

QANU-Research Review
Industrial Design Engineering
Delft University of Technology

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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 results of the research submitted for this review and to give feedback to the internal quality assurance of the organisation 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.F. Veldhuis
Chairman of the Board

PREFACE

The research review committee Industrial Design Engineering had the task to evaluate five research programmes and their organisational structure at Delft University of Technology. This review covers the research in the period 2001-2006. The previous research review covered the period 1995-2000 and was combined with the review of the educational programme in Industrial Design Engineering. Since the previous review, departments for Industrial Design Engineering were also formed at Eindhoven University of Technology and at Twente University, but the research of those departments is not subject of this review.

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

The Committee appreciated the thorough self-assessment that was provided by the Faculty and the openness of the management, researchers and PhD-students during the interviews.

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 Faculty and the University.

Prof. dr. ir. Lucienne Blessing
chair of the review committee

1. Executive Summary

Overall, the Committee values and appreciates what goes on in the Faculty; the researchers are an excellent group of people doing very good work. The Committee appreciated the intellectual honesty in the discussions with the programme leaders and the management and the open atmosphere. The remarks of the Committee are grounded upon this appreciation.

The critical review process has brought the Committee to the conclusion that the IDE Faculty is on the right track. The Faculty has shown a generally very good research performance during the last 6 years with progress in many fields, despite a decline of staff, which in some areas causes a sub-critical mass.

The international visibility of the Delft concept of integrating industrial design and engineering design has improved in the period under review and IDE has benefited from being an independent Faculty again.

The long and unique history of combining industrial design, engineering design, marketing and ergonomics, is an example for many, in particular for teaching. The Committee wishes to see the design engineering intelligence that is characteristic for IDE's teaching also more clearly visible in all its research.

The new research portfolio presented by the Faculty, contains many promising elements towards this goal. The five research areas can contribute to transdisciplinarity by realising a unique pool of skills and expertise. It is the combination of science and design, and the inclusion of market, society and environment, that makes IDE unique and world leading and this should therefore be encouraged and fostered as a main aim of the new portfolio.

The senior management shows an effective combination of flexibility and perseverance, which is the right approach in the light of the challenges of introducing a new portfolio and the various issues in managing and further improving the research in the department.

The collaboration within the Faculty must be more than the use of each other's methods and tools. Three elements have to be internalized strongly into the overall culture and thinking of each researcher, so that they emerge in any activity:

- *Sustainability*
- *Ergonomics* (physical, cognitive and social)
- *Design Thinking* (multiple solutions must be explored; critique must be a fundamental part of the practice; results, methods and expertise of other groups must be taken up).

The Committee appreciates the extensive collaboration with external partners and is aware of the many additional informal contacts that exist and contribute to the visibility of the Faculty. Such collaborations should be further encouraged and maintained.

In terms of research assessment and monitoring, the classic performance measures (PhD-theses and scientific journal articles and to some extent patents) play an increasingly important role and the Faculty will be measured against this. Publishing in A-journals must be further stimulated and be the aim of *all* groups. Also, IDE should look into *additional* performance indicators, such as those related to societal relevance, as an important incentive not to lose the

designerly way of thinking, the synthesis activities. These indicators should be on an equal footing with the classic ones. Care has to be taken that a good balance between the scientific and other (societal) indicators is maintained within each group and not only at Faculty level. The University should support these indicators while at the same time also provide an incentive for classical performance measurement.

The educational, monitoring, reviewing and career defining measures that have been put in place are considered excellent; in particular because they cover *all* research staff and consist of a wide range of different measures.

2. The Review Committee and the review procedures

2.1. *Scope of the assessment*

The Review Committee was asked to perform an assessment of research of the Faculty of Industrial Design Engineering (IDE) of Delft University of Technology. 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 Institute and the research programmes on the basis of the information provided by the institute and through interviews with the management and the research leaders, and to advise how this quality might be improved.

2.2. *Composition of the Committee*

The composition of the Committee was as follows:

- Prof. Lucienne Blessing, University of Luxemburg, chair
- Prof. Gloria Barczak, Northeastern University
- Prof. Bill Buxton, University of Toronto
- Prof. Jan Dul, Erasmus University Rotterdam
- Prof. Lorraine Justice, Hong Kong Polytechnic University
- Prof. MariAnne Karlsson, Chalmers University of Technology
- Prof. Michael Tovey, Coventry University
- Prof. Christian Weber, Technische Universität Ilmenau.

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.

2.3. *Independence*

All members of the Committee signed a statement of independence to safeguard that they would assess the quality of the Institute 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.

2.4. *Data provided to the Committee*

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

1. Self evaluation report of IDE, including all the information required by the Standard Evaluation Protocol (SEP), 170 pp.

