field.
<i>Satisfactory (2)</i>	Research is nationally visible. Work adds to our understanding and is solid, but not exciting.
<i>Unsatisfactory (1)</i>	Work is neither solid nor exciting, flawed in the scientific and/or technical approach, repetitions of other work, etc.

Quality refers to the level of the research compared to accepted (international) standards in the field. As a rule, quality is measured by judging the international academic reputation, the position and the output of the unit to be evaluated. In case of a *national* orientation of a research field, the point of reference consists of other groups in the country.

Productivity regards the relationship between input and output. Output should always be judged in relation to the mission and resources of the institute. When looking at productivity in terms of publications of scientific articles and the like, a verdict is usually cast in comparison with international standards of a quantitative nature. However, this is often not possible when looking at other forms of output (for example health protocols, designs, policy reports). Since many institutes will have variegated output and scientific activities, evaluators are asked to also include other forms of (qualitative) information in their assessment.

Relevance covers the social, economic and cultural relevance of the research. Evaluators are asked to consider one or more of the following three aspects:

- *Societal quality of the work.* This aspect refers primarily to the policy and efforts of the institute and/or research groups to interact in a productive way with stakeholders in society who are interested in input from scientific research. It may also refer to the contribution of research to important issues and debates in society.
- *Societal impact of the work.* This aspect refers to how research affects specific stakeholders or specific procedures in society (for example protocols, laws and regulations, curricula). This can be measured, for example, via charting behavioural changes of actors or institutions.
- *Valorisation of the work.* This aspect refers to the activities aimed at making research results available and suitable for application in products, processes and services. This includes activities regarding the availability of results and interaction with public and private organisations, as well as direct contributions such as commercial or non-profit use of research results and expertise.

Vitality and feasibility regards the institute's ability to react adequately to important changes in the environment. It refers to both internal (personnel, research practice) and external (developments in the field, in society) dynamics of the group.

Appendix C: Personnel Resources Overview

The Faculty of Civil Engineering and Geosciences (TU Delft) and the Faculty of Engineering Technology (University of Twente) have provided the following personnel resources overview (full-time equivalents research time) in their self evaluation reports.

Research program	Total Research Staff (fte)					
	2005	2006	2007	2008	2009	2010
1. Structural Mechanics	14.51	16.27	18.86	21.95	21.03	21.90
2. Materials & Environment	9.08	16.77	22.98	29.16	36.02	40.32
3. Steel, Wood & Composite Structures	5.83	7.94	8.08	9.44	10.41	8.85
4. Concrete Structures	3.88	4.32	3.65	6.35	6.76	8.03
5. Road and Railway Engineering	10.33	10.90	11.82	14.51	16.65	20.45
6. Transport & Planning	22.82	25.08	25.73	20.74	29.29	27.86
7. Hydraulic Engineering	33.25	35.11	39.12	39.85	43.10	44.05
8. Environmental Fluid Mechanics	12.20	13.30	15.58	11.88	10.93	11.18
9. Water Resources Engineering	18.48	19.81	20.57	22.89	22.92	25.43
10. Sanitary Engineering	10.59	13.75	15.02	16.98	15.10	15.65
11. Construction Management & Engineering	12.50	15.08	15.27	16.67	18.09	17.15
12. Centre for Transport Studies	5.20	7.01	4.81	6.61	7.62	10.55
13. Water Engineering & Management	23.27	21.13	20.51	21.06	18.70	16.73

Appendix D: Funding Overview

The Faculty of Civil Engineering and Geosciences (TU Delft) and the Faculty of Engineering Technology (University of Twente) have provided the following funding overview in their self evaluation reports.

Research program	Total Funding (k€)					
	2005	2006	2007	2008	2009	2010
1. Structural Mechanics	1520	1818	1182	1247	2859	1717
2. Materials & Environment	947	1010	1172	2299	1649	3183
3+4 Structural Engineering	4606	3263	2928	1552	1905	2676
5. Road and Railway Engineering	1432	1474	1664	1960	2215	1434
6. Transport & Planning	2328	2319	2067	2162	3573	3444
7. Hydraulic Engineering	2537	2958	3445	4050	3763	3751
8. Environmental Fluid Mechanics	1052	1255	971	747	587	1241
9. Water Resources Engineering	1132	1304	1254	1752	1999	3040
10. Sanitary Engineering	1087	1005	1379	1586	1612	2157
11. Construction Management & Engineering	2376	2608	2947	3472	3464	3525
12. Centre for Transport Studies	648	937	1021	1324	1506	1254
13. Water Engineering & Management	2576	2516	3003	2654	2670	2429

Appendix E: Productivity Overview

The Faculty of Civil Engineering and Geosciences (TU Delft) and the Faculty of Engineering Technology (University of Twente) have provided the following productivity overview (number of publications) in their self evaluation reports.

Research program	Total Publications (nrs)					
	2005	2006	2007	2008	2009	2010
1. Structural Mechanics	57	86	113	116	115	83
2. Materials & Environment	108	157	157	143	124	132
3. Steel, Wood & Composite Structures	58	44	53	80	43	51
4. Concrete Structures	66	43	41	45	60	33
5. Road and Railway Engineering	48	71	48	75	70	102
6. Transport & Planning	176	209	201	199	205	198
7. Hydraulic Engineering	227	179	284	234	254	172
8. Environmental Fluid Mechanics	31	42	58	34	65	67
9. Water Resources Engineering	129	116	147	166	160	130
10. Sanitary Engineering	174	144	192	168	209	144
11. Construction Management & Engineering	58	64	78	100	123	103
12. Centre for Transport Studies	28	30	32	40	30	72
13. Water Engineering & Management	99	90	134	111	119	96

Appendix F: Abbreviations

Abbr.	Description
AIDA	Knowledge Centre Applications of Integrated Driver Assistance
CE	Civil Engineering
CEG	Faculty of Civil Engineering and Geosciences
CE&M	Civil Engineering and Management
CME	Construction Management and Engineering
CTS	Centre for Transport Studies
EU	European Union
FP7	Seventh Framework Program (EU instrument for the financing of research for the period 2007/2013)
fte	Full time job equivalent (40 hours per week)
KNAW	Koninklijke Nederlandse Academie van Wetenschappen / Royal Netherlands Academy of Arts and Sciences
NWO	Nederlandse Organisatie voor Wetenschappelijk Onderzoek / Netherlands Organisation for Scientific Research
PSIB	Proces en Systeem Innovatie in de Bouw
QANU	Quality Assurance Netherlands Universities
SEP	Standard Evaluation Protocol
STW	The Dutch Technology Foundation
TNO	The Netherlands Organisation for Applied Scientific Research
TTE	Transportation Planning and Traffic Engineering
TU Delft	Delft University of Technology
SWAN	Simulating Waves Nearshore (third generation wave model)
SWASH	Simulating Waves till Shore (non-hydrostatic wave-flow model)
UT	University of Twente
VSNU	Vereniging van Universiteiten in Nederland / Association of Universities in the Netherlands