QANU-Research Review
Mechanical Engineering

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FOREWORD

This report follows the Standard Evaluation Protocol 2003-2009 for Public Research Organisations (SEP) that was developed by VSNU, KNAW and NWO. The purpose of this report is to present a reliable picture of the research activities submitted for this review and to give feedback to the internal quality assurance of the organisations concerned.

The review committee was supported by QANU (Quality Assurance Netherlands Universities). QANU aims to ensure compliance with SEP in all aspects and to produce independent assessment reports with peer review committees of international experts in the academic fields involved.

QANU wishes to thank the chairperson and members of the Review Committee for their participation in this assessment and for the dedication with which they carried out this task. We also thank the staff of the units under review for their carefully prepared documentation and for their co-operation during the assessment.

Quality Assurance Netherlands Universities

Mr. Chris J. Peels
Director

Dr. Jan G.E. Veldhuis
Chairman of the Board

PREFACE

The research review committee Mechanical Engineering had the task to evaluate forty-nine research programs and their organizational embedding in eight institutes at Delft University of Technology, Eindhoven University of Technology and University of Twente. The review covers the research in the period 2001-2006.

As Chair of the Review Committee I wish to thank the committee members for their valuable contributions, for the time they were willing to spend and for the discussions in the Committee that added value to this team effort.

The Committee appreciated the thorough self-assessments that were provided by the Faculties and the openness of the management, Program Directors and PhD-students during the interviews.

The process of putting the report in its final form, after the draft version had been submitted to the Faculties, took an unusually long time. It appears that the delay was to some extent caused by a disproportionate focus on the numerical scores and on their assumed absolute and relative value. The Committee has been very careful not to enter into negotiations about scores, while preserving the right of all participating groups to point out possible mistakes and ask for clarification. We strongly believe that the scores are only one element in the assessment and they should never be used as the only basis for policy decisions. The textual material of the report, including the written evaluations, the objectives, the context and the stage of development of the programs must be taken into account, as well as the differences between the several subfields of Mechanical Engineering.

The Committee hopes and trusts that the feedback that this report is intended to provide, will be used wisely in the quality assurance procedures of the Faculties and Universities.

Last but not least, the Committee wishes to thank Roel Bennink, the Committee's Secretary, for his indispensible assistance and wise counsel in the preparation of the visits, and in the completion of the final report.

Prof. Jan Achenbach
Chairman of the Review Committee

1. The review committee and the review procedures

Scope of the assessment
The Review Committee was asked to perform an assessment of the research in Mechanical Engineering at the Delft University of Technology (TUD), at Eindhoven University of Technology (TUE) and at the University of Twente (UT). This assessment covers the research in the period 2001-2006.

In accordance with the Standard Evaluation Protocol 2003-2009 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 programme leaders, and to advise how this quality might be improved.

Composition of the Committee
The composition of the Committee was as follows:

- Prof. Jan D. Achenbach, Northwestern University, chairman of the Committee
- Prof. Yusuf Altintas, University of British Columbia
- Prof. Torgeir Moan, Norwegian University of Science and Technology
- Prof. Roger Owen, Swansea University, Wales
- Prof. Paul Roth, Universität Duisburg-Essen
- Prof. Robert E. Skelton, University of California San Diego
- Prof. Frans Spaepen, Harvard University
- Prof. Cameron Tropea, Technische Universität Darmstadt
- Prof. Ward Winer, Georgia Institute of Technology.

A short curriculum vitae of the Committee members is included in Appendix A.

Roel Bennink of the Bureau of QANU (Quality Assurance Netherlands Universities) was appointed secretary to the Committee.

Independence
All members of the Committee signed a statement of independence to safeguard 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 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 risk in terms of bias or undue influence.

Data provided to the Committee
The Committee has received detailed documentation consisting of the following parts:

- Self-evaluation reports of the units under review, including all the information required by the Standard Evaluation Protocol (SEP), with appendices
- Copies of three key publications per research programme
- Bibliographic Study 1999-2006, CWTS
- Research Coordination by 3TU Graduate Schools (JM Burgers Centre for fluid mechanics, Engineering Mechanics, Dutch Institute of Systems and Control DISC).

Remarks about the data provided
The SWOT analyses in the self-evaluations were clear, candid and pertinent in most cases and proved to be very valuable for the evaluation and recommendation work of the Committee. The preparation of the self-evaluation obviously is an important part of the research review.

A bibliometric analysis produced by the Leiden University Centre for Science and Technology Studies (CWTS) was provided to the Committee in March 2008. This study was commissioned by the three participating universities in order to provide insight in the publication output and international impact of the Mechanical Engineering research programmes that are considered in this review. The Committee has used the bibliometric analysis as point of reference in the interviews and in the assessments. The Bibliometric Study provided valuable insight on the publication output and the international impact of the research on Mechanical Engineering using the citation indices databases (CI). The authors of this study have done a careful analysis of the output and impact indicators of the programmes. Several important indicators are produced for each programme in this review:

- P: the number of CI papers;
- C: the number of citations in CI journals to these papers (excluding self-citations);
- CPP=C/P: the number of citations per paper;
- CPP/FCSm: the impact of the papers of a research programme compared to the average citation rate (FCSm) of the journal set of that research programme.

The use of this ratio CPP/FCSm makes a fair comparison possible between groups that have a traditionally different citation culture. It is a well-known fact that lower citation counts are obtained for programmes that are close to conventional technology or industrial applications. A value CPP/FCSm=1 implies that the papers produced in this programme have an average impact that is equal to that of authors of similar papers in the world. A value CPP/FCSm substantially larger than 1 on the other hand implies that the papers of the programme have on average substantially more impact than similar papers in the world.

The Committee was fully aware of the differences in presentation of research results (conferences versus journals, CI journals versus other journals) and publication traditions in the different programmes. Hence, the Committee agrees with the authors of the Bibliometric Study that bibliometric indicators cannot be interpreted properly without background knowledge of both the research programmes that are evaluated and the subfields in which the researchers are active. For that reason, the productivity evaluations made by the Committee are not only based on the Bibliometric Study, but also on considerations that are specific to the research programme.

Procedures followed by the Committee
The Committee proceeded according to the Standard Evaluation Protocol (SEP). Prior to the Committee meeting, each 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 with the leaders of the programmes. The interviews took place on March 31-April 4, 2008 (see the schedule in Appendix C) on location in Twente, Eindhoven and Delft.

Preceding the interviews, the Committee was briefed by QANU about research assessment according to SEP. The Committee discussed the preliminary assessments and for each pro-

gramme a number of comments and questions were decided upon. The Committee also agreed upon procedural matters and aspects of the assessment. After the interviews the Committee discussed the scores and comments. The texts for the programme and institute assessments were drafted during the visit and finalised through email exchanges. The final draft version of the report was presented to the faculties for factual corrections and comments. The comments were discussed in the Committee and led to changes in the report on a number of points. The final report was presented to the boards of the participating universities and was printed after formal acceptance of the report.
The Committee used the rating system of the Standard Evaluation Protocol (SEP). The meaning of the scores is described in Appendix B.
The Committee wishes to emphasise that the assessment texts for the programmes are not intended to provide a complete explanation of the scores. As prescribed by the Standard Evaluation Protocol, the scores mainly express to what extent the research is regarded as internationally leading and what impact it is considered to have in its field, also in the future. The Committee based the scores on:

- the self-evaluations, SWOT-analyses, key publications and publication lists
- the interviews with the programme directors, the Dean and the research management
- the expertise and experience of the committee members and the internal deliberations of the Committee
- the bibliometric study carried out by CWTS.

The assessment texts can never fully describe all elements that have played a role in determining the scores for the programmes. The texts describe a number of characteristics of the programmes that were noted by the Committee, especially in a positive sense. For determining the scores, not all these elements have carried equal weight, because not all of them are directly related to the international ranking and academic impact of the groups.

2. General remarks

The Field of Mechanical Engineering
Practically every major university-level engineering school has a Department or Faculty of Mechanical Engineering. At the graduate research level, mechanical engineering encompasses classical areas as well as areas that have more recently been initiated.

The classical areas of research are concerned with the design, analysis, manufacturing and control of mechanical systems, together with the associated analytical, numerical and experimental methods in heat transfer, control theory, and solid and fluid mechanics. Related key areas are combustion and other energy conversion processes as well as tribology.

Novel applications of technology, systems integration and development of new products have always been part of programmes at the graduate research level. However, in recent years Mechanical Engineering proved itself to be particularly well prepared to embrace fundamental new results in the sciences and provide the engineering know-how for further developments towards innovative technological applications.

Examples of more recently initiated research areas are:

- development of optoelectrical mechanical machines,
- materials research over many length scales,
- micro and nanoscale devices,
- biomedical research for tissue engineering, medical instrumentation, prostheses and medical devices.

In addition, research carried out in Mechanical Engineering has started to play a central role in technological developments of immediate societal importance. Examples are:

- more efficient and cleaner energy conversion,
- the solution of environmental problems
- the development of alternative methods for the sustainable production of energy.

Societal relevance
It is of national interest to the Netherlands that the Technical Universities direct substantial parts of their research efforts to the short term as well as the long term needs of Dutch industry, and thereby to Dutch society. In this connection the Committee was pleased to note that the Department of Mechanical Engineering of the University of Twente includes in its Mission Statement that its research mission is "to develop qualitative and quantitative knowledge on all phasas of the life cycle of mechanical engineering systems and objects, i.e. initiative, design, production, operation, maintenance and demolition, all in a societal and environmental context". The Committee was pleased to note that the programmes of the Department of Mechanical Engineering at the University of Twente generally do indeed place great emphasis on national or international societal relevance. The Committee is of the opinion that this aspect of the Twente research mission deserves all appropriate support.

Main findings
The research programmes in Mechanical Engineering at the three TU's are in line with the description of the field of mechanical engineering given earlier. Each of the ME research programmes at the three TU's has significant elements of the classical core programmes, but each also has several recently initiated programmes in novel areas.

It is noteworthy that significant overlap has been avoided, which forestalls undesirable competition in a relatively small environment of research programmes. This is not to say that there should be no healthy competition between Mechanical Engineering research at the three TU's. There is ample evidence of healthy competition, as there should be, on a broader plane.

In general, the Committee was impressed by the quality and quantity of the research in Mechanical Engineering in the Netherlands. The research that is carried out makes significant contributions to the field, in cutting edge research as well as in innovative applications of new concepts and methodologies.

The assessments of the programmes often contain specific comments and recommendations. In the following, we list a number of concerns that came up in the assessment of different programmes.

Overview of main recommendations on the programme level:

- Funding for fundamental research has decreased as the funding for applied research is increased. The Committee considers this a dangerous trend. Without a healthy effort at the fundamental level, there will be no long-term input to work on innovative applications. Fundamental research also is more rewarding in terms of programme recognition.
- Difficulties in attracting native-born students for the PhD-degree are a problem that the Netherlands shares with almost all developed countries. A possible solution has to start with generating interest in science and engineering at the early stages of secondary education.
- More attention should also be given to attracting female students to mechanical engineering.
- The novel areas of mechanical engineering research are generally more successful in having their MSc-students continue for the PhD-degree. As in other developed countries, international students are filling up the available vacancies.
- The large number of small programmes may be a constraint on the organizational flexibility of individuals to branch into new, more productive areas.
- Teaching assignments should not prevent active participation in research programmes, which seems to be the case in some groups.
- The accounting scheme for formal recognition of joint work should give appropriate credit to all faculty efforts on joint papers, grants, or PhD student supervision. This will encourage collaborative efforts at little cost.
- Opportunities for independent research by young investigators should be enhanced.
- Flexible internal funding for fast response to innovative research ideas, especially from young investigators, should be enhanced.

3. Assessments per institute and per programme

3.1. TU Delft - Part A: Assessment at the institute level

Mission & Goals
The self-evaluation report states the mission of 3mE as
"The faculty of 3mE educates committed engineers and PhD graduates and conducts breakthrough scientific research in the fields of mechanical engineering, maritime engineering and materials science. The Faculty wishes to be an excellent example of a dynamic and innovative faculty, which pursues a leading position in Europe and makes a direct contribution to the economy and society."

The report supplements the mission statement by sections entitled "Vision" and "Towards 2011 and beyond." These sections show a well thought-out plan for the future of the 3mE Faculty.

Leadership
In terms of management, the Faculty of 3mE is divided into six departments, each acting as an independent research institute, with its own research programme. The six departments are:

- Process and Energy (P&E), Prof. dr. ir. P.J. (Peter) Jansens
- Maritime and Transport Technology (M&TT), Prof. dr ir. G. (Gabriël) Lodewijks
- Biomechanical Engineering (BMechE), Prof. dr. F.C.T. (Frans) van der Helm
- Materials Science and Engineering (MSE), Prof. dr. ir. A.H.M. (Ad) Verkooijen
- Precision and Microsystems Engineering (PME), Prof. dr. ir. A. (Fred) van Keulen
- Delft Centre for Systems and Control (DCSC), Prof. dr. ir. P.M.J. (Paul) Van den Hof.

As stated, the Dean, Prof. drs. Marco Waas, forms the board of the Faculty. However, as also stated, a management team consisting of the Dean, the department heads, the director of education, the secretary to the faculty and the managers for finance & control and HRM, is a platform for sharing ideas on vision and strategy and for discussing decisions that will be made. The management team meets every two weeks to discuss day-to-day business and confers on policy and strategy three times a year at off-site meetings. All full professors of the Faculty meet once or twice a year to discuss strategic matters relating to educational programmes and research directions.

In the view of the Committee, the management of the Faculty appears to be well-defined.

Strategy & Policy
Every two years the Faculty updates its strategy and corresponding targets, which are derived from external and internal input, discussed with the employee council and the student council and then agreed with the University Board. Every year strategic priorities are determined, which are laid down in a one page strategic summary.

The creation of the departments within 3mE does not appear to have met major disagreements from the faculty. Clearly the chairperson of the department has a very important responsibility in his role of overall manager and scientifically responsible director. The Committee has some concern that the division into the departments may have erected barriers for contacts and synergies between faculty members.

Balance of Strengths & Weaknesses
The faculty has three major disciplines, namely, Mechanical, Maritime and Materials Engineering. The core research areas are divided into six institutes (or departments) each having several subdisciplines. The faculty has well equipped laboratories for teaching and for basic and applied research ranging from small to very large projects with national and international partners.
The committee reviewed all disciplines except the recently created Intelligent Mechanical Systems (IMS) within the Department of BioMechanical Engineering. The impact of grouping programmes under departments has benefited some members of the faculty, while others had difficulty to adjust because of the change in the focus of research as well as the delayed appointment of new chairs. In some cases, the faculty has more work to do to bring their programme to an international level of excellence. The programmes seem to be grouped appropriately.

The committee noted that 3ME has been moving into the Micro and Nano Engineering fields in a substantial way. The faculty is recommended to avoid duplication of similar efforts in sister departments, and design a well prepared research strategy ahead of major initiatives. The leadership of the departments must be carefully selected with a clear mandate and research direction before establishing new chairs, or asking the programmes to change their existing research direction and expertise.

3ME covers a wide range of engineering disciplines which enables the departments to participate in research projects. Such cooperative activities are easily seen between Dynamics Systems and Controls, BioMechanical and Mechatronics Groups. The faculty can improve the cross- collaboration between the departments by creating incentives for joint publications and supervision of PhD-students.

The graduate students did not express any concerns, and they were all positive about the environment and research training they are receiving in their programmes. While emerging fields have no problem in attracting Dutch graduate students to PhD-programmes, the classical fields have to recruit from an international pool which is common in all universities in North America and Europe.

The 3ME Faculty appears to have increased the rate of training of PhD-students and the publication of archival journal papers in recent years, which is in-line with its goals. However, the faculty is recommended to measure the research publications by a weighted combination of quantity, quality and impact. The departments, which receive significant industrial funding, are encouraged to reserve funds for curiosity driven basic research, which will lead to new proposals for competitive research funding from public agencies.

The committee noted that there are a number of part-time professors from industry, who bring synergy and help to create relevant research projects. However, the programmes can best focus when they are led by full time professors whose commitments are only to the research based at the university. The part time professors may not be able to lead both the programmes at the university and in industry, which have different cultures and mandates.

The committee feels that in an overall sense the faculty has an academic quality, productivity, relevance and viability well above the average in comparison to similar international institutes.

Resources
The Department has provided the following overview of the personnel resources, in full-time equivalents (fte) research time.

Faculty level	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Tenured staff	37,9	37,3	38,3	38,8	39,4	38,6
Non-tenured staff	37,3	38,6	38,6	47,7	59,3	64
PhD students	104,4	105	110,6	118,8	131,5	145,6
Total research staff	179,5	180,9	187,5	205,3	230,2	248,2

Department level	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
BmechE						
Tenured staff	2,6	3,1	3,5	3,3	4,2	3,4
Non-tenured staff	4,5	5	4,2	3,3	2,4	3,3
PhD students	12,1	11,1	8,6	6,8	10	12,8
Total research staff	19,2	19,2	16,3	13,4	16,6	19,5
DCSC						
Tenured staff	6,2	6,4	6	6,3	5,8	5,4
Non-tenured staff	2,6	1,9	1,8	5,1	6,5	5,4
PhD students	17,3	16,6	15,6	15,6	18,9	27,4
Total research staff	26,1	24,9	23,4	27	31,2	38,2
MSE						
Tenured staff	6,8	6,2	6,3	7	7,5	7,5
Non-tenured staff	16	20,6	20,2	23,1	28,5	29,7
PhD students	26,1	25,4	26,9	28,6	29,7	29,2
Total research staff	48,9	52,2	53,4	58,7	65,7	66,4
M&TT						
Tenured staff	9,9	8,9	9,4	8,8	8,7	8,3
Non-tenured staff	4	1,7	2	4,7	6	7,5
PhD students	7,8	6,7	6,7	9,9	12,9	15
Total research staff	21,7	17,3	18,1	23,4	27,6	30,8
PME						
Tenured staff	6	6,3	6,2	6,6	6,7	6,7
Non-tenured staff	1,5	3,1	4,1	3,1	4	6,8
PhD students	10,7	11	15	18,9	22,4	24,3
Total research staff	18,2	20,4	25,3	28,6	33,1	37,8
P&E						
Tenured staff	6,5	6,5	6,8	6,8	6,5	7,3
Non-tenured staff	8,6	6,3	6,3	8,5	11,8	11,3
PhD students	30,4	34,2	37,8	39,1	37,6	36,9
Total research staff	45,5	47	50,9	54,4	55,9	55,5

Remarks per Institute

TUD Department: Biomechanical Engineering (BmechE)
The mission of the Department of Biomechanical Engineering is to understand and to improve the interaction between humans and technical systems, through fundamental research and innovative designs focused on the controllability of the technical systems and the properties of the human controller. Major application areas of the research are in biomedical engineering (smart tools for difficult surgery, prosthetics, implants and diagnostic tools for patients), in Man-Machine Systems (interfaces for surgery, car driving and tele-operation) and in Biorobotics (humanoid robots, haptic feedback interfaces and robot manipulators for diagnosis).