2. Copies of three key publications per research programme.
3. Towards a new research portfolio for IDE/TUD, 16 pp.
4. IDE PhD course 2007/2008, Preliminary course set-up, 3 pp.
5. PhD outline of the faculty of Industrial Design Engineering, draft November 2007, 5 pp.
6. Colour brochure “This is Research at the Faculty of Industrial Design Engineering”, 36 pp..
7. Colour brochure “Leading in Product Design”, 15 pp.
8. “Alternative Energy Sources in Product Design 2000-2005” (IDE Graduation Projects, publication no. 1), 102 pp.
9. “Base of the Pyramid, Design of Product and Services” (IDE Graduation Projects, public. 2), 87 pp.
10. “IDE PhD day 2007, an overview of PhD research in Industrial Design Engineering”, 88 pp.
11. UNEP-TUD report “Design for Sustainability, A Practical Approach for Developing Economies”, 124 pp.
12. MSc Yearbook 2007, TU Delft, 154 pp.
13. TU Eindhoven, Department of Industrial Design: Summary of Research Profile 2007, 9 pp.
14. Twente University, Industrial Design Engineering research at UT: Research projects and plans, 32 pp.

In addition, the commission received handouts of the presentations given by the programme leaders and many of the publications and dissertations from the period 2001-2007 were on display or were handed out in the laboratories that were visited.

2.5. Remarks about the data provided

The data provided a good overview of the research activities in the faculty. The self-evaluation report is of an excellent quality: well structured, easily readable, excellent use of graphics to support and enliven the text. The change from the current situation as described in the self-evaluation report and the new portfolio was not evident, but discussions during the visit were able to clarify the transition. A suggestion that would make future evaluation processes easier for the reviewers and perhaps more useful for the researchers is to break down the conference proceedings in the publications lists into sub-categories, including: peer review of full papers, peer review of abstract, invited talks, no peer review (magazines, such as Interactions).

The Committee regretted that it was not possible to evaluate the research strategy of the University of Twente (UT) and Eindhoven University of Technology (TUE) as well. The reports of these universities were in a different format and no representatives were available for discussion. As a consequence, the Committee found that it could not fully assess complementarities, synergies and overlap, although the overall picture was taken into account as much as possible. A summary of the main strategies can be found in Appendix D.

The presentations have shown enthusiastic researchers and interesting topics, but a significant number of presentations took the form of a “show-and-tell” description or demonstration, rather than a research presentation. In order to judge the research contribution of each theme, programme and project, the Committee was especially interested in answers to the following questions:

- What is the underlying question?
- What is the underlying hypothesis and foundation of the approach?
- What is the approach taken and why?
- What alternatives were considered?
- What are the results?

The Committee recommends focusing on these questions in future evaluations.

2.6. 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 Institute, the key publications and the interviews. The interviews took place on November 19-21, 2007 (see the schedule in Appendix B) at IDE in Delft.

Preceding the interviews, the Committee was briefed by QANU about research assessment according to SEP and the rating system used (see Appendix C for the meaning of the scores). On the same day, the Committee discussed the preliminary assessments. For each programme 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 first general impressions were presented by the committee chair to the Rector Magnificus and the Faculty on the last day of the visit. The texts for the committee report were finalised through email exchanges. The final version was presented to the Faculty for factual corrections. 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 Board of the University and was printed after formal acceptance of the report.

3. Part A: Assessment at the Institute level

3.1. Mission & Goals

The mission of the Faculty as a whole, including education and research, is as follows: *To contribute to the knowledge, skills, methods and professional attitudes in the field of integrated product development. We aim to achieve this through research and education at an internationally recognised scientific level, as befits our status as part of the Delft University of Technology. The Faculty of Industrial Design Engineering's concern is to study, innovate and improve the development of durable products and their related services for people, on the basis of the balanced interests of users, industry, society and environment.*

This mission statement has remained a constant for over 10 years. In 2004 the mission statement was summarised in the slogan “Creating successful products people love to use.” In view of the increasing diversity in design manifestations, the Faculty is in the process of formulating a new research portfolio for the coming years. The new direction is characterised as ‘sustainable well-being’, which further emphasises societal relevance.

The Faculty states that rapid changes in technology and society, and a substantial increase in complexity in both fields make the design practice more and more knowledge-intensive. Selection, adaptation, combination and integration of knowledge in the design of products are the key academic activities for successful design. The Faculty wants to focus on types of research that concentrate on the integration of knowledge from the various classical and new disciplines. One of the research approaches that seems to be suitable for this purpose is ‘design inclusive research’, in which the actual development of (parts of) a product is incorporated in the research process.

The Committee agrees that the Faculty has made good progress in transforming itself from an organisation that was primarily focused on education towards an organisation in which there is more of a balance between scientific research and education. In the last six years the faculty has clearly obtained a much more prominent position in the field of research in industrial design engineering, in particular from 2002 onwards through the explicit incorporation of goals to first strengthen the organisation and culture as necessary conditions for a healthy growth in scientific research.