The department has the following research programmes:

BioMechatronics & BioRobotics:

- Neuromuscular models and measurement techniques
- Large-scale musculoskeletal models
- Prosthetics and orthopaedics
- Interactive mechanisms
- Humanoid robots
- Haptic interfaces

Man-Machine Systems & Medical Instruments:

- LIFE OR – OR process and design
- BITE – Bio-Inspired Technology
- S4 - Surgical Sensing & Support Systems
- VA - Virtual Assistant for car driver simulator

Intelligent Mechanical Systems:

- Design Theory for multi-disciplinary product development of complex high-tech systems
- Design methodology for innovative, bio-inspired features
- Manufacturing applications of intelligent machines
- Life-cycle engineering.

Evaluative remarks
The department of BioMechanical Engineering has flourished under the present leadership and became an international leader in the field. In the view of the Committee, the department will continue to expand and will improve its academic distinction in the fields of Man-Machine Systems, Medical Instruments and Intelligent Mechanical Systems when these sub-groups further elevate their presently good status by publishing in prestigious journals.

The director is to be commended for his passionate and dynamic academic leadership, which led to an internationally recognized centre in the field of Biomechanical Engineering at the university**.**

TUD Department: Delft Centre for Systems and Control (DCSC)
The research of the Delft Centre for Systems and Control covers modelling, control and optimisation of complex dynamical systems mainly in mechatronics and microsystems, sustainable industrial processes, traffic and transportation systems. The research is aimed at contributing to the fundamental aspects of dynamical Systems and Control, as well as to advancing innovative and high-tech applications.
The Centre has the following research programmes:

1. Modelling, identification, control and optimisation of complex dynamic systems (Fundamentals)
2. Mechatronics and Microsystems
3. Sustainable Industrial Processes
4. Traffic and Transportation Systems

Evaluative remarks
The research in this institute applies systems and control mathematical methods to solve important problems in control theory and industrial applications of control theory. The focus of performance-based design is well-motivated because that focus drives new analytical methods that contribute to improved performance which the industry can readily appreciate. The broad range of research topics include Model-based control design, robust control, identification and data-based control, mechatronics, discrete event systems, sustainable industrial processes, and traffic control. The merger of 3 groups at Delft to form the Systems and Control group was a good move to give the institute a wider lateral range of control problems. The programme has strategic alliances with cross faculty appointments with specific application departments such as Biomechanical, Transportation, Precision and Microsystems Engineering. Their application of control concepts to improve AFM technology is a great example of interdisciplinary success and positive interactions across disciplines.

The international reputation of this institute is high and there is every reason to be optimistic about the ability of this institute to provide world leadership in the areas of their strength, systems and control theory, and systems and control applications.

The leadership is strong and has an excellent international reputation as a world-wide leader in systems identification.

Since control theory is relatively new (less than 70 years old, compared to the 200 year history of some scientific disciplines like dynamics), it is especially important in this field to provide unrestricted research opportunities to bright young students or faculty to get a jump-start on innovative new ideas or directions in control. Whether this type of funding (which we can call “Fellowships”) should be provided by the university or the institute can be a matter of discussion.

TUD Department: Materials Science and Engineering (MSE)
The research in the Department of Materials Science and Engineering covers the entire materials processing route from extractive metallurgy through downstream processing to service properties and recycling. The research ranges from fundamental understanding of materials to the implementation of technology. The ambition is to play a leading role in materials research and to provide top level academic education in a research-oriented environment.

In the view of the Department, sustainable technology development is needed to bridge the gap between societal needs and natural resources. For materials science the focus must be on improving the entire life cycle of materials, including the processing of raw materials and the design of new materials with revolutionary properties that help fulfil societal needs, while diminishing the burden on natural resources and the environment. Sustainability demands an increase in a materials life span and efficient recycling of materials. The Department responds to these challenges by improving the understanding of materials and structures and the development of processing routes which maximise efficiency whilst minimising resource consumption. The Department has chosen to concentrate most of its research efforts on metals. Increasing knowledge of properties, behaviour and processes will support engineers that design new components and structures.

The Department has well equipped state-of-the-art laboratories at its disposal, partly funded through collaboration with NIMR, STW, NWO and industries like Corus. The equipment enables the study of production processes such as casting, rolling, extrusion, powder forming and welding. Advanced facilities are available for the formation of thin layers and hard coatings, while other facilities permit the determination of macroscopic mechanical properties and the study of corrosion. The composition and properties of materials can be studied at microscopic scale. The instruments allow *in situ* application of external stress, both mechanical and thermal. Experiments using synchrotron radiation and experiments with neutrons are also carried out in large-scale facilities elsewhere. Many scientific breakthroughs in materials science have been a direct result of the new analytical and experimental techniques, such as large-scale synchrotron radiation which enables scientists and engineers to probe deep into the structure of matter.

The research themes in the Department are:

- Joining and Mechanical Behaviour (JMB)
- Light Metals Processing (LMP)
- Microstructure Control in Metals (MCM)
- Materials Structure and Change (S&C)
- Surfaces and Interfaces (S&I).

Evaluative remarks
The department has seen many organizational changes over the last few years and deserves a period of administrative stability to enable it to develop worthwhile long-range plans. The imminent retirement of Verkooijen makes is necessary to think carefully about the selection of a thoughtful yet dynamic new chairman.

In terms of strategy, the focus of the Department on metals is a wise one: in a world where most Metallurgy Departments have almost disappeared, it provides clear visibility. At the same time, most of the problems posed in metallurgy are very much generic ones, so that it allows

the faculty to maintain sufficient scientific breadth. The appointment of three new professors will lead to additional visibility.

The University and the 3ME faculty seem dedicated to maintaining the health of the MSE departments. Two specific additional aspects could be considered, regarding the resources and funding: (i) The establishment of a flexible funding mechanism that allows quick response, especially by junior researchers, to innovative ideas. (ii) Investment in some strategic major pieces of equipment. In particular, the heavy demand for high-end transmission electron microscopy may require acquisition of another instrument, either for the department or as part of the electron microscopy centre.

More generally speaking, there seems to be a need for a university fund for pursuing new ideas in fundamental materials science that cannot be easily supported by the existing sources.

Regarding the scientific reputation of the institute, although materials science at Delft was at one point much larger than this Department, in its current configuration it has been noted for several reasons: its re-emphasis of metallurgy, its central role in the NIMR, and the appointment of clever young people. It is to be hoped that it will now experience a period of stability that will allow it to develop further and acquire an even better international image.

The societal relevance of the institute is high. Materials engineering is central to much of human activity: “Everything is made of something”. The Department’s activity will never cease to be relevant.

TUD Department: Maritime and Transport Technology (M&TT)
The mission of the Department of Maritime & Transport Technology is to educate committed BSc, MSc and PhD students to develop, design, build and operate marine, offshore, dredging and transport systems, their respective equipment, and to carry out cutting edge research based on the technology and management of the systems and processes involved. To this end M&TT offers high quality, worldwide acknowledged research and education and contributes to the competitive position of the Dutch and European marine and transport sector in a global context.

The research themes of the Department are:

- Transport Engineering & Logistics (TEL)
- Ship Design, Production & Operation (SDPO)
- Ship Hydromechanics & Structures (SHS)
- Offshore & Dredging Engineering (ODE).

Since 2003, four focus areas have been identified for the research:
Intelligent Transport Control: Design of future industrial systems focusing on their control and management, the powering of the equipment, the effects of automation, and their ambient impact.
Design for Service: Development of integrated systems for simulation of representative operational conditions to enable improved ship designs and automation of the design process.
Deep Water Offshore and Dredging: New technologies and tools to model and control the interaction between the offshore and dredging engineering systems on one hand, and the elements (wind, water, waves, current and the seabed) on the other hand.
Intelligent Shipbuilding and Shipping Processes: Development of new technology for the intelligent acquisition, analysis, interpretation and communication of large amounts of data in order to optimise the ship itself, to streamline the processes involved in fabrication and operation, to improve decision-making and to support management.

Evaluative remarks
The M&TT Department educates students and carries out research related to facilities for offshore oil and gas, renewable ocean energy, dredging as well as marine and other transport systems, covering design, fabrication and operation of such systems. The research focus seems to be laid on technology and less on management of technology. Many of the marine systems are of large scale and hence often one of a kind designs or processes (operations) that differ from most mechanical engineering systems. Most of the activities and laboratories managed by this Department are unique within the Netherlands.

The organisation of the Department has gone through a significant change during the period under review, with new leadership (chairs) in three out of four research programmes. Some changes were made at the end of the six-year period. A vacant chair within the area of ship and offshore structures needs to be filled to complete the maritime programme.

The department has a clear strategy and policy under able leadership. The new organisational structure has already led to synergetic effects and more are expected in the future. In this connection it would be an advantage if the Marine Transport and Logistics programme include activities that are more integrated with the activities in other MT&T programmes.

The four research programmes have links to other units of TUD:

- TE&L spans widely and relates to vehicles and processes for land and air. TEL cooperates with other transport units through the transport RCD at TUD and the research school TRAIL;
- O&DE dredging relates to soil mechanics (in Civil Engineering);
- SH&S relates to the fluid mechanics research school and the Graduate School of Engineering Mechanics;
- SDP&O participates in TRAIL and DCMM.

The Department also collaborates with the 3 TU Centres of Excellence (ST High Tech Systems and DRC Next Generation Infrastructures) and is a key-player in a public-private consortium, the Maritime Innovation Programme. The Department has excellent links to the vital and innovative Dutch maritime industry.

In general, the research focuses on systems and processes which require the integration of disciplines and close ties with the industry. This has been achieved by hiring many part-time professors from the industry. The Dutch maritime industry represents a particularly competitive and innovative environment. In this way knowledge has been easily disseminated. It is noted that the Department has also been involved in 3 out of 9 start-up companies as well as in 2 out of 8 innovative designs highlighted by the 3mE Faculty.

On the other hand, this strategy has led to a reduced focus on the academic research and the publishing of research results in high-impact journals. The Department is well aware of this fact and intends to increase the number of publications in journals. The planned significant increase in the production of PhD-candidates is an important means towards this aim and a crucial measure of research productivity in its own right. Moreover, increased publishing in journals also leads to a greater likelihood of collecting desirable research funds and increased academic reputation.

The viability of this department is ensured by several new, active chair holders, an able department head and a government and an industry that support its activity.

TUD Department: Process & Energy (P&E)
The Process & Energy Department aspires to conduct world-class research and education focusing on process and energy technologies for sustainable development. The research ranges from fundamental to conceptual and applied in nature. In terms of scale the research covers the range from the molecular to the equipment scale.

The Department has the following research themes:

- Fluid Mechanics
- Engineering Thermodynamics
- Energy Technology
- Separation Technology
- Process Equipment.

The Fluid Mechanics group is housed in the Aero and Hydrodynamics laboratory while the other four groups inhabit the Process & Energy laboratory.

In the last two years three new full professors in Engineering Thermodynamics, Turbulence and Process Intensification were appointed and two new part-time professors in Irreversible Thermodynamics and Process Intensification.

The P&E Department aims to work on enabling sciences, forming a bridge between fundamental research on fluid dynamics and molecular thermodynamics to processes on a conceptual and on an equipment level. An indicator of the balance between fundamental research and application oriented research is the percentage of funding by research foundations (10-15%) and funding through industry and government (35-40%). Another indicator are the experimental facilities, spanning the range from physical property measurements to pilot-plant scale processes.

Evaluative remarks
The department of Process and Energy is relatively new, having only reached its present constellation in 2005. Several new appointments and a new experimental laboratory for the Thermodynamics group strengthens the overall capabilities and scope of the institute. The institute maintains a flat leadership, led nominally by Prof. Jansens but involving all programme leaders in a very active manner. There is a recognizable need for further integration measures among the staff of the different programmes, arising from the rather heterogeneous past history of the individual programmes in the institute.

Understanding the underlying physics of processes related to industrial applications and societal needs is a stated mission of the institute. This goal is to a large extent achieved, if not in every programme individually, certainly globally within the institute. Equally successful is the stated strive for scientific leadership in designated areas.

The architecture of the institute positions the fundamental disciplines of Fluid Mechanics and Thermodynamics at the foundation of a hierarchical pyramid, culminating in the more application orientated topics of Process Equipment. This concept of research portfolio is convincing, but its realization in cooperation among the groups could be and is being strengthened. This is aided by participation in a number of joint research organisations in Delft and nationally (e.g. Burgers Center, DSTI, etc.)

The institute has excellent resources at its disposal and has adopted a forward-looking policy for future investments (strategic investment pool). One resource posing a threat to the institute is the lack of students. This has been recently counteracted by increasing the presence of the institute in the curriculum of Chemical Engineering in Delft

The funding of the research programme is extremely healthy and appears to be secure in the coming years. There is an emphasis towards contract funding, usually in direct partnership with industry. Considering the stated goals of the Institute and in the interests of remaining a scientific leader, it may be advisable to strive for higher research funds in the future.

All research programmes in this Institute have access to excellent facilities, both in research and education. Some strategic investments have been made in very specific and unique laboratory facilities, which have paid off nicely. New investments (Thermodynamics) attempt to maintain these high standards.

The reputation of the institute is still largely based on the reputation of the individual programmes, which is well above average in all cases. Furthermore, the institute is well represented on numerous editorial boards, national and European committees and in the scientific community through conference organisation and advisory boards.

This institute addresses topics of high societal relevance and of particular importance to the Netherlands. The valorisation of the research can be considered very high, not only through the high level of contract funding but also through the high participation of industry in the education programme. All measures of this appear to be increasing during the past years. This is evidenced for instance in the fact that TNO will not only physically but also thematically strengthen its ties with the institute in the near future.

The institute has a number of strengths and weaknesses which are also dynamically changing with the fluctuation of personnel. Important is that a working environment has been created in which decisions, both strategic and operational, can be reached quickly and effectively. It is important that some attention is given to educational issues, since this Institute is quite dependent on having some graduate students and Ph.D. students in their programme from streams other than Mechanical Engineering, e.g. Applied Physics or Chemistry/Chemical Engineering.

TUD Department: Precision and Microsystems Engineering (PME)
The research area of the Department of Precision and Microsystems Engineering is the development of fundamental knowledge for the design and manufacturing of microsystems as well as for innovative high precision tools required for microsystem realisation. The mission of the Department is to offer high quality education and research in the field of precision and microsystems engineering, which is acknowledged worldwide in academia, society and industry.

The Department has the following research programmes:
Applied Mechanics: concentrating on the more theoretical aspects of mechanics and the related computations, enabling PME to research precision and microsystems starting at a fundamental level, including material, multiscale, multiphysics, reliability and computational engineering issues.
Mechatronics: concentrating on the design and realisation of high performance mechatronic systems for the world leading Dutch precision industry. The programme seeks as its ultimate goal to sustain and support the present unique competence level of this industry on a global scale.
Precision Manufacturing and Assembly: per November 2007 the name of the research programme is Micro and Nano Engineering. The research will focus on the structuring on micro and nano level and on system integration (micro-assembly), exploring phenomena and technology for the benefit of new manufacturing techniques.

Evaluative remarks
Research and development on the design and manufacturing of micro- and nanosystems properly has a place in mechanical engineering. TU Delft has responded by establishing in 2005 a Department (or 'Institute') of Precision and Microsystems Engineering by combining the programmes of Applied Mechanics, Mechatronics and Precision Manufacturing in one organizational unit.

The research area and mission have been appropriately defined. The Institute has a number of affiliates. The total research staff is quite large (37.8), with a budget of k€ 5,072 in 2006. The mission statement indicates high ambitions. The Chairman of the Institute appears to be very dynamic. He has been involved in the formation of related units such as MicroNed and DCMM.

The stated strategy has much to be recommended. The personnel is quite young. Education will be an important part of the programme. The funding picture looks positive. Facilities are very good.

There will be a period of refocusing on new objectives. The Mechatronics programme is encouraged to improve its academic output under the new leadership, and the name might be changed to Precision Mechatronics Engineering. The opportunities for this Institute are excellent. Weaknesses such as a relative lack of visibility on an international level have been identified and will be dealt with.

3.2. TU Delft - Part B: Assessment per programme

The committee assessed the following programmes of the Faculty of Mechanical, Maritime and Materials Engineering (3mE), Delft University of Technology:

BMechE	**Biomechanical Engineering**
TUD 1	Man-Machine Systems & Medical Instruments
TUD 2	Biomechatronics and Bio-robotics
DCSC	**Delft Center for Systems and Control**
TUD 4	Systems and Control
MSE	**Materials Science and Engineering**
TUD 5	Joining and Mechanical Behaviour
TUD 6	Light Metals Processing
TUD 7	Microstructural Control in Metals
TUD 8	Structure and Change in Materials
TUD 9	Surfaces and Interfaces
M&TT	**Maritime and Transport Technology**
TUD 10	Offshore & Dredging Engineering
TUD 11	Ship Design, Production & Operation
TUD 12	Ship Hydromechanics & Structures
TUD 13	Transport Engineering and Logistics
P&E	**Process and Energy**
TUD 14	Energy Technology
TUD 16	Lab for Aero and Hydrodynamics
TUD 17	Process Equipment
TUD 18	Separation Technology
PME	**Precision and Microsystems Engineering**
TUD 19	Applied Mechanics
TUD 20	Mechatronics
TUD 21	Precision Manufacturing and Assembly

Two programmes were included in the self-assessment report, but they were withdrawn from the review because they had started very recently:

TUD 3	Intelligent Mechanical Systems
TUD 15	Engineering Thermodynamics

The detailed assessment per programme follows in the next section of this report.

Programme TUD 1:	**Man Machine Systems & Medical Instruments (MMS&MI)**	
Programme director	Prof. dr. J. Dankelman	
Research staff in 2006	1.1 tenured, 7.8 total fte	
Assessments:	Quality:	3
	Productivity:	4
	Relevance:	4
	Viability:	4

This programme conducts research in developing processes, procedures, simulation models and instruments to assist surgical procedures in operating rooms and in environments where humans interact with machines. They develop minimally invasive surgical instruments and methods, requirements for operator rooms, for orthopaedics, and for driving simulators for training purposes.

Quality
The research conducted in this group is highly applied and interdisciplinary. The group has a strong publication and patent record.

Productivity
The programme graduates an average of 2 PhDs per year, 1.4 papers and 0.25 patents per research FTE per year during last five years. The programme created spin-off companies, and some of the patents were licensed by local companies. The pause in PhD-training in 2002 and 2004 seems to be due to funding shortages during that period. In general, the productivity of the group is very good considering the nature of the design, patent and clinical involvement of the group. The direct research funding dropped from 54% in year 2000 to 28% in 2006, the competitive research funding sustained its level of 32-34%, and the contract funding has increased from 11% to a very commendable 39% during the same period.

Relevance
The MMS&MI group is an essential part of Biomechanical Engineering Department. While the Biomechanics and the Biorobotics programmes develop mathematical models, control algorithms and general systems, the MMS&MI group develops the instruments used by medical surgeons. Furthermore, MMS&MI creates methods which enable the department's research results to be interfaced in real medical and human-robot interaction environment. Especially, they play a strong role in linking the engineering technology with the society who uses robots in industry and medical world. They are very relevant to the biomechanical research and education activities at the university.

Viability
Biomedical research and technology is an emerging field in developed countries, where the population is ageing. The MMS & MI group's mandate is to provide a link in transferring the research knowledge to the end users of the technology in the society. Their role will continue to grow as in parallel to the research activities in Biomechanical Engineering. The increase in the contract funding demonstrates the sustainability and relevance of the group to the society and the department.

Conclusion
The group is very active and productive in linking biomechanical research results with the end users in medical world and the users of robotics devices in the society. The programme

is recommended to improve its academic image by publishing not only in application oriented journals, but in journals where the scientific contributions can be better reviewed and assessed.

Programme TUD 2:	**BioMechatronics & BioRobotics (BM+BR)**	
Programme director	Prof. dr. ir. F. van der Helm	
Research staff in 2006	1.9 tenured, 9.4 total fte	
Assessments:	Quality:	5
	Productivity:	4
	Relevance:	5
	Viability:	5

The BM&BR programme conducts research in humanoid robots, haptic interfaces, prosthetics and orthopaedics, teleoperation, and studies neural control properties of human motor systems. The group conducts core research in biomechanical engineering, and it feeds the activities that are the key discoveries and fundamental knowledge to sister programmes in the department.

Quality
The chair of the group is an international leader with an impressive research record and passion in the Biomechanical engineering field. The assistant professors in the group reflect a similar passion about the research field. The journal publications appear in distinguished journals such as Transactions of IEEE, Journal of Robotics, Robotica, Journal of Biomechanics. The impact of archival publications and research results are very strong as indicated by citations and transfer of technology to industry. The group seems to be leading the research field in the world.

Productivity
During last five years, the programme graduated an average of 2 Ph.D. per year, and 2.7 journal papers per research FTE per year. There is room to increase the number of PhD-students slightly. The programme sustained high productivity and research quality, while continuing to excel in its impact on the society and academic community. The direct research funding increased from 25% in year 2000 to 31% in 2006, the research funding dropped from 37% to 13%, and while the contract funding has increased from 0% to a very commendable level of 57% during the same period.

Relevance
The BioMechatronics and Biorobotics programme is the engine of this department. They drive the fundamental research, study the fundamental aspects of human body models, identify the behaviour, and design humanoids and haptic devices by integrating dynamics, systems, modelling and control theories on human motor mechanisms. The group's research leads to the devices which assist patients, aging humans, and users of medical robotic devices. The group's research is the most relevant in the Department of BioMechanical Engineering at TUD.

Viability
The group is a world leader in the field of Biomechatronics and Biorobotics. They will continue to excel under the dynamic leadership of the chair and energetic assistant professors. The programme has started to transfer knowledge nationally and internationally, and now has a worldwide impact.

Conclusion
The review committee believes that the Biomechatronics and Biorobotics programme is very strong, and provides international leadership. The researchers in the programme interact well

with the Dynamic Systems and Control Group in Delft, and have an active national and international cooperation with leading laboratories. TUD can be proud of having such an outstanding research group and programme.

Programme TUD 4:	**Systems and Control**
Programme director	Prof. dr. ir. P.M.J. Van den Hof
Research staff 2006	5.4 tenured, 38.2 total fte
Assessments:	Quality: 5
	Productivity: 4
	Relevance: 5
	Viability: 5

The research focuses on model-based control design, robust control, identification and data-based control, mechatronics, discrete event systems, sustainable industrial processes, traffic control. The merger of three groups at Delft to form the Systems and Control group was a good move. The programme has strategic alliances with cross-faculty appointments with specific application departments such as Biomechanical, Transportation, Precision and Microsystems Engineering.

Quality
The international reputation of the programme is very high, and provides world-wide leadership in some areas of control. The papers are published in the top journals, but the applications treated with the new theory are also important problems with a high visibility, allowing high impact in the applied sector of the field. The programme director served as the editor of Automatica (among the top two control journals), and has received fellow distinction from IEEE and IFAC. Other professors served on the editorial boards of distinguished journals, as associate editors of Automatica, and a number of other high ranking journals. The department reserves part of the budget for fundamental research to be spent by 4 PhD-students and post-docs. This "seed money" assures fast reaction times to develop new ideas.

Productivity
In 2003: 6.0 tenured staff with 15.6 PhD-students produced 37 journal papers, and 3 theses. In 2006: 5.4 tenured staff with 27,4 PhD-students produced 27 journal papers, and 7 theses. During this transition period there was a lag in getting publications out, but no fundamental structural or procedural problems were discovered. The programme has the goal of publishing 3 or 4 journal papers per PhD, and this is a good target. An average of 4 PhD-students graduated per year, and they keep an average of 30 to 35 PhD-students at a time, and the average PhD student per research FTE is about 4. The research funding has been steady at around 3.5M€, and the balance of funding from various sources is fine (direct 60%, research grants 14% and contracts 26%).

Relevance
The societal impact of this work is high. Local industry can benefit from the techniques produced by this research programme. This is evident from the amount of industrial funding.

Viability
The merger of the three control groups enhances the visibility. The controls programme is even stronger now and well positioned to provide a leading role in world-class research in controls and systems.

Conclusion
The programme will benefit from the merger of the three groups, and is now even stronger than before. No further organizational changes are recommended. The researchers in the control programme interact with their programme neighbours effectively, to produce highly leveraged joint research.

Programme TUD 5:	**Joining and Mechanical Behaviour**	
Programme director	Prof. dr. ir. I.M. Richardson	
Research staff 2006	1.8 tenured, 12.0 total fte	
Assessments:	Quality:	4
	Productivity:	3
	Relevance:	4
	Viability:	4

Experimental and modeling work on a number of welding techniques and on mechanical properties of materials.

Quality
The work on welding has continued to grow since Prof. Richardson's appointment. It effectively combines modeling and experimental work. The activity on mechanical properties has been substantially strengthened by the appointment of Dr. Nicola.

Productivity
Prof. Richardson has made a sustained effort to increase the number of journal papers, which has had success. It is reasonable, given the nature of the field that a substantial number of articles will continue to be written in conference proceedings. Similarly, the applied nature of the field leads to an underestimate of the usefulness of the papers, since the end-users of the result are those who apply them to practice and are unlikely to write papers.

Relevance
Welding remains an industrially very important technique and the work of this group will continue to be noticed scientifically and be applied in industry. Given the metals focus of the Delft materials effort, research in this area acquires even more importance.

A healthy effort in mechanical properties is essential to any materials programme.

Viability
The effort on welding is in good hands and the effort in mechanical properties has been strengthened substantially by Dr. Nicola's appointment.

Conclusion
This programme will undoubtedly continue to develop well. Given the importance of research on mechanical properties for a materials department, this part should be allowed to grow, eventually into its own programme. There will be much mutual benefit from increased collaboration between the researchers on mechanical properties with the rest of the programmes in the Department.

Programme TUD 6:	**Light Metal processing**
Programme director	Prof. dr. ir. L. Katgerman
Research staff in 2006	1.7 tenured, 20 total fte
Assessments:	Quality: 4
	Productivity: 4
	Relevance: 3
	Viability: 4

The programme has three sub-disciplines: Metals Production, refining and recycling; Solidification Processing and Forming; Coating and Powder Technology.

Quality
The programme covers a wide range of metal processing and forming technologies and has a strong presence in journal and conference publications. The research results are transferred to industry as is evident from a healthy number of industrial collaborations. The academic staff members are active as programme members of a number of conferences. They have also close links with industry. The programme has unique experimental facilities and a wide range of computational tools.

Productivity
The programme graduates an average of 1.8 Ph.D. students per year, which leaves room for an improvement. The number of journal paper per research staff is 2.25, which is above the average. The group has disclosed a healthy number of patents since 2003. The total funding has increased from €1.903M in 2001 to €2.887M in 2006, which is a commendable achievement. The total funding is distributed on average in the 6 year period as 56% direct funding, 10% research funding, and 34% contract funding. The research grant funding could be improved by increased competitiveness in fundamental research.

Relevance
Processing is one of the pillars of materials engineering, where basic science is transformed into metal products. The programme may improve its impact on the university by increased cooperation with programmes in the Department. While it may be easier to focus on industry-driven and sponsored projects, the programme is run at the university and it must contribute to the scholarly activities by contributing to in fundamental research as well.

Viability
The present leadership has successfully managed a large research group with diversified interests. The programme activities are in high demand by national and international industry. The infusion of more scientific input within or from other programmes will further amplify its success. Katgerman's succession and the attendant shift of research emphasis will be an important milestone in the future of this programme.

Conclusion
The Light Metal Processing group is productive, dynamic and focuses on industrially relevant, applied research activities. Increased cooperation with other programmes should improve its impact within the university and scientific community.

Programme TUD 7:	**Microstructure Control in Metals**	
Programme director	Prof. dr. ir. L.A.I. Kestens	
Research staff 2006	1.2 tenured, 15.1 total fte	
Assessments:	Quality:	5
	Productivity:	4
	Relevance:	4
	Viability:	4

The research involves experimental work on the development of several aspects of metallic microstructure, in particular phase transformations and texture.

Quality
The work on phase transformations that makes use of the microfocus x-ray synchrotron facility is highly innovative. It has gotten us to take a new look at a well known phenomenon of the nucleation and growth. The effort has also benefited from the inclusion of internationally recognized work on texture development.

Productivity
The publication rate of the group is very good and many of the papers have received much attention. The low normalized citation rates are therefore very surprising. This is most likely the result of the area being comparatively small compared to other areas in metallurgy (e.g., bulk metallic glasses), which raises the normalization factor. Given the high originality and technical quality of the papers in this group, these lower numbers should be of no concern.

Relevance
Given the high relevance of microstructural control to the metallurgical industry, it is no surprise that this group has excellent links with this industry. Some of it was nurtured by its past close involvement with the NIMR; the continuation of this programme as M2i will solidify these links even further.

Viability
The appointment of Offerman is an excellent one, since it ensures the continued vitality and originality of the X-ray effort. The continued integration of the texture effort will further strengthen the programme. The approval of M2i is a further guarantee of the programmes' viability

Conclusion
A highly innovative, internationally visible programme that contributes much to the Delft materials effort.

Programme TUD 8:	**Structure and Change in Materials**
Programme director	Prof. dr. B.J. Thijsse
Research staff 2006	1.6 tenured, 7.5 total fte
Assessments:	Quality: 4
	Productivity: 4
	Relevance: 4
	Viability: 4

The research involves large-scale simulation of the structure and processes in materials, application of materials characterization techniques to objects from art and archaeology, X-ray studies of structure and kinetic processes.

Quality
The simulation work addresses important problems and gets international recognition. The work in art and archaeology is new, but has already yielded noticeable results. The X-ray group maintains the Delft group's long-standing tradition for sophisticated use of diffraction.

Productivity
The group's publication rate is excellent and the papers are of very good quality.

Relevance
A flexible, multi-faceted simulation effort can be very valuable to a Materials Department. The Virtual Materials Laboratory increasingly plays this role and its connections to other department activities are likely to increase.

The Art and Archaeology effort is in line with similar activities in major materials departments elsewhere in the world and promises to get increased visibility.

A healthy X-ray facility is essential to the good workings of any materials department and the current configuration will serve it well for the foreseeable future.

Viability
The recent appointment of Sluiter substantially strengthens the simulation effort and increases the number of ways it can link to the other programmes in the Department. The Art and Archaeology effort is just taking off, but will likely find its niche nicely between similar efforts abroad. The recent promotion of Bottger lends stability to the X-ray effort.

Conclusion
This is an interesting, varied programme that is in good hands and will increasingly contribute to the depth of other programmes in the Department.

Programme TUD 9:	**Surfaces and Interfaces**
Programme director	Prof. dr. G.C.A.M. Janssen
Research staff 2006	1.3 tenured, 11.8 total fte
Assessments:	Quality: 4
	Productivity: 4
	Relevance: 4
	Viability: 4

The research involves experimental work on the basics of corrosion and corrosion technology, experimental and modeling work on high-temperature oxidation, and synthesis, characterization and modeling of hard coatings on metals.

Quality
The work on corrosion is highly innovative, in that it has taken full advantage of the recent revolution in this field due to the development of new local probes. The work on high-temperature oxidation includes some of the most precise measurements of the oxidation kinetics. The work on hard coatings has provided some key insights into the origins of intrinsic stresses in deposited thin films.

Productivity
The group's overall productivity is very good. Janssen has made a concerted effort to increase the visibility of their publications. The appointment of Mol, and the stability it brings to the corrosion effort, will undoubtedly lead to increased productivity from that activity as well.

Relevance
Corrosion remains a technologically extremely important phenomenon. Given the emphasis on metallurgical research in the Delft materials department, a corrosion effort is well placed. It is also one of the few extensive such efforts left in the world.

The work on high-temperature oxidation is directly relevant to a number of technologically important applications, such as the adhesion of thermal barrier coatings and the quality control of UV mirrors.

The work on hard coatings is very well connected to industry (equipment manufacturers, users of coatings) and will undoubtedly contribute new applications in this area as they emerge. Fundamental research into the origin of stresses in deposited films contributes and this group is now a know player in this field.

Viability
The recent appointments of Janssen and Mol have brought much needed stability to this effort. The work is highly technologically relevant and has solid fundamental foundations. On both counts, its prospects are very bright.

Conclusion
This group is a vital component of the Delft materials effort, which, under its young leadership, will become even more visible in the future.

Programme TUD 10:	**Offshore and Dredging Engineering**	
Programme director	Prof. dr. ir. C.A. Willemse / Prof. dr. ir. C. van Rhee	
Research staff 2006	1.1 tenured, 6.0 total fte	
Assessments:	Quality:	3
	Productivity:	3
	Relevance:	4
	Viability:	4

The ODE programme covers structures and systems used in the offshore oil and gas industry, ocean renewable energy as well as dredging; that all utilise large, unique facilities that call for advanced multidisciplinary knowledge in the design and operation planning. The ODE programmes are, hence, important and also unique in the Netherlands.

Quality
The academic reputation is limited due to lower than average rate of journal publications and graduation of PhD candidates.

Productivity
The number of journal publications and PhD graduates in the assessment period is lower than the average for mechanical engineering in the Netherlands. The research programme has, however, contributed practical useful knowledge especially to the dredging industry.

In the past 6-year period, the research activity in the offshore area did not have personnel resources nor cooperative relationships, nor a strategy to represent a partner for this part of the offshore industry. The dredging activities however have had more resources, but without excelling.

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Relevance
The academic impact of the research in the ODE group is limited while the practical relevance is good due to its close links with the unique Dutch dredging industry. In the offshore field one of the most significant innovations at TUD in the last 6-year period - the “Ampelmann” – a device for personnel and cargo transfer from boats to other offshore installations - is particularly noted.

Viability
The future plans presented by the two recently appointed chair holders point to vital and relevant research activities that will fit well into the significant industrial potential for renewable offshore energy, offshore oil and gas, dredging in shallow waters as well as possibly deep sea mining. Some of these industrial activities are envisaged to take place under arctic conditions.

Conclusion
The ODE group needs to increase its academic reputation and productivity by focussing more on journal publications and graduating PhD candidates. The relevance of the planned work should ensure a potential for the necessary funding. The level of contract funding needs to be brought back to the level it was in 1999-2002. At the same time, it is important that the research groups aim at soliciting research funds which will be linked to improving the “academic” research profile

Programme TUD 11:	**Ship Design, Production and Operation**	
Programme director	Prof. dr. ir. J. J. Hopman – since September 2006	
Research staff 2006	1.7 tenured, 8.3 total fte	
Assessments:	Quality:	4
	Productivity:	3
	Relevance:	5
	Viability:	4.5

The research in the SDPO programme spans the life cycle of ship hulls and machinery; and includes design, fabrication and operation. The area covered by this programme is apparently very broad; requiring integration of knowledge from many disciplines. The focus area is to develop methods and computer tools to support distributed multidisciplinary (early) design and engineering environments.

Quality
The academic reputation is limited due to lower than average rate of journal publications and graduation of PhD candidates.

Productivity
The number of journal publications and PhD graduates in the assessment period is lower than the average for mechanical engineering in the Netherlands. The research programme has, however, contributed practical knowledge in intimate contact with the industry.

In the last 6 years period a positive trend of increased recruiting of PhD candidates and publishing research results is noted. However, the papers are mainly presented at conferences.

Relevance
The academic impact of the research in the SDPO group is limited while the practical relevance is significant due to its unique situation by the involvement of several part-time professors from the industry and placing PhD students in the industry. In general the SDPO group has an excellent industry network. At the same time it is important that this benefit is balanced by having the students at the university to create the necessary good research environment there.

Viability
The actions already undertaken by the new chair holder to increase the research activity, the significant increase of the number of PhD students and the good outlook for financial support from the Dutch government, industry and EU show the viability of this area.

Conclusion
The academic reputation should be improved while maintaining the excellent working relationship with the industry, by increasing the output of refereed journal papers. The significant increase in the number of PhD candidates and a clear publishing strategy are expected to contribute to an improved academic standing.
While it is considered extremely useful for students in this area to spend time in industry, this beneficial arrangement should be balanced by also having the students at the university to create the necessary good research environment there.

Programme TUD 12:	**Ship Hydromechanics and Structures**
Programme director	Prof. dr. ir. R. H. M. Huijsmans (from late 2006) (director in the main part of the period: Prof. dr. ir. J. A. Pinkster)
Research staff 2006	2.5 tenured, 9.5 total fte
Assessments:	Quality: 4 Productivity: 3 Relevance: 5 Viability: 4

The SHS programme deals with the behaviour of ships and other floating structures in a seaway and their structural aspects. While the hydrodynamic and manoeuvring issues are clearly specified in the outline of the research programme, the scope of the structural engineering is less clear. The hydrodynamics group has got excellent experimental facilities and an international research network. Also, the hydromechanics discipline dominates the production of research results. This is believed to be related to the vacancy of the chair for this discipline since 2002.

Quality
The quality of refereed journal papers produced by the hydromechanics discipline is very good, but the number of such publications still needs to be increased to a stable higher level.

Productivity
The number of journal publications and PhD graduates in the assessment period is lower than the average for mechanical engineering in the Netherlands. The research programme has, however, contributed practical knowledge in intimate contact with the industry.

Relevance
The academic and practical impact of the research in the SHS group is very good. In recent years contact with industry seems to have been emphasized more that dissemination of research in the academic environment.

Viability
The past performance of the group, the clear strategy for the research in the hydromechanics area, the international cooperative network as well as the good outlook for funding in the ship and offshore area show the viability of the research programme. However, filling the vacant chair in ship and offshore structures is important to form a true SHS group; which is needed especially in solving problems involving fluid-structure interaction.