The Committee wishes to underline the importance and relevance of the mission statement of the Faculty and the intentions of the New Portfolio; close integration of the disciplines into a multidisciplinary or even transdisciplinary perspective is essential. Product Development is becoming an increasingly important topic in research and teaching in many internationally renowned universities. The number of researchers, publications and journals has increased substantially over the last decade. The IDE faculty with its long and unique history of combining industrial design, engineering design, marketing and ergonomics in one faculty, is an example for many, in particular for teaching. The Committee wishes to see all aspects of the design engineering intelligence that is characteristic for IDE's teaching also more clearly visible in its research. In particular the three key elements sustainability, ergonomics and design approach will have to be further internalised in the overall culture of the research community in order to achieve the overall research objective to foster *sustainable well-being*.

The design approach has always been a characteristic of this faculty and the five research programmes in the new research portfolio can provide more opportunity to build the reputation of IDE provided that these new research programmes are not just a replacement of the current areas. The aforementioned and intended truly integrated (transdisciplinary) nature of the research is to be encouraged and explicitly supported.

The challenges and changes in the new portfolio are encouraged, because also in view of the development at the other universities in the Netherlands, at UT and TUE, it will be vital to build on the good quality and to create opportunities for the younger generation.

3.2. Leadership

In 1997 the Faculties of Mechanical Engineering, Maritime Technology and Industrial Design Engineering (IDE) merged to form the Faculty of Design, Engineering and Production (DEP). From June 1998 until April 2005 the Faculty of Industrial Design Engineering had to share its dean with the Faculty of Mechanical and Maritime Engineering. In the summer of 2004 the Executive Board of the university reversed this decision and Industrial Design Engineering became an independent faculty again on 1 September 2004. From September 2004 until April 2005, Prof. dr. J.P.L. Schoormans (now vice-dean) acted as interim dean of the Faculty of IDE. The current dean is Prof. dr. C.J.P.M. de Bont.

The dean is responsible for the educational and research programmes and the way they are executed. He is also responsible for the management of the Faculty. He makes his strategic and policy decisions in collaboration with the faculty management team. The management team is chaired by the dean and consists of the heads of the three departments and the director of education. A director of research has only been in place for one year, during which period he joined the management team.

The Faculty has three departments, built around discipline-related groups:

- Industrial Design (approx. 110 fte) focuses on ‘interaction’ linking human and technology,
- Design Engineering (approx. 65 fte) focuses on ‘transformation’ linking technology and business
- Product Innovation & Management (approx. 45 fte) focuses on ‘market’ linking business and human.

Each department is headed by one of the full-time professors, appointed on a four yearly basis. The department head is assisted by the departmental management team, consisting of at least all the full professors in the department.

Administrative and technical support is organised at faculty and departmental level, and for some areas at University level.

In October 2004, the first Research Director, Prof.dr. I. Horváth, was appointed. The Research Director’s task was to monitor and assess the quality of research, and to encourage internal and external collaboration. He analysed PhD-projects and research methods used within the faculty, generating an overview and framing methodology that has proven to be stimulating

in formulating directions for the new research portfolio. In September 2005, the new Dean installed and chaired a strategy team, consisting of 6 staff members, professors and associate professors, chosen from the three different departments and representing different generations. Their assignment was to formulate a new strategy for the Faculty of IDE and to build up a new research portfolio, based on the strategy, mission and vision. The faculty's scientific committee (*Commissie Wetenschapsbeoefening*, CWB) acts as an independent board to safeguard research policy changes and to provide recommendations to the faculty concerning the research programme, its development and its efficient implementation. The faculty has an external Research Advisory Board (RAB) to review the research, its content and its quality. International representatives of the industrial design engineering professional field attend this committee, which is invited at least once a year.

The self-evaluation report covers, to a large extent, the period in which the Faculty was merged. The Committee considers the step (back) to independency of crucial importance to regain the visibility of IDE and its mission, and to bring back the creative spirit, which had been so characteristic. The Committee expects to see more changes in the coming years, although the Faculty already demonstrates very good research performance with considerable progress in many fields since the last evaluation. The Committee was also very pleased with the presentations and poster sessions, which showed enthusiastic researchers and the creative atmosphere so typical of ID.

The Committee found the approach taken by the senior management very positive; for the issues at stake it came across as an effective combination of flexibility and perseverance. Such an approach is required in the light of the challenges of introducing a new portfolio and the various issues in managing and improving the research in the department. In particular the attempts to keep good people, to give room to younger researchers to develop their views, and to encourage a multidisciplinary approach was appreciated. The Committee therefore wishes to encourage the approach.