Conclusion
The SHS group needs to increase its productivity by focussing more on journal publications and graduating PhD candidates. The relevance of the planned work should ensure a potential for the necessary funding

Programme TUD 13:	**Transport Engineering and Logistics**	
Programme director	Prof. dr. ir. G. Lodewijks	
Research staff 2006	2.9 tenured, 7.0 total fte	
Assessments:	Quality:	4
	Productivity:	3
	Relevance:	4
	Viability:	4

The TEL programme deals with research relating to the engineering of efficient and safe transport systems for cargo and people and logistics. The group is unique and has an important role to play in the Netherlands. The strategy and policy of this programme is coherent and clear. It involves aspects of air, land and sea transport. The maritime transport issues apparently seem to be less prominent in this activity. Yet, in view of the fact that sea transport takes care of 90 % of the mass which is transported internationally, it is reasonable that this multidisciplinary research programme is organised as a unit of a maritime department. The international network is very good even though the group has not managed to hire foreigners among their staff.

Quality
The academic reputation is limited due to a lower than average rate of journal publications and graduation of PhD candidates for mechanical engineering departments in the Netherlands.

Productivity
The number of journal publications and PhD graduates in the assessment period is lower than the average for mechanical engineering in the Netherlands. The research programme has, however, contributed practical knowledge in intimate contact with the industry.

As a result of a clear publishing strategy the number of academic publications has increased during the 6 years period. However, it remains to be proven that the TEL group can reach a desirable steady high level of refereed journal papers.

Relevance
The academic impact of the research in the TEL group is limited while the practical relevance is significant due to its excellent industry network.

Viability
The actions already undertaken by the new chair holder to increase the research activity, the significant increase of the number of PhD students and the good outlook for financial support from the Dutch government, industry and EU show the viability of this area.

Conclusion
The TEL group needs to increase its academic reputation and productivity by focussing more on journal publications and graduating PhD candidates. This goal is also clearly expressed in strategic goals and policy of this group. It would be good if the TEL group engages in maritime transport systems, for instance in land-sea transport chains, together with other groups in the MT&T department. While this initiative could come from any of the groups, the TEL group has a particular role by the character of its research and the fact that the chairholder is head of the department.

Programme TUD 14:	**Energy Technology**	
Programme director	Prof. dr. ir. Adrian Verkooijen	
Research staff 2006	1.6 tenured, 21.9 total fte	
Assessments:	Quality:	4
	Productivity:	4
	Relevance:	5
	Viability:	4.5

The programme is primarily concerned with energy conversion systems. It receives most of its research funding from industry. Based on the bibliometric study the programme has a CPP/FCSu = 1.46 and a P/Fte = 0.72. The funding is coming roughly 50% from direct support and 50% from contract funding.

Quality
The research is mostly published in proceedings but some in refereed journals. The quality is quite heterogeneous and depends largely on the topics addressed. It is on average very good.

Productivity
The quantity of papers in referred journals declined over the period under review and should be increased in the coming period. The number of PhDs graduated per year is approximately one and which is low for the size of the group.

Relevance
The mission of the research area is very general. The group wants to "expand the know-how and contribute to sustainable energy conversion of usable energy and to gradually decrease society's dependence on fossil fuels. According to the several programmes the group wants to work on seven topics ranging among zero emission power plants, fuel cells, nuclear power plants, turbomachinery, to bio-energy processes. This is considered to be quite broad and heterogeneous. Although the various elements are in the focus of future needs in energy technology, each of the various topics addressed are in the working plans of various large institutions in Europe. So an extensive focusing on appropriate topics like biomass, gasification, and flue gas cleaning seems to be necessary. The work being done is of practical relevance by increasing the body of knowledge.

Viability
The subject matter of the group is very important to the future technological needs of society, but the group needs to refocus its efforts if it wants to be a major contributor in this field.

Conclusion
There is still a vacancy in the full time chairs and the programme seems to be suffering from it. The ties to industry are very good as indicated by the relatively high amount of industrial support. The scientific relevance of the work produced with respect to the advancement of knowledge is moderate. The various research topics are within the area of future socio-economic needs. Nevertheless the scientific visibility of the group is not very good. It should be increased by drastically focusing and reshaping the programmes.

Programme TUD 16:	**Lab for Aero and Hydrodynamics**	
Programme director	Prof. dr. ir. J. Westerweel	
Research staff 2006	2.2 tenured, 12.4 total fte	
Assessments:	Quality:	5
	Productivity:	5
	Relevance:	4
	Viability:	4.5

This research group focuses on four key areas: turbulence, multiphase flows, microfluidics and biological flows, whereby the most modern techniques of experimental and numerical fluid mechanics are being applied. This is a very young group after losing the leader in 2005, but with a relatively high number of tenured staff (2.2 in 2006) and Ph.D. students. The leader of this programme has made an effort to maintain a strong fundamental research component but at the same time with a goal to bring fundamental results to applications. The laboratory is well equipped, although this will demand an ambitious research programme to maintain, especially the laser-based techniques. With a recent appointment, the numerical field of fluid mechanics has been strengthened.

Quality
This group is known internationally for a number of unique results of significance and several 'first-time' measurements. They publish only in the top journals of the field, in addition to Nature and Science. The programme director is very prominent in the community as are several of the other members of the research group, either through editorships, committees or publications.

Productivity
The number of Ph.D. thesis decreased during some years due to personnel changes; however this number has now increased and has reached former high levels. The group publishes primarily in scientific journals and books and both of these measures are high. Furthermore the members of this group hold numerous editorships.

Relevance
The problems of fundamental research being pursued by the group are quite relevant to current questions posed by the scientific community, laying foundations for addressing more complex flow systems, e.g. multiphase flows. Dissemination has been very successful, either through publications, workshops or other networks, e.g. arising from European networks. Industrial links appeared weaker during the assessment period but has since increased significantly.

Viability
This is a young group with excellent past scientific performance; hence a positive and strong future can be expected. The research plan is coherent and potential synergies among the various research topics can be expected. They have a strong collaboration with other programmes in the same institute.

Conclusion
This research programme is a strong component at 3mE and supports through collaborative projects, both inner faculty and interfaculty programmes at TUD. All measures of quality and quantity are high and a continuation at this level can be expected.

Programme TUD 17:	**Process Equipment**	
Programme director	Prof. dr. ir. G.J. Witkamp	
Research staff 2006	1.6 tenured, 9.8 total fte	
Assessments:	Quality:	4.5
	Productivity:	4.5
	Relevance:	4
	Viability:	4

This is a young research group embracing three strong areas: crystallisation, eutectic freezing and supercritical textile dyeing. The mission is to perform solution-driven scientific research in the application field by bridging process industry and technical suppliers. It exhibits a strong autonomous development and is prosperous in terms of funding and scientific output.

Quality
The quality of the work is considered to be very good. It has a solid scientific basis and lives from interesting and relevant industrial applications. The bibliometric data (CPP/FCSm = 1.15) confirms the above-average significance of the published work. The citation rate of the group has increased significantly over the past years. A further measure of quality are the awards recently conferred on some of the members.

Productivity
The productivity of the group rated by the bibliometric data is P/Fte=2.36 and is one of the highest scores in the faculty. The number of Ph.D. students and post-docs has been increased in the review period and continues to increase. The group has successfully procured significant industrial financing for the implementation of their results.

Relevance
The relevance of the work is considered to be high. A clear strength lies in the cooperation with industry. Especially the work in supercritical textile dyeing is expected to have a significant impact on future sustainable use of resources. The advancement of the knowledge is the main strength of the programme.

Viability
This is a young group, now well-established and well recognized in their respective fields. One staff member will spend a two-year term abroad, but will return to the group afterwards. Also the laboratories are well equipped and major investments are no longer necessary. Hence the group is well posed for a successful future in the coming years.

Conclusion
This group has a strong presence in both the academic and industrial environments. The research programme is coherent and strategically well designed.

Programme TUD 18:	**Separation Technology**
Programme director	Prof. dr. ir. P.J. Jansens
Research staff 2006	2.0 tenured, 9.8 total fte
Assessments:	Quality: 4
	Productivity: 4
	Relevance: 5
	Viability: 4

This group pursues research in four main areas: Intensified Separations, Green Fluid Technology, Industrial Crystallisation, and Crystallisation Fundamentals. These are well interrelated topics with strong potential for synergies. There is also ample scope for both fundamental research and applied research; indeed the group has developed a very strong industrial network for dissemination of results.

Quality
This group is distinguished through some very basic research leading to a fundamental understanding of crystal nucleation and growth which has been published in leading journals and cited strongly. This is aided by the high standing and prominence of the group leader in this field, the other members of the group are representing to a large extent other areas of interest, but are also well established in their respective fields. This applies also to the relatively new field of process intensification, in which the newly appointed professor has already secured important positions at the European level for future network programmes. The quality of the work in this group is also reflected in the numerous awards granted to and editorships held by its members.

Productivity
The bibliometric data indicate that this group is very productive at a scientific level. Furthermore, a large number of patents have been granted over the review period. The number of Ph.D. theses during this period was low; however this has exhibited a rapid increase in the past two years. The productivity is also reflected in a sustained high interest of industry in cooperating with the group and the continued high level of funding through direct contracts.

Relevance
The group can be commended on attaining a high relevance both at the academic level and through its implementation of results into the industrial environment. The dissemination of knowledge has been pursued not only through channels of publication, but also through the establishment of the Dutch Separation Technology Institute (DSTI) in 2005, in which a large number of companies are effectively networked. The programme leader is the Scientific Programme Manager of the DSTI and also the Scientific Director of the Delft Research Centre for Sustainable Industrial Processes.

Viability
The group is very well established in all its fields of activity. The leader of the group will return shortly to an industrial position and therefore it will be essential that the faculty make a strong effort to maintain the scholarly expertise in his fields of research, in particular relating to crystal nucleation and growth. It is reassuring that the faculty has already committed itself to a replacement appointment.

Conclusion
This group has a strong presence in both the academic and industrial environments. The research programme is coherent and strategically well designed.

Programme TUD 19:	**Applied Mechanics**	
Programme director	Prof. dr. ir. L. Ernst, prof. dr. ir. F. van Keulen, prof. dr. ir. D. Rixen	
Research staff 2006	3.3 tenured, total fte 18.6	
Assessments:	Quality:	4
	Productivity:	3.5
	Relevance:	4.5
	Viability:	4

The group is recognisable as the amalgamation of three distinct entities and the integration process is still evident. Activities in the past have not reflected the current mission of precision and nano/micro engineering, which represent new directions of research for the group. The unit is jointly managed by the full time chairs of the three subject areas. The research of the group is currently predominantly funded by industrial projects (70%) and supported by the well founded common laboratory and experimental facilities of the Institute. The need to achieve a better balance between public and private funding is recognised. The programme has gone through reorganisation during the assessment period, but it now seems to have reached a stable position. From 2001-2006, the research staff increased from 12 to 18.6. The programme now has well-defined goals and a good list of activities. The full professors have established international research reputations and the remainder of the tenured staff are active in research and prominent in national and international collaborations.

Quality
Specific research topics have been identified in the three programme themes which reflect the new research directions of the group. These activities are of direct academic and industrial relevance and, if successful, likely to make a significant contribution to progress. Effort has been made to develop research paths which meet the aim of the current mission. The publication strategy is biased towards conference papers, but with a substantial number of journal articles being also published. The three programme directors are highly visible in the group's activities and the other members also make significant contributions. MS and PhD graduates of the programme are in demand by industrial organisations.

Productivity
The last two years have shown improvement in the production of PhD theses. The publication productivity of the unit is above average with a P/Fte ratio of 1.14 but the citation rate of 0.92 is low, and the percentage of papers without citations is high (57%). It appears that many of the papers are published in journals with low citation rates. The group has also registered a significant number of patents in comparison with other units. Direct funding has gone down but indirect funding has increased.

Relevance
The analytical, experimental, and numerical techniques of applied mechanics have numerous applications in Mechanical Engineering. It is, therefore, important that ME of TUD should have a strong programme of research and development in applied mechanics. The refocusing of the group's activities will improve the relevance of the research in relation to industrial and societal needs. Work undertaken to date has shown a very good contribution to computational, theoretical and experimental knowledge and substantial dissemination has taken place both through the rapid route of presentation at leading international conferences and more permanent journal publications. There is evidence of collaboration with

both academic and industrial organisations representing take-up of the scientific knowledge outside the group.

Viability
The tenured staff members have substantial experience and knowledge in the three subject areas constituting the activities of the group. However, the past activities of the group do not reflect the research direction chosen for future progress – namely engineering at the micro-scale. Therefore, it remains to be seen whether this transition can be successfully accomplished, but given the composition of the group the future prospects are good. The age profile of the current tenured staff is balanced and distributed, which should aid continuity of future developments.

Conclusion
The Delft programme of applied mechanics has a distinguished history, with world-class experts as programme leaders. It appears that the current programme has got its act together. The future looks promising.

Programme TUD 20:	**Mechatronics**	
Programme director	Prof. dr. ir. R.H. Munnig Schmidt	
Research staff in 2006	1.9 tenured, 9.2 non tenured FTE, 11.1 total FTE	
Assessments:	Quality:	2
	Productivity:	2
	Relevance:	4
	Viability:	3

The programme conducts applied research to design precision positioning systems used in fabrication of electronics and micro components, and to design precision metrology and tribology used in precision machines and instruments. Precision engineering is one of the most relevant technologies for Dutch industry and society.

Quality
The programme is rather new, and went through frequent changes with limited leadership in the field of precision engineering. The tribology group has dominated the limited number of journal publications. The quality of current research projects can be only measured after the group is established, but the ongoing projects are novel and with innovative ideas. The chair and professors of the programme must try harder to demonstrate creation of new knowledge and technology, and increase their activities in publishing peer reviewed journal articles. The professors are too fragmented in the disciplines and in their commitments to create a measurable academic output.

Productivity
Two professors have part-time employments, while having major commitments in industry. There have been only 2 completed PhD-theses since 1999, which is low. The group failed to publish any journal publication between 2000 and 2002, and increased to an average of 1 paper per PhD-student in 2005. The group obtained 3 patents between 2005 and 2006. The proportion of direct research funding rose from 25% in 2001 to 48% in 2006, the research funding rose from 7% to 15%, and the proportion of contract funding dropped from 68% to 38% during the same period. The total research budget has been steadily increasing from 222 K€ in 2001 to 1,169 K€ in 2006, which is proportional to the increase in research FTE (from 2.5 FTE to 11.1 FTE including Ph.D. students).

Relevance
The programme is strongly relevant to Dutch precision machinery, the electronics and instrumentation industry. They are also the key group in designing instruments used in the Dynamic Systems & Control and Biomechanical Engineering Departments.

Viability
Two full professors commit only 10% of the time, which is insufficient to lead the programme. Both professors have established track records in industry and in precision engineering societies. They naturally split their energy between the university and industrial activities. Based on the past history of academic productivity, the junior professors need guidance and mentorship. The programme needs major improvements in the academic leadership and research productivity in order to improve its current status in the faculty.

Conclusion
This programme went through major changes since 1999. The committee recommends to commit a university resident chair professor to lead the programme and to change the name into Precision Mechatronics which is a more accurate description of the programme activities.

Programme TUD 21:	**Precision Manufacturing and Assembly**	
Programme director	Prof. dr. U. Staufer (appointed in November 2007)	
Research staff in 2006		
Assessments:	Quality:	Not Rated
	Productivity:	Not Rated
	Relevance:	Not Rated
	Viability:	Not Rated

This programme has a new chair with a completely new focus which is not related to the past research activities; hence it is not rated by the committee with the following explanations.

This programme went through major changes in its focus and research activities since 2000 when Professor Kals retired. The programme was world class in machining science (1960s-70s); Pekelharing was the head. The flexible automation research (1980s) also left its mark in industry and academia, but at a decreased level when the programme had a decreased leadership in the 1990s. Professor Karpuschewski tried to revive classical machining and grinding research, but left before his initiative could produce results.

In summary, the past activities of this programme have not been continued, hence the committee feels that it is unfair to judge the current programme based on the past activities.

The committee heard the presentation of the new chair, Prof. U. Staufer, who will focus on micro and nano devices, which is totally different from the past activities of the programme. The new initiative fits very well with the current activities of the Applied Mechanics and Mechatronics programmes.

3.3. UT - Part A: Assessment at the institute level

Mission & Goals
The mission of the Department of Mechanical Engineering is to educate students and to carry out research related to life cycle assessment of mechanical engineering systems and products. The department consists of multidisciplinary research groups that form a well-balanced and coherent research unit which is a good basis for running larger projects (programmes) in cooperation with the industry and applied scientific institutes.

Regarding the organisation of the department, it appears to the committee that the research strength could be improved by some minor modifications, such as having Production Technology under the same umbrella as Mechanics of Forming Technology. Obviously the decision needs to be made by the department through a total assessment of teaching, research and infrastructure.

The department management and the different research groups emphasize the importance of doing research relevant to practical engineering. In the committee's opinion it is important that the university contributes socio-economically to the country but also balances that with its role to contribute to the lasting information in the scientific community by journal publications. In this connection it is important that the university take on tasks that are inspired by practice.

Based on the citation study the department performs better than world average for mechanical engineering in about 1/2 of its research programmes.

While the department expresses future ambitions regarding improved academic reputation, visibility in the society, increased external funding and stimulating entrepreneurial behaviour, it would have been appropriate to indicate possible plans regarding new areas of research.

The department makes up a part of the matrix organisation of all faculties/departments and research institutes at University of Twente. It seems that this matrix structure provides a good means to integrate research activities within the various research groups and also ensure an efficient use of the laboratory infrastructure.

The department of Mechanical Engineering is part of the Faculty of Engineering Technology, which is composed of three Departments-Mechanical Engineering, Industrial Design Engineering and Civil Engineering & Management.

The Faculty is headed by the Dean, Prof. dr. Rikus Eising. The Dean chairs a Management Team consisting of representatives of the three Departments. The Management team meets every two weeks, primarily to discuss all strategic matters. Every month, the Management Team and the so-called 'Chamber' gather to discuss matters of interest to the Faculty and to exchange information and views. The members of the Chamber are all full professors and programme leaders of the three Departments. All other (part-time) professors have a standing invitation to participate in the chamber meetings.

The Dean of the Faculty of Engineering Technology also heads the Department of Mechanical Engineering. He chairs the Disciplinary Science Council of this Department, in which the research strategy of the Department is discussed. The members of this council are the full

professors and programme leaders of the Department of Mechanical Engineering, and the Director of Education of that Department. The Council also meets every month.

The Department has ten programmes

	Programme leader:
1. Design Engineering	Prof. dr. ir. Fred van Houten
2. Elastomer Technology & Engineering	Prof. dr. ir. Jacques Noordermeer
3. Surface Technology & Tribology	Prof. dr. ir. Dik Schipper
4. Production Technology	Prof. dr. ir. Remko Akkerman
5. Mechanics of Forming Technology	Prof. dr.. ir. Han Huétink
6. Structural Dynamics & Acoustics	Prof. dr. ir. André de Boer
7. Biomechanical Engineering	Prof. dr. ir. Bart Koopman
8. Engineering Fluid Dynamics	Prof. dr. ir. Harry Hoeijmakers
9. Mechanical Automation	Prof. dr. ir. Ben Jonker
10. Thermal Engineering	Prof. dr. Ir. Theo van der Meer.

The department has links to TUD and TUE through the federation of 3TU, and to large applied Dutch research institutes and research schools.

The Committee is of the opinion that the organizational structure and management of the Department is well done. It provides ample opportunity for discussion between the dean and the faculty of important strategic issues.

Strategy & Policy
The department focuses more on contract research as a substitute to direct funding as a source of income. This seems to be necessary to reach the goal of increased PhD production. In addition, this effort will increase the interaction with the industry and hence, also further improve the relevance of research. As an issue in the efforts to improve the academic image, some research programmes, such as Design Engineering, Production Technology and Thermal Engineering should perhaps also increase the research funding. This is a reasonable expectation now for the first two groups since they have completed their significant contributions to establishing the Industrial Design Engineering programme in the last 6 years period.

It is of great importance to encourage new ideas (along the lines of encouraging a more entrepreneurial spirit). The seed project and the business accelerator schemes at the university seem to provide a means to take care of this issue. The committee finds it a good policy that at the level of the department or the research institutes some funds are reserved for such purposes. In line with that it is also important to hire good faculty candidates and to provide a tenure track; which involves support in terms of a research funding including support for 1-2 PhD students.

The committee finds that the laboratories and other research facilities that the department has at its disposal, are of a very good standard.

Academic Reputation
The department has many young scientists. This is reflected in an enthusiastic, informal and cooperative spirit. The department produces PhD-candidates and journal papers which in number per fte of tenured faculty correspond to the average productivity in the Dutch Mechanical Engineering community. The academic reputation can be further enhanced by

increasing the number of graduating PhD-candidates and by a greater focus on publishing in high impact journals.

Societal Relevance
The Department has a pronounced entrepreneurial character, with a tradition of interdisciplinary research and education, which well serves society at large. The Department also has significant connections with industrial organizations to the benefit of both the Department, Industry and Society.

The societal relevance of the research is high. The research results are successfully implemented in practice. A large part of the knowledge transfer takes place in conferences and seminars, and in projects funded directly by users and practitioners. All groups have strong ties with the industry, institutes for applied science and various ministries.

Resources
The Department has provided the following overview of the personnel resources, in full-time equivalents (fte) research time.

Institutional level	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Tenured staff	16,92	16,92	17,29	16,64	17,44	17,85
Non-tenured staff	8,95	8,86	7,6	10,51	8,05	6,56
PhD students	49,07	54,51	58,69	65,42	63,78	61,85
Total research staff	74,94	80,29	83,58	92,57	89,27	86,26

Programme level	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Programme *Design Engineering*						
Tenured staff	2,6	2,72	3,33	3,7	4,1	4,15
Non-tenured staff	0	0	0,64	1,08	0,8	0,8
PhD students	5,8	6,6	6,17	5,7	6,34	7,54
Total research staff	8,4	9,32	10,14	10,48	11,24	12,49
Programme *Elastomer Technology & Engineering*						
Tenured staff	0,55	0,8	0,8	0,8	0,8	0,8
Non-tenured staff	0,9	0,8	0,87	0,84	0,58	0,24
PhD students	4,34	5,48	7,4	6,96	7,85	8,73
Total research staff	5,79	7,08	9,07	8,6	9,23	9,77
Programme *Surface Technology & Tribology*						
Tenured staff	1,46	1,13	0,93	0,8	0,8	1,03
Non-tenured staff	0,96	0,68	0,32	0,32	0,84	0,88
PhD students	6,12	7,59	7,07	7,51	6,26	4,37
Total research staff	8,54	9,4	8,32	8,63	7,9	6,28
Programme *Production Technology*						
Tenured staff	0,9	0,9	0,9	0,95	1	1,6
Non-tenured staff	0	0	0,23	0,37	0,6	0,46
PhD students	2,34	3,83	4,39	4,34	4,27	3,53
Total research staff	3,24	4,73	5,52	5,66	5,87	5,59
Programme *Mechanics of Forming Technology*						
Tenured staff	1,92	1,92	1,92	1,52	1,52	1,52
Non-tenured staff	2,86	3,2	1,6	1,2	0,92	1,4

PhD students	5,2	3,53	2,88	5,39	6,45	7,67
Total research staff	9,98	8,65	6,4	8,11	8,89	10,59
Programme *Structural Dynamics & Acoustics*						
Tenured staff	1,28	1,31	1,38	1,19	1,18	1,09
Non-tenured staff	0	0	0	0,8	0	0
PhD students	3,83	4,3	4,23	5,03	4,8	5,23
Total research staff	5,11	5,61	5,61	7,02	5,98	6,32
Programme *Biomechanical Engineering*						
Tenured staff	1,42	1,4	1,38	1,41	1,73	1,73
Non-tenured staff	0,23	0,8	1,28	0,37	0,06	0,06
PhD students	4,64	4,71	4,56	4,18	4,92	5,08
Total research staff	6,29	6,91	7,22	5,96	6,71	6,87
Programme *Engineering Fluid Dynamics*						
Tenured staff	2,08	2,41	2,52	2,65	2,65	2,27
Non-tenured staff	1	0,98	0,29	0,72	1,12	0
PhD students	8,63	10,27	8,5	8,96	7,37	5,2
Total research staff	11,71	13,66	11,31	12,33	11,14	7,47
Programme *Mechanical Automation*						
Tenured staff	2,28	2,03	1,9	1,9	1,9	1,9
Non-tenured staff	1,6	1,6	1,8	3,21	2,72	2,72
PhD students	4,47	4,23	7,73	10,87	9,4	9,58
Total research staff	8,35	7,86	11,43	15,98	14,02	14,2
Programme *Thermal Engineering*						
Tenured staff	2,43	2,3	2,23	1,72	1,76	1,76
Non-tenured staff	1,4	0,8	0,57	1,6	0,41	0
PhD students	3,7	3,97	5,76	6,48	6,12	4,92
Total research staff	7,53	7,07	8,56	9,8	8,29	6,68

Balance of Strengths & Weaknesses

The self-evaluation realistically describes the strength, weaknesses and opportunities of the Department. The Committee agrees with the assessment. The threats are, in general terms, the same as for the Departments at the two other Technical Universities. The Committee is optimistic that the Department will be able to deal successfully with these threats. The Department is encouraged to build upon its differences with Delft and Eindhoven, to more firmly establish its own signature.

The Committee thinks that the Policy perspective for 2007-2012 is well defined. The Committee was pleased to note that careful attention was given to the comments and suggestions of the previous accreditation committee, and that positive and effective measures were taken to follow up on these comments and suggestions..

3.4. UT - Part B: Assessment per programme

The committee assessed the following programmes of the Department of Mechanical Engineering, University of Twente:

UT 1	Design Engineering
UT 2	Elastomer Technology and Engineering
UT 3	Surface Technology and Tribology
UT 4	Production Technology
UT 5	Mechanics of Forming Technology
UT 6	Structural Dynamics and Acoustics
UT 7	Biomechanical Engineering
UT 8	Engineering Fluid Dynamics
UT 9	Mechanical Automation
UT 10	Thermal Engineering

The detailed assessment per programme follows in the next section of this report.

Programme UT 1:	**Design Engineering**	
Programme director	Prof. dr. ir. F. J. A. M. Van Houten (from 2003)	
Research staff 2006	4.15 tenured, 12.5 total fte	
Assessments:	Quality:	4
	Productivity:	3
	Relevance:	4
	Viability:	4

The DE group focuses on understanding and improving design from a life cycle perspective. Its main contribution is new methods and tools for design in the areas of: a) Design synthesis; b) Process Planning & Tool Design; c) Product Life Cycle Management, Production & Control. For their research efforts the group has an excellent large-scale laboratory at its disposal. The group seems to have a good international network and reputation.

This group had the highest relative teaching load in the Department of Mechanical Engineering. Moreover, it has many young scientists. These two factors, especially when they are present together, may easily reduce the efficiency of the research. This is a management problem for the leader of the group.

Quality
The relative citation rate is about the world average. The academic reputation could be improved by an increased rate of high quality journal publications and graduation of more PhD candidates.

Productivity
The number of journal papers/fte tenured staff is about half the average in mechanical engineering in the Netherlands while the journal publication rate is much lower than the Dutch average in this sector of engineering.

Relevance
The academic and practical impact of the research is good; with a good balance between academic and applied research.

Viability
Design engineering is a changing and important field, especially as a result of globalization of the engineering community. The future plans of this group show that they wish to be a part of that trend and serve especially the Dutch industry. The number of young scientists in the programme points towards future vital and relevant research activities.

Conclusion
After a period of intensive efforts in contributing to the build up of the curriculum of the Industrial Engineering Programme, this group is expected to demonstrate its ability to continue to develop their academic quality while maintaining the industry oriented applied profile. In this connection it is desirable to increase the number of PhD graduates. The goals and the policy of the group are very good.

While maintaining the level of contract research funding, it is important that the research group aims at solliciting research funds which will contribute to improving the academic profile of the research.

Programme UT 2:	**Elastomer Technology and Engineering**
Programme director	Prof. dr. ir. J.W.M. Noordermeer
Research staff 2006	0.8 tenured, 9.77 total fte
Assessments:	Quality: 4
	Productivity: 4
	Relevance: 4
	Viability: 4

The programme focuses on experimental and modeling work on the science and technology of rubber.

Quality
The programme addresses a number of problems that are highly relevant to the modern use of rubber, such as the use of silica filler particles and the development of new methods of rubber recycling. The self-evaluation mentions that the programme leader has won international awards in 1999, 2000 and 2005, and a national award in 2006.

Productivity
The publication rate of the group is good and some members of the group have a high citation frequency. That a fairly large fraction of the papers does not get cited is probably the result of some of the work being highly technological in nature. The end users of the publications of that part of the work are unlikely to write papers.

Relevance
Rubber is obviously of great technological importance. This is a unique programme in this part of Europe, and as such if fulfils an important role in maintaining manpower in this field. The group also works well with other groups at Twente and in the Netherlands on problems such as road noise. The problems associated with the recycling of various types of rubber will only increase in importance and the group is well positioned to take the lead.

Viability
The imminent retirement of Noordermeer requires careful thought about the future of this unique programme. The appointment of Dierkes promises continuation at least in some very important part of the work (recycling). Continuation of the other aspects of rubber research, especially those relevant to collaborating groups at the UT and other Dutch institutions, will probably require an additional senior appointment.

Conclusion
This group is productive, visible, and has a unique technological position in the Netherlands that is very much worth preserving.

Programme UT 3:	**Surface Technology & Tribology**
Programme director	Prof. dr. ir. D.J. Schipper
Research staff 2006	6.03 fte tenured, 6.28 fte total
Assessments:	Quality: 3
	Productivity: 3
	Relevance: 4
	Viability: 4

The programme is primarily concerned with the area of tribology (friction, lubrication and wear) and the surface treatments needed for optimize friction, lubrication and wear in mechanical systems. This is an important technical area for all modern machinery and particularly appropriate in the context of a mechanical engineering programme.

Quality
The quality of the intellectual products of the group is good. They publish in the top journals in the field of tribology and present their work at the major conferences in the field. They maintain contacts with several important tribology groups around the world. Members of the group have received recognition from tribology societies indicating that their work is respected. The principal members of the group are asked to and do serve on society boards and committees as well as serve on editorial boards and as chairs of sessions at conferences. Another indicator of the external respect the programme commands is the fact that some of their PhD-students are supported by industry coming to study with their own support.

Productivity
The number of publications in refereed journals is respectable (25 or 34 depending on the source of the data, with 74 citations for 34 papers averaging 2.18 citations per paper), but below the average for the journals in which the papers are published. It should be noted that 41% of the papers are not cited at all, which requires attention.

Relevance
The subject matter is very relevant to today's mechanical systems. The group is relevant in that it is the only group in the Netherlands with the word tribology in its name. However there are other groups in mechanical engineering programmes in the country that are doing tribology research.

Viability
The group is viable and should be maintained because it is in an important subject area. In addition the number of tribology research groups has been declining in recent years worldwide. However, the group is small and has had considerable turnover of personnel in the period under review. In addition many of the current research projects of the group seem to be traditional subjects that have been studied for many years. This may be a result of the fact that the group is heavily supported by industry and the work is often of a service nature.

Conclusion
The group is reasonably productive and well recognized internationally for its research products and service to the community. It should be maintained and strengthened. The group leader is relatively new and has done well in the time he has been in his position. The group attracts a large number of PhD students some of whom are supported by industry. The group should focus on undertaking more fundamental research and less on service to industry.

Programme UT 4:	**Production Technology**	
Programme director	Prof. dr. ir. R. Akkerman (from 2003)	
Research staff 2006	1.6 tenured, 5.59 total fte	
Assessments:	Quality:	3.5
	Productivity:	3.5
	Relevance:	4
	Viability:	4

The PT group carries out research with the aim to develop methods for optimal manufacturing processes and the resulting product performance, within the scope of lightweight materials. While the focus has been on plastics, light metals are also pursued. This relatively small research group is embedded in the IMPACT institute, and various research schools. By combining numerical analyses and use of a good small-scale experimental facility as well as cooperation with the industry the group seems to have been able to develop very relevant tools for some leading industry companies.

Quality
The academic reputation is limited due to lower than average rate of journal publications and graduation of PhD candidates. The group has developed very relevant tools for some leading industrial companies.

Productivity
The number of PhD graduates in the assessment period is about the average for mechanical engineering in the Netherlands while the publication rate in high quality journals is somewhat below the average. The research programme has, however, contributed practical knowledge in good contact with the industry.

Relevance
The group has been able to increasingly attract research funds; while also maintaining a reasonable level of contract funding. This shows that both the academic and practical relevance is good.

Viability
This is a relatively small and young group. Despite these facts the research activity has been developing quite well since 2003. Research funding and contracts have increased towards the end of the period in a very positive manner. The group has a significant research potential to further develop the quality of the academic research to attract research funds and expand the link to the industry.

Conclusion
The teaching work load has been relatively high for this group. It is a relatively small and young group with a future potential. An increasing rate of conference publications is noted; more refereed journal papers are needed. The name "Production Technology" does not reflect the research activities of the group; the activities are very similar to UT 5 (Mechanics of Forming Technology), and it might be better to merge the two groups.

Programme UT 5:	**Mechanics of Forming Technology**
Programme director	Prof. dr. ir. H. Huétink
Research staff 2006	1.52 tenured, 10.59 total fte
Assessments:	Quality: 4
	Productivity: 3
	Relevance: 4
	Viability: 4

The objectives of the programme are clearly expressed in the Mission Statement and the research is highly focused and directed towards specific requirements related to the understanding, design and advancement of forming processes. The programme has three research themes, which complement each other, and the work ranges from the development of fundamental constitutive models for material and contact behaviour, the simulation of industrial forming operations and the development of optimisation procedures for improved production. The activities are predominantly biased towards numerical simulation and experimental work is limited. The leadership of the programme recognises that the objectives are limiting on the longer term and consideration is being given to use their accumulated experience to branch into new areas.

Quality
The work is innovative with regard to developments in computational algorithms and the modelling of fundamental material behaviour. Other aspects are, understandably, more application oriented. The overall programme displays a cohesive research strategy whose outcomes are highly regarded by industry. To date, publication has been biased towards conference papers and it is recognised by the group that more emphasis on publication in refereed journals is required. However, the refereed papers produced by the group show a high citation index (4.03). The impact score CPP/FCSm of 2.13 is the best score of all 3TU ME programmes in the evaluation period (2001-2006). The programme director is a member of the Editorial Boards of two journals, he is a highly respected member of the international forming technology community and much of the group's reputation revolves about his activities.

Productivity
The productivity of the group in terms of scientific papers (30 journal papers) appears low with a P/Fte ratio of 0.42, but including the large number of conference papers (57) shows the position to be a little healthier. Although the percentage of the journal publications that are not cited at all, is on the average for all programmes in this review (43%), paper content and journal selection may require attention.

Relevance
The programme is of first-rate quality and it apparently serves a significant function for industry as suggested by the funding that is received from NIMR and other industry related organisations. There is clear evidence of significant contribution to the computational modelling of forming problems and that these developments have been applied to industrial forming and manufacturing problems. The knowledge gained from the research has been effectively disseminated through journal and conference publications. In this respect, the relatively large number of conference papers presented is significant.

Viability
The group recognises its shortcomings in terms of its narrow research programme, the need to diversify its funding base and its limited experimental facilities. While its in-house codes are valuable and important for in-depth computational developments, they nevertheless pose serious issues in terms of maintenance. The future of the group may also be compromised by the future retirement (within 5 years) of the programme director, unless the problem is addressed.

Conclusion
Although the university and department of Mechanical Engineering adopt a "matrix" style management, the group has a flat structure which is suitable for its directed research goals. The group's current strategy is somewhat narrowly focused on the development of computational methods for the simulation of industrial forming processes and in this respect it is one of the leading research centres in Europe. The group recognises the need to diversify its funding base. The facilities are adequate for its present activities, but for the group to broaden its research directions its experimental amenities will have to be improved. In the specific field of forming technology, the group has an international research reputation which is, however, largely centred on that of the programme director.

Programme UT 6:	**Structural Dynamics and Acoustics**
Programme director	Prof. dr. ir. A. de Boer
Research staff 2006	1.09 tenured, 6.32 total fte
Assessments:	Quality: 4
	Productivity: 3
	Relevance: 4
	Viability: 4

The group has been heavily involved in the restructuring of the educational programmes at the university, while at the same time a new programme director took up his responsibilities. Despite these distractions, the group managed to continue its work in good order. Two principal research areas (structural dynamics & fluid-structure interaction and acoustics) have been identified. There is considerable commonality between these topics and when collaboration with the Engineering Fluid Dynamics and Thermal Engineering groups at UT is established, a good basis will exist for research across the spectrum of computational and experimental acoustics. Such an activity will be supported by a well funded acoustic laboratory.

Quality
By focusing on two related areas the group has an opportunity to make significant contributions to both academic research and industry through collaborative research. The two general areas, structural dynamics and fluid structure interaction and acoustics, have conventional components but also components that branch into issues of current international interest related to Microsystems. The group members, including the programme director, are heavily involved in teaching commitments, which undoubtedly limits their research activities. However, they see this as a benefit with regards to accessing SMEs and potential PhD students. The programme carries out considerable research for companies in the Netherlands and elsewhere. It also has a strong interest in innovations in technical education, and is providing technical support to SMEs.

Productivity
There has been a substantial improvement in the number of journal publications. The number published in refereed journals in 2007 alone is twice that published during the whole assessment period 2001-2006. Papers have also been published in proceedings of conferences, but these may draw relatively little attention after a short time. The number of citations for the assessment period is relatively low, 2.57 per paper, but this number is comparable to the average number of citations per paper for the journals of the publication. These journals were, however, generally less cited. The production of PhDs is still low, about 1 per year, even though new PhDs have no trouble finding positions in industry. A good sign is that more MS and PhD students are recently joining the programme.

Relevance
The activities of the group are focused on the delivery of their mission. There is clear evidence of collaboration with other research groups, industrial consortia and SMEs which implies that their contribution is valued in the external community. Because of its unique position in the Netherlands, it should be possible to increase external funding, particularly if an Institute of Acoustics is established.

Viability
The group underwent a period of restructuring caused by a change of programme director and also became heavily involved in the development of new educational programmes. With these hurdles having been overcome, the group should be in a stronger position to develop its future research strategy.

Conclusion
The past and present leaders have been very active on Boards and Committees. The current senior staff may be expected to accumulate a record of invitations to present plenary and key-note lectures at international conferences, membership of editorial boards of major journals and major awards from major technical societies. There is a clear indication that substantial progress has been achieved since the last review. The programme is in a good position to achieve further progress towards establishing a very good international reputation.

Programme UT 7:	**Biomechanical Engineering**
Programme director	Prof. dr. ir. B. Koopman
Research staff 2006	1.73 tenured, 6.87 total fte
Assessments:	Quality: 4
	Productivity: 4
	Relevance: 3
	Viability: 3

The mission of the group is to excel in research at the interface of the technological and medical sciences. The research endeavour is primarily aimed at the rehabilitation of patients with sensory or motor disorders to give them increased independence.

Quality
The quality of the published work of the group is good with a citation rate of 3.33 citations per paper (excluding self citations). This is the second highest of any Mechanical Engineering group at Twente University. However, 41% of the group's papers published in the review period received no citations. This is a matter of concern.

Productivity
The group has increased the number of publications in refereed journals each year of the review period. In terms of citations per paper and publications per fte, the group is among the best in this review. However, the number of papers presented at conferences has declined over the same period. This needs attention. Presenting work at conferences is important for building a research network and to interact with potential funding sources. The PhD degree productivity of the group is low for the size of the faculty group.

Relevance
This is an important field in both education and research. The group has unique projects, such as the robotic assistance for rehabilitation, and good links with clinical activity in this area. However, they may be trying to cover too wide a range of research subjects for the size of the group. Bioengineering is a very broad area covering many important and diverse subjects. A group of this size needs to focus to make an impact.

Viability
The programme has undergone considerable reorganization during the period under review. They need some stability to develop a clear focus in their research. They cover an interesting mix of subjects but need to focus to develop strength and recognition in some subset of bioengineering.

Conclusion
This is an important area for mechanical engineering and the group is doing a reasonable job of increasing productivity. They need to focus the research areas they are involved in and they need to put additional effort into recruiting PhD students.

Programme UT 8:	**Engineering Fluid Dynamics**
Programme director	Prof. dr. ir. H. W. M. Hoeijmakers
Research staff 2006	2.27 tenured, 7.47 total fte
Assessments:	Quality: 4
	Productivity: 3
	Relevance: 4
	Viability: 4

The research group concentrates on three main topics: rotating flow machinery, aero-acoustics and multiphase flows, as well as a new topic of granular flow. This represents a diverse number of topics partly emanating from the origins of the programme (transferred from Applied Physics) and partly from the expertise of the members. A number of unique experimental facilities are available, such as an acoustic wind tunnel, a bearing lubrication facility and a centrifugal machine test rig. The research encompasses experimental and numerical studies on both fundamental and industrial problems.

Quality
The publications of this group attain a reasonably high impact according to citation statistics, although a significant contribution is made by part-time professors without inclusion of other members of the group. Also, there is not much evidence of close collaboration across the three research areas, all of which are broad in their own right. Additionally, the group supplied an amended table of funding sources, reinforcing the impression that both the basic research and contract funding is quite low for the field of fluid dynamics. However, the group maintains a significant number of collaborative programmes with prominent national and international research centres.

Productivity
With regard to PhD theses, the completion rate shows a worrying trend. Overall the productivity of the group in terms of publications is low, especially considering the significant input attributed to the part-time professors. For the future wellbeing of the group an increase in journal publications is essential.

Relevance
The group has chosen challenging scientific problems with potential contributions to both fundamental knowledge and industrial implementation. There is evidence of collaboration with industrial organisations, representing transfer of the scientific knowledge. The percentage of direct funding by industry is on average about 30%.

Viability
The group comprises a collection of researchers with knowledge in three quite disparate fields. The quality and productivity measures suggest that consolidation would be advisable since the synergies among research directions are not convincing. This consolidation should take a form which also allows basic research and scientific publications to be increased.

Conclusion
The high reputation of the staff is notable. Nonetheless, their potential is possibly not being fully exploited because of a lack of critical mass in the numerous research topics.

Programme UT 9:	**Mechanical Automation**
Programme director	Prof. dr. ir. J.B. Jonker
Research staff in 2006	1.9 tenured, 14.20 total fte
Assessments:	Quality: 3
	Productivity: 3
	Relevance: 4
	Viability: 4

The focus of the programme is on design and development of controlled mechanical systems, with a specific application to laser machining. Prof. Jonker leads the control and dynamics group. Laser machining is led by Professor Meijer who is now emeritus, and the mechatronics group is led on a part time basis by Professor Soemers.

Quality
The institute's strength is in the application of control, robotics, sensors and dynamics on laser machining. The institute has strong academic strength in control and dynamics, as well as in the laser machining process which is the essential application technology in the institute. Mechatronics has a lesser strength and presence, but it is an important complimentary activity in packaging the robot guided laser machining for industry. Therefore, the reputation of the institute is based on the integration of three disciplines, which should be maintained. The publications also reflect the application of laser machining via mechanical automation. Instead of traditional control or laser processing of materials, the papers appear in the Journal of Laser Applications and few in application oriented dynamics and control journals. If the group wishes to be distinguished also in the dynamics and control areas, they should publish peer reviewed articles in highly reputable theoretical journals as well.

Productivity
The number of PhD graduates from 2001 to 2006 was only 6, but the institute graduated 6 PhD students in 2007 alone. Currently, they have about 13 PhD students. It appears that the institute started to increase the enrolment of PhD students in 2002, and its impact started to become visible in 2007 when both PhD graduates and journal publications become equivalent to all outputs in the previous six years. The group has a potential to publish one journal article per PhD student per year. The research funding has also increased from €1.381 in 2001 M to €2.069M in 2006, which is a commendable achievement. The contract research increased from €193K to €862K, which indicates a very healthy interaction with industry. The research funding is distributed as 48% direct funding, 7% research funding and 45% contract funding and others. The institute generated 8 patents since 2001, and their impact on the industry has yet to be measured in the coming years. However, the institute is successful in transferring robot guided laser machining technology to industry, as evidenced from industrial research contracts and the list of collaborators. The group has developed their own multibody dynamics software: SPACAR, which distinguishes them from other groups.

Relevance
The application of control, dynamics, mechanical automation on laser machining, welding and cladding is very relevant to industry in the Netherlands, Europe and the industrial world. The transfer of laser automation technology by training MS and Ph.D. students with integrated knowledge in laser machining, controls, dynamics, sensors, instrumentation and mechanical design is in high demand by the modern production industry. The institute also teaches fundamental courses in control, dynamics and manufacturing processes to undergraduate and

master students. In short, the institute's expertise and activities are highly relevant to society and to the University.

Viability
The present leadership seems to successfully manage the balanced integration of three disciplines. The institute would not be as successful if either dynamics/control or laser machining were removed. The institute has excellent prospects to continue expanding in automation of laser processing. It is important to keep the strength of the institute in the areas of dynamics, control and laser processing by avoiding control applications to wider disciplines, which may weaken the quality of the academic output.

Conclusion
The institute's strength is automation of laser machining. The future leader of the institute must have strong expertise in either dynamics and control, or laser machining.

Programme UT 10:	**Thermal Engineering**	
Programme director	Prof. dr. ir. T.H. van der Meer	
Research staff 2006	1.76 tenured, 6.66 total fte	
Assessments:	Quality:	3.5
	Productivity:	3
	Relevance:	4
	Viability:	3

This programme focuses on the goals of 'Clean energy/sustainable energy' with three research themes: fuel conversion processes, turbulent combustion and thermo-acoustics, and convective heat transfer. The research is performed primarily experimentally and numerically. The overall goals and mission of the group have high societal relevance and funding opportunities at national and European levels are plentiful.

Quality
The quality of the group is quite heterogeneous, being significantly higher in the areas of turbulent combustion. The research results are published in good journals. The impact of research articles of the unit compared to the world average is good. The acceptance of the research results by other groups is very good. The members of the research group are more prominent nationally than internationally, but overall the recognition is not high (e.g. no editorships).

Productivity
All measures of productivity based on publications/theses are low, although combustion related numbers are somewhat higher. The low productivity has been attributed to some personnel difficulties (i.e. illness). Further increases are expected in the areas of biomass conversion, and related to piston compression machine applications.

Relevance
The problems of fundamental research being pursued by the group are quite relevant to current questions posed by the scientific community, and they lay foundations for addressing more complex flow systems, e.g. multiphase flows. Dissemination has been very successful, either through publications, workshops or communications arising from European networks. Industrial links appeared weaker during the assessment period but have since increased significantly.

Viability
The performance of this group has been quite variable over the reporting period, reflecting significant personnel difficulties. Furthermore, the group has had difficulties in attracting sufficient numbers of PhD and Masters students. However, the present composition of the group suggests that the overall performance can now be improved.

Conclusion
This research group addresses topics of high potential. To achieve this potential the committee suggests that an increase of basic research will be essential, as will be an increase of scientific output and academic reputation. Cooperation with industrial organizations appears to be quite healthy.

3.5. TU Eindhoven - Part A: Assessment at the institute level

Mission & Goals
The mission of the Faculty of Mechanical Engineering is:
to carry out long-term, generic, world-class research on carefully selected topics that match with the technological interest of high-tech, internationally oriented industry
to realise an education and research programme with a balance of fundamental and application aspects.
The Committee regards the mission and goals as well-defined and appropriate.

Leadership
The organization to meet the mission and goals has a flat structure. The Dean, Prof. dr. ir. De Borst is in charge of the Department Board which maintains a direct line of communication with the research groups. The nine research groups are organized in three divisions, as follows

Polymer Technology	Prof. dr. ir. H.E.H. Meijer
Mechanics of Materials	Prof. dr. ir. M.G.D. Geers
Micro-and Nano-scale Engineering	Prof. dr. A.H. Dietzel
Dynamics and Control	Prof. dr. H. Nijmeijer
Control Systems Technology	Prof. dr. ir. M. Steinbuch
Systems Engineering	Prof. dr. ir. J.E. Rooda
Energy Technology	Prof. dr. ir. A.A. van Steenhoven
Process Technology	Prof. dr. ir. J.J.H. Brouwers
Combustion Technology	Prof. dr. L.P.H. de Goey

Each research group has a full-time chair, part-time professors, as well as further tenured staff. The leadership of the Department Board is excellent, and has high recognition in the mechanical engineering community.

The divisional structure has been very beneficial for sharing laboratories and skilled technical staff. It appears that the cooperation between the groups is very good. Since the new structure of divisions and research groups has only been introduced recently, the committee expects that further benefits are expected to become recognizable as more time will have passed. The Department has extensive internal and external cooperative programmes.

Strategy & Policy
The strategy and policy for developing the department is very straightforward. The number of full professors in attractive research fields is planned to be increased by 3 to 4. The interdisciplinary research between the groups has been promoted by application-oriented themes:

- automotive engineering science
- micro and nanotechnology.
- This seems to be appropriate.

The new programmes in Micro and Nano-scale Engineering and Numerical Methods in Engineering respond to world-wide interest in these areas, and will be directed by individuals with a highly recognized expertise.

Resources, Funding Policy & Facilities
The Department has provided the following overview of the personnel resources, in full-time equivalents (fte) research time.

Institutional level	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Tenured staff	13	14	14	16	17	17
Non-tenured staff	15	15	17	15	13	15
PhD students	47	47	58	67	70	78
Total research staff	75	76	89	98	100	110

Research programme level	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Programme *Control Systems Technology*						
Tenured staff	3,1	2,7	2,7	2,8	2,8	2,6
Non-tenured staff	0,6	1,9	1,2	0,9	0,8	0,9
PhD students	3,4	5	8,1	12,4	16,5	16,9
Total research staff	7,1	9,6	12	16,1	20,1	20,4
Programme *Dynamics and Control*						
Tenured staff	1,6	1,7	1,6	1,3	1,4	1,7
Non-tenured staff	4	2,7	2,2	1,8	1,6	1,2
PhD students	8,6	7,1	7,4	8,4	7,4	9,3
Total research staff	14,2	11,5	11,2	11,5	10,4	12,2
Programme *Systems Engineering*						
Tenured staff	1,3	1,5	1,5	1,9	2,3	2,3
Non-tenured staff	0,7	0,6	0,9	0,7	0,1	0,8
PhD students	4,4	2,4	3,1	6	6,2	7,9
Total research staff	6,4	4,5	5,5	8,6	8,6	11
Programme *Combustion Technology*						
Tenured staff	0,8	1	1,4	1,6	1,7	1,9
Non-tenured staff	2,9	3,3	4,5	3,3	2,2	2,5
PhD students	5,8	6,9	8,0	9,4	9,2	10
Total research staff	9,5	11,2	13,9	14,3	13,1	14,4
Programme *Energy Technology*						
Tenured staff	1,2	1,2	1,2	1,2	1,6	1,6
Non-tenured staff	0,9	0,8	1,9	2,2	2,1	1,8
PhD students	4,4	4,4	6,5	6,9	7	7
Total research staff	6,5	6,4	9,6	10,3	10,7	10,4
Programme *Process Technology*						
Tenured staff	1,4	1,9	1,7	2	2	1,8
Non-tenured staff	1,3	0	0	0,3	1	1
PhD students	3,2	2,5	5,1	5,2	5,9	6,9
Total research staff	5,9	4,4	6,8	7,5	8,9	9,7
Programme *Mechanics of Materials*						
Tenured staff	1,2	1,2	1,6	1,3	1,2	1,2
Non-tenured staff	1	2,2	2,4	3	3,15	4,4

PhD students	5,4	7	9	8,9	6,6	7,5
Total research staff	7,6	10,4	13	13,2	10,95	13,1
Programme *Polymer Technology*						
Tenured staff	2,2	2,4	2,5	2,6	2,6	2,6
Non-tenured staff	3,2	3,5	4	2,9	2,1	2,4
PhD students	11,8	11,2	10,7	8,2	9,3	8,7
Total research staff	17,2	17,1	17,2	13,7	14	13,7

The Committee finds that the programmes are well supported by the university. The number of research staff increased over the review period from 74 to 111. The number of faculty staff distributed over the nine groups compared to the number of students should be increased in the future.

The total direct funding also increased from about 17.5 M€ to 20 M€. The direct funding is slightly decreasing in terms of fte. The central funding is nearly constant at about 45%. The percentage of research grants is moderate and has room for growth. The department chair is aware of this. The experimental facilities available are very good and fulfil the highest international standards.

Academic Reputation
The academic reputation of the department varies slightly between the groups but is considered to be excellent in general. Many of the group leaders are internationally well known and have an excellent visibility in their research fields.

The scientific output of the various groups is noted to be excellent. This is in agreement with the field-harmonised and journal-harmonised impact factors, which are the highest among the three technical universities and are significantly above the average world standard.

Societal Relevance
The societal relevance of the various topics and of the work of the department members are all within the focus of policy formulated and the targets set for Thermo-Fluids Engineering, Dynamical Systems Design, and Computational and Experimental Mechanics. The socio-economic relevance of all parts of the research programme is very good. The research activities are nicely embedded in the various European and national programmes. There are also numerous examples of university-industry cooperations.

Balance of Strengths & Weaknesses
The department management pursues an excellent policy in enlarging the faculty towards promising modern research areas. This will further strengthen its importance as a technological brain port with a solid foundation in basic engineering sciences.

The Committee believes that the Department has a realistic view of its weaknesses. The Committee agrees that matching requirements will cream off funds that should be used for fundamental, high risk and curiosity-driven research, which is indeed highly undesirable.

3.6. TU Eindhoven - Part B: Assessment per programme

The committee assessed the following programmes of the Department of Mechanical Engineering, Eindhoven University of Technology:

TUE 1	Control Systems Technology
TUE 2	Dynamics and Control
TUE 3	Systems Engineering
TUE 4	Combustion Technology
TUE 5	Energy Technology
TUE 6	Process Technology
TUE 7	Mechanics of Materials
TUE 8	Polymer Technology

The detailed assessment per programme follows in the next section of this report.

Programme TUE 1:	**Control Systems Technology**
Programme director	Prof. dr. ir. M. Steinbuch
Research staff 2006	2.6 tenured, 20.4 fte
Assessments:	Quality: 5
	Productivity: 5
	Relevance: 5
	Viability: 5

The programme director has a strong theoretical background in control theory and signal processing, with an excellent industrial experience in instrumentation, packaging and integration. The director has the required fundamental scientific and practical knowledge in the field of Mechatronics Engineering. He joined TUE in 1999 from Philips Research Labs in Eindhoven, where he was extraordinarily successful in convincing industry of the value of theoretical control theory. Hence, his contracts now with industry include some emphasis on theoretical research, allowing the TUe programme to build a strong reputation for quality and leadership in both the theoretical and the applied control community. The industrial experience of the leader facilitates the greatly expanded industrial interactions. The performance-driven systems point of view forms an excellent strategy for improving products as well as analytical tools. The leadership has an excellent understanding of performance-driven system design, and has a proven track record of using this goal to achieve both fundamental new research and relevant applications of interest to industry. Labs are shared between groups (a good thing).

Quality
The director is the editor at large of the European Journal of Control, and has been associate editor of the IEEE Transactions on Control Systems Technology and several other related journals. The publications appeared in prestigious journals such as in IEEE Transactions in Automatic control and Automatica. The group has an impressive number of patents with industrial relevance and applications. The laboratory is recognized as one of the international centres of excellence in mechatronics where design, instrumentation, measurement and control technology are integrated. One indicator of research quality is the amount of competitive research funding received. This number seems quite low (15%), although the industrial funding is high (60%). This latter fact is a testimony of the high reputation in industry. Investments in labs from industry also constitute a measure of confidence from industry. The funding and the number of PhDs doubled since 2003, but only 15% of the funding is due to competitive research funding; (one measure of quality). Another quality indicator is the number of papers appearing in the top journals. They have published 13 journal papers in 2006, and a substantial number are in good journals.

Productivity
The CST programme has 7 tenured faculty, 5 staff, 16.9 PhD students, 40 MSc students, and 2 postdocs. This is less than 1 paper per PhD student per year, however. The stated goal is to achieve at least three journal papers per PhD. CST has been very successful in attracting enough funding to sponsor some “free”, unrestricted theses. This provides an excellent chance to get the jump on a new idea, or modify a research direction. New start-up companies have been successful. Labs are well funded from industrial contributions.
The group had 3.1 FTE tenured research staff in 2001 and increased to 2.6 in 2006. The number of PhD students increased from 3.6 FTE to 16.9. The funding increased from k€ 516 in 2001 to k€ 1,354 in 2006, and the number of journal articles jumped from 6 to 20. There were two patents per year on average. The rate of quality journal publication has been

very healthy, and the laboratory reached a steady state level of PhD students. The industrial collaboration is extremely strong as evident from the funding, and the patent and collaborative research projects with industrial partners.
The research funding is healthy and fairly divided between the direct funding (32%), external (15%) and contract research (53%) funding, totalling € 5,601 over the period 2001-2006. The journal publication reached more than one article per PhD student. The conference presentations and contributions to the books have been strong and very visible. The group's academic productivity is excellent, and equal to or above international standards.

Relevance
The Dutch industry is among the world leaders in ultra precision motion control systems used in the electronics, optics, instrumentation and medical industry. The chair targeted areas in Precision Machines, Robotics, Biomedical and Automotive engineering by designing performance based controllers and intelligent machine designs. The control and signal processing theory, precision machine design and electronics are integrated to demonstrate the application of modern control laws to achieve mechatronic systems, which is one of the core industrial strength of Netherlands in Mechanical Engineering.

Viability
TUe seems to have no difficulty attracting good students and good faculty. This attraction of good students is due in part to the leadership's focus on hiring high quality faculty, and focusing on high quality research. The Control Systems Technology absorbed the precision design engineering group when that programme's chair retired. Although the precision machines are achieved by applying advanced motion control laws, the core of the discipline is thermally stable machine design with minimum friction. It involves machine metrology, tribology, materials, optics and lasers. Therefore, the precision machine design engineering is a very important application area of control, but the basic research here is not restricted to control design. The Ph.D. students and research staff reached a steady state level, and will continue to be very productive if they maintain the current level of high quality research and industrial collaboration.

Conclusion
Control Systems Technology has distinguished itself with a strong leadership, outstanding academic performance and quality, with high industrial relevance in precision instrument and mechatronics design. The group has an outstanding productivity and internationally recognized reputation in mechatronics and precision motion control.

Programme TUE 2:	**Dynamics and Control**
Programme director	Prof. dr. H. Nijmeijer
Research staff 2006 12.2	1.7 tenured, 12.2 total fte

Assessments:	Quality:	5
	Productivity:	5
	Relevance:	5
	Viability:	5

Prof. Nijmeijer moved to TUE in the year 2000. He has a strong background and history of research in applied mathematics and nonlinear control from his past position at University of Twente, and has demonstrated a remarkable integration of high level, nonlinear dynamics and control theory on a variety of mechanical systems.

Quality
The chair is a fellow of IEEE, editor in chief of the Journal of Applied Mathematics, and associate editor of the distinguished journals Automatica and the International Journal of Control. This is among the best education in dynamics in the world. Stuttgart is probably the only competition for best dynamics. 7 courses in dynamics is a very substantial education in dynamics, exceeding what most schools have. Dynamics is an essential field of study that should not be judged solely on the basis of funding support. Dynamic models are essential for any control effort, yet funding to research dynamics is hard to obtain. So in spite of the low numbers for funding, I believe this is a vital programme, deserving strong support from the administration. The papers appear in top journals with internationally accepted quality, and the chair became nationally and internationally known in nonlinear dynamics and control. The chair cooperates closely with Control Systems Technology as well as with other laboratories which draws high level mathematical modelling and analysis knowledge from the chair.

Productivity
From 8.4 PhDs, 2 theses and 18 journal papers were produced in 2004, compared to the 2006 production of 9.3 PhDs, 0 theses, and 10 journal papers. The new programme under the new leader will take some time to get these numbers up. Papers per PhD went down, but faculty numbers increased. This is probably due to a higher percentage of younger faculty, with the new start under the new leader in 2004. During this period, funding increased from K€ 295 in 2001 to K€ 675 in 2006, and the number of journal articles jumped from 13 to 22. The journal publication rate is excellent. Although the group is well known with its theoretical research in nonlinear dynamics and control, the industrial collaboration is also very strong. The open minded and collaborative culture of the chair with a strong and highly desired theoretical base makes the group an ideal partner in a number of industrially relevant projects. The research funding is healthy and is divided between the direct funding (43%), external (28%) and contract research (29%), totalling 828K€ in 2007. The chair seems to have a substantial percentage of his programme supported by competitive, external research grants (29%). This is another indicator of high quality and academic excellence of the research.

Relevance
Many nonlinear dynamic and applied mathematics groups do not attract projects and funds from industry like this chair in TUE. The chair created a strategic alliance with industry by demonstrating that the complex dynamic problems can be modelled, their physics can be better understood and their performance can be improved thorough scientific methods and

fundamental research with a strong mathematical base. In cooperation with other research laboratories in TUE and Netherlands, the chair is working on industrially relevant problems originating from automotive, precision motion, robotics, Micro-Electro-Mechanical and Biomedical systems. The graduating students are in high demand, and the industry provides strong support through collaborative research initiatives.

Viability
Together with Control Systems Technology group, the chair absorbed the precision design engineering activities when that programme's chair retired. The two chairs sustained the precision engineering activities which had world wide reputation in designing ultra precision machines used in the electronics industry. This is commendable and works well at the present time under the dynamics and control programme. The nature of the research and the growth of research in precision engineering might in the future grow to a special field deserving a dedicated chair, but at this time no such plans are required.

Conclusion
Dynamics and Control Group has distinguished itself with a strong academic leadership, outstanding academic performance and quality, with industrial relevance research activities.

Programme TUE 3:	**Systems Engineering**
Programme director	Prof. dr. ir. J. E. Rooda
Research staff 2006	2.3 tenured, 11 fte
Assessments:	Quality: 4
	Productivity: 4
	Relevance: 5
	Viability: 5

Prof. Rooda is a senior researcher with a research focus in discrete-event systems control with application in factory layout, production flow control, and optimization of discrete event driven industrial systems.

Quality
The papers appear in a mixture of journals with high international quality and average quality. The chair is established as an expert in discrete systems and supervisory control.

Productivity
Research output has doubled the number of papers in recent years. Greater focus on journal papers (as opposed to only conference papers) is recommended.

Relevance
This work is highly relevant to industrial uses, and the industrial funding reflects that fact. The research is quite fundamental, so the number of applications should be many. The absence of interactions between control systems and engineering systems seems somewhat strange, since discrete-event systems are probably studied by both groups.

Viability
The current chair will retire in the near future. Plans have been made to attract a new chair in the area of Systems Design and Control, which will also be the name of the programme.

Conclusion
The Systems Engineering chair will retire in a few years, and the programme will have to adapt to a new focus of the selected new chair. For now the programme is an asset and the number of publications should increase, with the new focus on journal papers.

Programme TUE 4:	**Combustion Technology**
Programme director	Prof. dr. L.P.H. de Goey
Research staff 2006	1.9 tenured, 14.4 total fte
Assessments:	Quality: 4.5
	Productivity: 4
	Relevance: 4
	Viability: 5

The research programme comprises four areas: fundamentals of combustion, turbulent combustion, internal combustion engine technology, and biomass conversion. These areas support the mission of covering combustion from a molecular scale to its use in engineering applications. The group is extremely well equipped both experimentally and with resources for numerical studies. The leader has implemented well disciplined procedures to maintain and improve effectiveness.

Quality
The group is very well known and respected in the international combustion community. The research is published in top-rated journals and has excellent impact according to citation statistics. A healthy balance and connection between experimental and numerical studies has been achieved. Numerous results from the group have achieved acceptance within the community, e.g. laminar flame properties, flamelet analysis, turbulent reacting flows.

Productivity
The productivity exhibits a strong upward trend during recent years. This is attributed to the establishment of new facilities and a significant number of new appointments during this period. Also the funding has been increasing strongly in recent years with a good mix between basic and applied research. This should insure a continued high level of productivity in the coming years.

Relevance
This group is advancing scientific knowledge through very basic studies to relevant combustion topics. The programme has done excellent networking both nationally and internationally, insuring that current and future studies are integrated well into on-going trends of the community. Through this networking and the publication in leading journals, the results of the group are disseminated in an excellent manner. The group's strategic use of part-time professors and sabbaticals aids this. Furthermore, the group has been successful in applying their knowledge to industrial situations, either through their numerical modelling or through the use of their engine test-bed facilities.

Viability
The group has recognized an increased need for expertise in the area of atomization by foreseeing a new professor and the continuation of a strong competence in the area of laser diagnostics and in combustion kinetics will be insured by two recent professorial appointments. Strategically well considered past development of facilities will now pay off.

Conclusion
Overall the group is excellently posed for a strong research programme in the future. They demonstrate a high degree of strategic thinking in their choice of research topics and investments, both in equipment and personnel. They are working at a world-class level of quality

and all indications are that this will not change in the future. If the faculty intends to expand in the area of automotive engineering, then the activities in the field of engine combustion of this research programme could be easily strengthened through additional university support.

Programme TUE 5:	**Energy Technology**
Programme director	Prof. dr. ir. A.A. van Steenhoven
Research staff 2006	1.6 tenured, 10.4 total fte
Assessments:	Quality: 4
	Productivity: 4
	Relevance: 5
	Viability: 4.5

The group has one fulltime chair, one part-time chair, two associate professors and a number of young assistant professors. The total research input in the period 2001-2006 was 54 fte and the total tenured staff was 8.0.

After the combustion activities became autonomous in 2002, the research area and mission were concentrated on fundamentals of convective heat transfer and on research into small-scale energy systems with emphasis on sustainability. The research programme was grouped into three areas:

- heat transfer and transitional flows
- heat transfer engineering
- small-scale energy systems.

Quality
The funding in the review period increased from 220 K€ in 2001 to 435 K€ in 2006. The percentages of direct funding, research grants and contract funding are 60%, 20%, 20%. It is notable that the direct funding is decreasing and the contract funding is increasing. This is an indication of an increasing proportion of applied work. The cooperation within the Thermo-fluids Engineering Lab at TUE and the internal harmonisation of the research programmes are excellent examples of progress. Some of the research topics are part of the Burgers Centre programme.

Productivity
The results of the research were published in first rate journals. The impact of the articles is slightly above world standard (CPP/FCSm = 1.03), the average number of citations per paper is CPP = 1.8. The productivity counted by the number of papers per fte is 1.02, which is very good.

Relevance
Topics treated are heat transfer in convective flows, simulation of heat transfer in microchannels, fouling processes, or Rankine compression machinery.

The topics are well-selected and they are important topics within the broad field of general energy technology. The programme combines fundamentally oriented work (topic 1 and partly 2). The programme leader has an excellent academic reputation and strengthens the research by his membership of influential boards and committees.

Viability
The programme of the Energy Technology group is well-organised. Its main strength is the combination of highly relevant technically oriented work with fundamental research in the respective fields. The research is clearly within in the scope of future requirements in energy

technology. The programme reacts very flexibly to new opportunities and needs in the energy area. The prospects of the research unit with regard to viability and flexibility are estimated to be excellent. New and promising research lines are on the way and will need time to grow.

Programme TUE 6:	**Process Technology**
Programme director	Prof. dr. ir. J.J.H. Brouwers
Research staff 2006	1.8 tenured, 9.7 total fte
Assessments:	Quality: 4
	Productivity: 4
	Relevance: 4
	Viability: 4

The main research areas of this programme include: Statistical turbulence, phase transitional flow, and rotating fluid flow, representing areas of very basic research as well as applied research. This is also reflected in a good balance of funding on basic and applied topics. This group has built up considerable laboratory facilities and several industrial partners. The topics chosen for study are of particular importance to the process industry in The Netherlands.

Quality
The leader of this group has a strong industrial background and is well known in the research fields of the group. The interest and significance of the results is reflected and in sustained industrial interest and some spin-off activities. The more fundamental work of this group has been published in top-rated journals. The group has been very successful in addressing the fundamental fluid mechanic problems of more complex apparatus.
Productivity
The bibliometric measures of this group indicate that publication productivity could be increased in the area of scientific publications; however, this is partially compensated by numerous patents and results of more direct industrial relevance. Several of the group's developments have been successfully brought into the industrial environment.

Relevance
The group has chosen research topics with high economic potential and impact and seems to disseminate it's knowledge and capabilities well within the industrial and academic community. The work on statistical turbulence is state-of-the-art and has led to a high level of competence in experimental methods (3D PTV) and numerical simulations (DNS). On the other hand several breakthrough technologies have been achieved and work is continuing to understand and optimize practical solutions. This should lead to further technological opportunities for the group.

Viability
This group is in a very stable mode of operation – well staffed, well equipped, well trained; hence they are well posed to continue in the future with equal or increased success. The faculty should be sure to integrate their activities early into their future strategic plans prior to retirement of the group leader.

Conclusion
This is a dynamic group with a good balance of basic and applied research. In both areas they are now well recognized and working at a high level of quality and relevance.

Programme TUE 7:	**Mechanics of Materials**
Programme director	Prof. dr. ir. M.G.D. Geers
Research staff 2006	tenured 1.2 fte, total 13.1 fte
Assessments:	Quality: 5
	Productivity: 4
	Relevance: 5
	Viability: 5

The scheme of research was started in 2000 and has developed rapidly into a programme with a first-rate international reputation. The research undertaken by the group spans the range of fundamental studies, numerical implementation, experimental validation and industrial application related to advanced material knowledge and behaviour. Specifically, the programme has five related research topics, three of a generally fundamental nature, one related to the manufacture of high-tech automotive materials, which is more application oriented, and one named Micromechanics of Functional Devices that would appear to lie somewhere between. Much of the fundamental work in multi-scale modelling, damage mechanics and strain gradient plasticity is at the leading edge of international research in these areas and the group is considered as a prominent contributor to the field.

Quality
Research on the three fundamental topics is being pursued worldwide and hence this area is very competitive. The ratio of fundamental to applied research is ideal, for an academic institution, but over the longer term, the programme may have to become more involved with applications. A significant proportion of the work undertaken is highly innovative and, in particular, advances in the fields of multi-scale modelling, damage mechanics and strain gradient crystal plasticity are internationally leading. The group has a notable record in terms of quality of publications, with high citation and impact factors and the internal and external collaborations, as well as the invitations for plenary and keynote lectures, indicate a rapidly developing academic reputation.

Productivity
The number of PhD theses produced is healthy and the number of PhD projects in progress is increasing. The relatively high number of PhD students in post is undoubtedly a reflection of the high proportion of industrial funding secured by the group (63%). The record of published papers (94) is good, but the average number of citations per published paper (4.09) could be better considering the large number of investigators in the area. Unless these papers were published in 2005-2006, the percentage of papers that were not cited at all (37%) is troubling. The bulk of the publication output is evenly balanced between journal and refereed conference articles, which is consistent with the high exposure of the group at leading international conferences in the field.

Relevance
The group is undertaking outstanding research work which is both fundamentally challenging and of direct relevance to current and future advanced industrial needs. The dissemination of this knowledge takes place through highly cited publications and the visibility of the group at major international conferences. The implementation of the research is clearly evident from the high level of participation of the group in industrial projects. The industrial cooperation, industrial results, spin-offs and outflows are impressive.

Viability
This is an outstanding group of highly motivated researchers that will make a strong impact on the theoretical/computational mechanics field. The programme is on an upward trajectory and the group has an excellent vision of future requirements that relate both to fundamental and computational research, as well as to the needs of the concentration of high-tech industries that are located in the TUe region. The average age of the group is young and the individual members have significant research potential. Indeed, the youth of the group may pose a problem in that it may be difficult to keep them as a cohesive group unless appropriate career advancement routes can be identified

Conclusion
The group is led by a talented young researcher whose enthusiasm permeates the entire programme. The academic reputation of the researchers involved is excellent, making it one of the strongest groups in Europe in the specific field of multi-scale modelling. The group is sufficiently small to allow it to pursue a flat management strategy and its vision of future requirements in the multi-scale, multi-physics research arena is clear. A primary strength is the well equipped multi-scale laboratory, which has been recently built up.

Programme TUE 8:	**Polymer Technology**
Programme director	Prof. dr. ir. H.E.H. Meijer
Research staff 2006	2.6 tenured, 13.7 total fte
Assessments:	Quality: 5
	Productivity: 5
	Relevance: 5
	Viability: 5

The programme includes research on a number of important aspects of polymer science: structure and development in flow, structure-property relations and mechanical properties

Quality
This programme is internationally recognized as one of the top polymer science institutes in the world.

Productivity
The productivity of this group is excellent. The publication and citation numbers speak for themselves.

Relevance
The problems addressed by this group are all central to the current development of polymer science.

Viability
Given that this group has maintained a first-rank international reputation in polymer science for more than a decade, and that they have demonstrated very good judgement on their choices of research topics, there is every reason to believe that the group will remain at the forefront of the field.

Conclusion
This group is one big reason that Eindhoven is an international centre of polymer research.

3.7. Overview of scores

Code	Institutes & Programmes	Q	P	R	V
Delft University of Technology					
BMechE	**Biomechanical Engineering**				
TUD 1	Man-Machine Systems & Medical Instruments	3	4	4	4
TUD 2	Biomechatronics and Bio-robotics	5	4	5	5
TUD 3	Intelligent Mechanical Systems (not reviewed)				
DCSC	**Delft Centre for Systems and Control**				
TUD 4	Systems and Control	5	4	5	5
MSE	**Materials Science and Engineering**				
TUD 5	Joining and Mechanical Behaviour	4	3	4	4
TUD 6	Light Metals Processing	4	4	3	4
TUD 7	Microstructural Control in Metals	5	4	4	4
TUD 8	Structure and Change in Materials	4	4	4	4
TUD 9	Surfaces and Interfaces	4	4	4	4
M&TT	**Maritime and Transport Technology**				
TUD 10	Offshore & Dredging Engineering	3	3	4	4
TUD 11	Ship Design, Production & Operation	4	3	5	4.5
TUD 12	Ship Hydromechanics & Structures	4	3	5	4
TUD 13	Transport Engineering and Logistics	4	3	4	4
P&E	**Process and Energy**				
TUD 14	Energy Technology	~~4~~	~~4~~	5	4.5
TUD 15	Engineering Thermodynamics (not reviewed)				
TUD 16	Lab for Aero and Hydrodynamics	5	5	4	4.5
TUD 17	Process Equipment	4.5	4.5	4	4
TUD 18	Separation Technology	4	4	5	4
PME	**Precision and Microsystems Engineering**				
TUD 19	Applied Mechanics	4	3.5	4.5	4
TUD 20	Mechatronics	2	2	4	3
TUD 21	Precision Manufacturing and Assembly	N/A	N/A	N/A	N/A
Eindhoven University of Technology					
TUE 1	Control Systems Technology	5	5	5	5
TUE 2	Dynamics and Control	5	5	5	5
TUE 3	Systems Engineering	4	4	5	5
TUE 4	Combustion Technology	4.5	4	4	5
TUE 5	Energy Technology	4	4	5	4.5
TUE 6	Process Technology	4	4	4	4
TUE 7	Mechanics of Materials	5	4	5	5
TUE 8	Polymer Technology	5	5	5	5
Twente University					
UT 1	Design Engineering	4	3	4	4
UT 2	Elastomer Technology and Engineering	4	4	4	4
UT 3	Surface Technology and Tribology	3	3	4	4
UT 4	Production Technology	3.5	3.5	4	4
UT 5	Mechanics of Forming Technology	4	3	4	4
UT 6	Structural Dynamics and Acoustics	4	3	4	4
UT 7	Biomechanical Engineering	4	4	3	3
UT 8	Engineering Fluid Dynamics	4	3	4	4
UT 9	Mechanical Automation	3	3	4	4
UT 10	Thermal Engineering	3.5	3	4	3

APPENDICES

Appendix A: Curricula vitae of the committee members

Jan D. Achenbach, chairman of the Committee, is Walter P. Murphy Professor and Distinguished McCormick School Professor of the Departments of Mechanical Engineering and Civil and Environmental Engineering, and Founder of the Centre for Quality Engineering and Failure Prevention. Professor Achenbach is a recipient of the 2003 National Medal of Technology and the 2005 National Medal of Science (the nation's highest honours awarded by the President of the U.S. for technological innovation and scientific accomplishments). He is a member of the National Academy of Engineering, a member of the National Academy of Sciences, and a fellow of the American Academy of Arts and Sciences. He is also a Corresponding Member of the Royal Dutch Academy of Arts and Sciences, an Honorary member of the American Society of Mechanical Engineers, and a fellow of ASME, ASA, SES, AMA and AAAS. His awards include the Timoshenko Medal and the William Prager Medal.
Professor Achenbach's research interests include propagation of mechanical disturbances in solids, ultrasonic methods in quantitative non-destructive evaluation, fracture mechanics, damage mechanisms in composites and vibrations of complex structures. His recent work has involved non-destructive evaluation and structural health monitoring of safety-critical structures.

Yusuf Altintas is director of the Manufacturing Automation Laboratory at the University of British Columbia UBC). He joined the university as an Assistant Professor in 1986, and subsequently promoted to Associate Professorship in 1991 and full Professorship in 1996. Professor Altintas spent four years in industry as a machine tool and manufacturing engineer. He spent sabbatical study leaves in Technical University of Aachen, WZL (1992-1993; July-December 2004), Technical University of Stuttgart (July-August 2000) and Machine Tool Research Centre at the University of Florida (1999-2000). The Manufacturing Automation Laboratory at UBC investigates metal cutting mechanics, machine tool vibrations, CAM, precision machining and CNC design topics. The technology created by his research group has been licensed to more than sixty companies world wide, especially in Virtual Machining Process Simulation. His laboratory developed Machine Tool Testing and Machining Process Simulation algorithms which are used by over 80 universities and companies world wide. He has been holding the NSERC – Pratt & Whitney Canada Industrial Research Chair Professorship to develop next generation Virtual High Performance Machining Technology since 2002.

Torgeir Moan is Keppel Professor in Ocean, Offshore and Marine Technology at the Department of Civil Engineering in the National University of Singapore, and Professor of Marine Structures at the Department of Marine Technology and director of the Centre for Ships and Ocean Structures in the Norwegian University of Science & Technology (NTNU). He has been a visiting professor at Massachusetts Institute of Technology (MIT) for one year and University of California, Berkeley for two years. Prof Moan has contributed to the development of various structural design standards for offshore structures, ships and floating bridges in Norway and internationally. Most recently, he was responsible for the most modern standard for analysis of loads and load effects for offshore structures (NORSOK N-003) that will serve as the basis for ISO standards for floating platforms. He has also been engaged in accident inquiries. Since 1976 he has been involved in the International Ship and Offshore Structure Congress (ISSC) for which he is currently a Standing Committee member. In 1998, he was honoured with the Statoil research prize.
Prof Moan is presently an editor of the journal Marine Structures and serves on the editorial board of 7 other journals. He is also an elected member of the academies NTVA and DKNVS,

Fellow of the Royal Academy of Engineering in UK, as well as elected Fellow of several international professional societies like ASCE and IABSE. Professor Moan had previously served as the Head of the Department of Marine Technology, NTH (NTNU) and served as Project Manager in several research projects in SINTEF.

Roger Owen is professor in Solid and structural mechanics in the University of Wales Swansea. His research has centred on the development of solution procedures for non-linear problems encountered in science and engineering. He was Walter P. Murphy Research Fellow at Northwestern, involved in both the analytical and computational study of fundamental plastic material deformation described by continuously distributed dislocation mechanisms. At the University of Wales Swansea he joined the Department of Civil Engineering, where he developed an interest in computational methods and contributed to the development of computational strategies for plastic deformation problems, both for fundamental material studies and for application to Civil and Mechanical structures and components. More recently Prof. Owen's work has focused on the development of discrete element methods for particulate modelling and the simulation of multi-fracturing phenomena in materials. Professor Owen is a member of the Executive Council of IACM (International Association for Computational Mechanics) and is a Board Member of the European Council for Computational Mechanics (ECCM). He is also Past Chairman of the UK Association for Computational Mechanics in Engineering. He was a member of the Research Assessment Exercise panel for Civil Engineering in 2001 and has been appointed to similar panels for the Deutsche Forschungsgemeinschaft (DFG) in 2006 and 2007. He was also a member of the International Advisory Board for the Institute for High Performance Computing in Singapore for a five year period. Due to his industrial involvement, Professor Owen has served for over ten years as elected Council Member of NAFEMS, which is an international organisation aimed at establishing standards and quality assurance procedures for the safe use of finite element methods.

Paul Roth is expert in nano-science and retired professor of the Universität Duisburg-Essen, where he established and directed the Institute for Combustion and Gasdynamics and participated in the research that laid the foundation for developing safer and more efficient Lithium-Ion batteries. He began his career at the German Aerospace Centre DLR Köln, Institut für Luftstrahlantriebe, and became department head at DLR Stuttgart, Institut für Reaktionskinetik. He became professor for Flow technology at the Universität Duisburg in 1974. He was visiting fellow at Stanford University in 1984 and dean of the department Maschinenbau in 1985. He was on the Editorial Board of several journals and became Deputy Editor of the journal Combustion and Flame in 2000. He was on the Board of Directors of ICDERS since 1999. He published extensively on gas-phase reaction kinetics, combustion, aerosol processes, computer simulation of reactive flow, reactive completion of nano particles, measurement techniques and nano particle characterisation.

Robert E. Skelton is professor and director of the Structural Systems and Control Laboratory in the Department of Mechanical & Aerospace Engineering, University of California, San Diego. His research is on Linear Control Theory, Tensegrity Systems Design and Applications. He is fellow of IEEE, AIAA, he was appointed Russell Severence Springer Professor, UC Berkeley, in 1991, he received the Award of the Japan Society for the Promotion of Science and the Senior Scientist Award of the Alexander von Humboldt Foundation. He was on the Aeronautics and Engineering Board of the National Research Council and was an External Independent Review Team Member for the second servicing mission of the Hubble Space Telescope.

Frans Spaepen is the John C. and Helen F. Franklin Professor of Applied Physics at Harvard University Division of Engineering and Applied Sciences. From 1990 through 1998 he was Director of the Harvard Materials Research Laboratory/Materials Research Science and Engineering Centre. His research interests span a wide range of experimental and theoretical topics in materials science, such as amorphous metals and semiconductors (viscosity, diffusion, mechanical properties), the structure and thermodynamics of interfaces (crystal/melt, amorphous/crystalline semiconductors, grain boundaries), mechanical properties of thin films, and the perfection of silicon crystals for metrological applications. He is a Fellow of the American Physical Society (Chairman, Division of Materials Physics, 1992), a Fellow of TMS-AIME, a Foreign Member of the Vlaamse Academie voor Wetenschappen en Kunsten, and a member of ASM, and the Materials Research Society. In 1988 he was Chairman of the Gordon Research Conference on Physical Metallurgy, and in 1990 he co-chaired the Fall Meeting of the MRS in Boston. He is co-editor of Solid State Physics, Principal editor of the Journal of Materials Research, and an editorial board member of a number of materials science journals.

Cameron Tropea is professor of Mechanical Engineering, Fluid Mechanics and Aerodynamics at the Technische Universität Darmstadt and director of the Centre for Smart Interfaces (CSI, DFG Cluster of Excellence 259). From 1992-1997 he was director of the department for Experimental Flow Mechanics at the Friedrich-Alexander Universität Erlangen-Nürnberg. From 1985-1988 he held positions at the Department of Mechanical Engineering, University of Waterloo, Canada, teaching Measurement Techniques in Fluid Mechanics. Since 2004 he is Elected Member of DFG Fachkolleg 'Strömungsmechanik' in the area of thermo-energy technology and propulsion, Elected Chairman of ESA Life and Physical Sciences Advisory Committee (LPSAC), ex-officio member of ESA Programme Board Human Spaceflight and Microgravity and ESA Exploration Programme Advisory Committee. In 2003 he was co-recipient of the Yasusi Tanasawa Award, conferred by ILASS-Japan for the best paper published in the ICLASS proceedings in 2000, with co-authors J. Walther, R. Wirth and R. Schaller for the paper 'Investigation of Internal Flow in Transparent Diesel Injection Nozzles Using Fluorescent Particle Image Velocimetry (FPIV)'. Since 2003 he is Coordinator Forschungsschwerpunkt "Biotechnik: Biologisch-Technische System", Technische Universität Darmstadt.

Ward O. Winer is retired Eugene C. Gwaltney Jr. Chair of the George W. Woodruff School of Mechanical Engineering, Georgia Institute of Technology. His research expertise is in lubricant rheology, thermal phenomena in tribology and machinery diagnostics. He is currently principal investigator on a Defense Department Multi-University Research Initiative in Integrated Diagnostics of Machinery. The emphasis of this programme is to develop techniques and instrumentation to detect incipient failures in mechanical systems. He has been principal investigator on projects sponsored by the National Aeronautics and Space Administration (NASA), the National Science Foundation (NSF), the Office of Naval Reserves (ONR), the Department of Transportation, the Department of Energy (DoE), and the Defense Advanced Research Projects Agency (DARPA). Professor Winer was named Distinguished Professor at Georgia Tech in 1987 and elected to the National Academy of Engineering (NAE) in 1988. The American Society of Engineering Education (ASEE) honoured him with the Benjamin Garver Lamme Award in 1995, and the Donald Marlowe Award in 1996. He has also received the American Society of Mechanical Engineers (ASME) Melville Medal, the ASME / Pi Tau Sigma (PTS/PTS) Charles Russ Richards Award, and the Tribology Gold Medal from the British Tribology Trust. He was awarded the Mechanical Engineering and Applied Mechanics (MEAM) Alumni Society Merit Award in 1998–99.

Appendix B: Explanation of the SEP-scores

Excellent (5)	Work is at the forefront internationally and will most likely have an important and substantial impact in the field. Group is considered an international leader.
Very Good (4)	Work is internationally competitive and is expected to make a significant contribution; nationally speaking at the forefront in the field. Group is considered international player, national leader.
Good (3)	Work is competitive at the national level and will probably make a valuable contribution in the international field. Group is considered internationally visible and a national player.
Satisfactory (2)	Work that is solid but not exciting, will add to our understanding and is in principle worthy of support. It is considered of less priority than work in the above categories. Group is nationally visible.
Unsatisfactory (1)	Work that is neither solid nor exciting, flawed in the scientific and or technical approach, repetitions of other work, etc. Work not worthy of pursuing.

Quality is to be seen as a measure of excellence and excitement. It refers to the eminence of a group's research activities, its abilities to perform at the highest level and its achievements in the international scientific community. It rests on the proficiency and rigour of research concepts and conduct; it shows in the success of the group at the forefront of scientific development.

Productivity refers to the total output of the group; that is, the variegated ways in which results of research and knowledge development are publicised. The output needs to be reviewed in relation to the input in terms of human resources.

Relevance is a criterion that covers both the scientific and the technical and socio-economic impact of the work. Here in particular research choices are assessed in relation to developments in the international scientific community or, in the case of technical and socio-economic impact, in relation to important developments or questions in society at large.

Vitality and feasibility. This dual criterion refers to the internal and external dynamics of the group in relation to the choices made and the success rate of projects. On the one hand, this criterion measures the flexibility of a group, which appears in its ability to close research lines that have no future and to initiate new venture projects. On the other hand, it measures the capacity of the management to run projects in a professional way. Assessment of policy decisions is at stake, as well as assessment of project management, including cost-benefit analysis.

Appendix C: Schedule of the site-visits

Monday March 31, 2008, University of Twente

Time	Activity	Present
09.00 - 9.30	Meeting with the Dean of the Faculty / Director Impact and members of the preparation committee	Prof.dr.ir. Rikus Eising, Prof.dr. J.A.M. (Hans) Kuipers, Prof.dr.ir. J. (Han) Huétink, Drs. C.T.A. (Kees) Ruijter
09.30 - 10.00	Design Engineering (UT 1)	Prof.dr.ir. Fred A.J.M. van Houten Dr.ir. Mascha C. van der Voort Dr.ir. D. (Eric) Lutters Dr.ir. Tom H.J. Vaneker
10.00 - 10.30	Elastomer Technology Engineering (UT 2)	Prof.dr.ir. Jacques Noordermeer Dr.ir. Wilma K. Dierkes
10.30 - 11.00	Surface Technology and Tribology (UT 3)	Prof.dr.ir. Dik Schipper Dr.ir. Matthijn B. de Rooij
11.00 - 12.00	Lab visit	Dr.ir. Laurent Warnet / Prof.dr.ir. J. (Han) Huétink Ir. Hendrik A. Breuker / Prof.dr.ir. Remko Akkerman
12.00 - 12.30	Production Technology (UT 4)	Prof.dr.ir. Remko Akkerman Dr.ir. Laurent Warnet
12.30 - 13.00	Mechanics of Forming Technology (UT 5)	Prof.dr.ir. J. (Han) Huétink Dr.ir. V. Timo Meinders Dr.ir. H.J.M. (Bert) Geijselaers
13.00 - 14.00	Lunch with PhD Students	Ir. Wessel W. Wits (DE), Mukund Tiwari (ETE), ir. Rob Bosman (TR), ir. Wouter J.B. Grouve (PT), ir. Maarten van Riel (MFT), ir. W. Ronald Kampinga (SD&A), ir. Gerdine J.M. Meijer (BE), ir. Marco T. van Zoelen (EFD), ir. Wouter B.J. Hakvoort (WA), ir. Timo Roestenberg (TE)
14.00 - 14.30	Structural Dynamics and Acoustics (UT 6)	Prof.dr.ir. André de Boer Dr.ir. Ysbrand Wijnant Dr.ir. Peter J.M. van der Hoogt
14.30 - 15.00	Biomechanical Engineering (UT 7)	Prof.dr.ir. H.J.F.M. (Bart) Koopman Dr.ir. Jasper J. Homminga Ir. Edsko E.G. Hekman
15.00 - 15.30	Engineering Fluid Dynamics (UT 8)	Prof.dr.ir. Harry W.M. Hoeijmakers Prof.dr. A. (Mico) Hirschberg
15.30 - 15.45	Tea break	
15.45 - 16.15	Mechanical Automation (UT 9)	Prof.dr.ir. J. Ben Jonker Prof.dr.ir. Johan Meijer Dr.ir. Ronald G.K.M. Aarts
16.15 - 16.45	Thermal Engineering (UT 10)	Prof.dr.ir. Theo van der Meer Dr.ir. Jim B.W. Kok

16.45 - 17.30	Meeting with the Dean & Director of Impact	Prof.dr.ir. Rikus Eising Prof.dr.ir. J.A.M. (Hans) Kuipers
17.15	Joined by the Rector of the University of Twente	Rector Prof.dr. W.H.M. (Henk) Zijm
18.00 - 19.30	Diner	
19.30	Bus to Eindhoven	

Tuesday, April 1, Eindhoven University of Technology

09:00 **Meeting with dean**:
Participants: prof. Rene de Borst, prof. Dick van Campen and ir. Alfons Bruekers

09:30-10:00 **Control Systems Technology**
Participants: prof. Maarten Steinbuch, dr. Nick Rosielle, dr. Bram de Jager
10:00-10:30 **Dynamics and Control**
Participants: prof. Henk Nijmeijer, dr. Nathan van de Wouw

10:30 Lab visit
Group 1: Rene de Borst, Jan Achenbach, Roger Owen, Frans Spaepen
Group 2: Alfons Bruekers, Yusuf Altintas, Torgeir Moan, Bob Skelton
Group 3: Dick van Campen, Paul Roth, Cameron Tropea, Ward Winer

12:00-12:30: **Systems Engineering**
Participants: prof. Koos Rooda, dr. Erjen Lefeber, dr. Pascal Etman
12:30-13:00: **Combustion Technology**
Participants: prof. Philip de Goey, prof. Rik Baert, dr. Rob Bastiaans

13:00 Lunch with **PhD students** (one from each reviewed program)
Participants: Roel Merry (CST), Rob Mestrom (DC), Roel van den Berg (SE), Giel Ramaekers (CT), Guy Willems (PTC), Henk Ouwerkerk (ET), Cem Tasan (MoM), Lambert van Breemen (PT)
14:00-14:30: **Energy Technology**
Participants: prof. Anton van Steenhoven, dr. Rick de Lange, dr. Silvia Nedea
14:30-15:00: Process Technology
Participants: prof. Bert Brouwers, dr. Hans Kuerten, dr. Cees van der Geld

15:15-15:45: **Mechanics of Materials**
Participants: prof. Marc Geers, dr. Ron Peerlings
15:45-16:15: **Polymer Technology**
Participant: prof. Han Meijer, dr. Patrick Anderson

16:15 **Meeting with dean**: prof. Rene de Borst

16:45 Committee meeting, discussing preliminary judgements

18:00 Dinner

19:30 Bus to TU Delft

Wednesday, April 2: Delft University of Technology

09:00 3mE (Waas)
09:30 DCSC (Van den Hof)
10:10 PME (Van Keulen)
10:30 lab visit: DCSC, PME, BMechE
11:10 PME (Rixen) TUD 19
11:40 PME – Mech (Munnig Schmidt) TUD 20
12:10 PME – PMA (Staufer) TUD 21
12:40 Lunch with PhD students from PME, DCSC and BMechE
13:40 BMechE (Van der Helm)
14:00 BmechE - MMS+MI (Dankelman) TUD 1
14:30 BMechE – BM+BR (Van der Helm) TUD 2
15:00 Transport Laboratory; Maritime Laboratory
15:30 M&TT (Lodewijks)
15:50 M&TT – ODE (Willemse) TUD 10
16:20 M&TT – SDPO (Hopman) TUD 11
16:50 M&TT – SHS (Huijsmans) TUD 12
17:20 M&TT – TEL (Lodewijks) TUD 13
17:50 Committee meeting, discussing preliminary judgements
19:30 Dinner

Thursday, April 3

09:00 P&E (Jansens)
09:20 P&E Laboratory ; AHD Laboratory
10:00 P&E – ET (Verkooijen) TUD 14
10:30 P&E – AHD (Westerweel) TUD 16
11:00 P&E – PEq (Witkamp) TUD 17
11:30 P&E – ST (Stankiewicz) TUD 18
12:00 Lunch with PhD students from P&E, M&TT, and MSE
13:00 MSE (Verkooijen)
13:20 MSE – JMB (Richardson) TUD 5
13:50 MSE – LMP (Katgerman) TUD 6
14:20 MSE – MCM (Kestens) TUD 7
14:50 MSE – S&C (Thijsse) TUD 8
15:20 MSE – S&I (Janssen) TUD 9
15:50 MSE Laboratory
16:20 Meeting with the Dean (Waas)
16:35 Committee meeting, discussing preliminary judgements
19:00 Dinner

Friday, April 5

09:00 Committee meeting
13:00 Lunch
15:00 End