The Committee responded very positively to the approach articulated by the senior management and wished to encourage them to implement the approach (new portfolio and style of management; flexibility; taking up challenges). The Committee was particularly pleased to see that some of the currently more critical issues are already being addressed in the new portfolio, such as the closer integration of disciplines within the Faculty. This shows a good understanding of the situation in the Faculty and the context in which it acts, as well as an interest in improvement, necessary to address the issues and challenges. Furthermore, the Committee appreciates the way in which the new portfolio has been developed (in close collaboration with all involved) and the way the management addressed the issues encountered. To put in place the new portfolio and to monitor its development would justify a director of research, who is part of the management team.

3.3. Strategy & Policy

In October 2002, IDE (at that time still merged) announced the goals of its research portfolio. The five most important goals were the following:

1. Improved collaboration within the faculty
2. Enhancement of the scientific results, both qualitatively and quantitatively

3. Increased income from second and third money streams
4. Stronger collaboration with other faculties at TU Delft
5. Enhanced relation between education and research.

In order to achieve these goals, a number of initiatives were taken, the most important being the following:

- The research portfolio 2002 (goal 1)
- Human resource management (HRM) policies (goal 2)
- Improved research facilities (goals 2 and 3)
- PhD policies (goal 2)
- Cooperation with the Faculty of Architecture (goal 4)
- New Master's programmes (goal 5).

The research portfolio described in 2002 distinguishes two research themes:

- Design Theory and Support
- Design of Future Products.

The research theme *Design Theory and Support* aims to expand the threshold of knowledge about the product design process and its supporting fields to cope with the increasing speed and sophistication of new product development. This research theme is divided into three programmes:

1. Methodology, Tools and Techniques (MTT)

This research theme focuses on the exploration, development, validation and implementation of innovative methodologies, techniques and tools to support product designers

2. Life Cycle Engineering and Design (LCE D)

Life Cycle Engineering considers mass and material flows over the whole life cycle of products. Special attention is paid to the use of alternative energy systems, opportunities presented by new materials and the innovation of product systems for the optimisation of lifecycles

3. Product Functionality and Experience (PFE)

The question that this programme aims to answer is: how can design mediate between the large range of technological possibilities and consumer demands? These demands relate to functional, aesthetic and experiential product benefits.

The research theme *Design of Future Products* is directed at the development of future products using state-of-the-art and new technologies. The aim is to evaluate these technologies by developing new, innovative products and solutions for existing problems and user wishes. This theme brings new knowledge into new product designs. This research theme is divided into two programmes:

4. Product Intelligence (PI)

This programme is concerned with communicating product functionality to the user, and vice versa: how people can communicate their needs and wishes about new products

5. Design for All (DfA)

The main focus of this programme is the way quantitative data concerning dynamic aspects of product use are collected and subsequently translated into (computerised) design-relevant guidelines and concepts.

These five programmes are evaluated by the Committee in the second part of this report.

The research themes are a cross-disciplinary programme based on thematic collaborations, which is an excellent basis to achieve the Faculty's mission. However, the leaders of the five research programmes are currently not part of the faculty management team. The new portfolio envisages the introduction of a Faculty Research Board consisting of the Research Coordinator and the five Programme Coordinators, who will make all strategic and operative decisions regarding research within the faculty. This is very much welcomed by the Committee.

Regarding the development of the strategy and policy, the Committee considers the Faculty to be on track. Much has been achieved, although in particular the first goal, improved collaboration within the Faculty, still requires considerable effort. The Committee wishes this to be seen as more than the use of each other's methods and tools. As mentioned earlier, three core elements of the Faculty have to be internalized strongly into the overall culture and thinking of each researcher. In some projects the Committee saw a lack of the spirit of what the Faculty is all about.

- *Sustainability*: this element is reflected in far too few of the examples that were presented
- *Ergonomics (human-centricity)*: again, too few examples demonstrated sensitivity to basic ergonomic concerns (physical, cognitive and social).
- *Design Thinking* (sketching/multiples/critique, etc.): a large number of examples clearly were taking an engineering rather than a design, i.e. an integrated approach. Multiple solutions were clearly not explored, and there was clear evidence that neither students nor faculty had integrated group conversations/critique as a core and fundamental part of their practice. The results, methods and expertise of other groups were often not taken up.

These three core elements identify IDE, these are the strengths that receive global recognition, and should therefore together emerge in any activity.

The Committee is very pleased to see this direction is emphasised in the new portfolio: sustainable well-being. It is necessary that promotion of the research in this sense is supported and encouraged *at management level*. The inclusion of the programme leaders into the management team may not be sufficient to guarantee the research goals to be reached. More management tools are needed. The Committee is not convinced the management structure can do without a Research Director, for example at the same level as the Education Director.

The new research portfolio clearly aims to increase collaboration between disciplines by stating that the Programme Coordinator leads and coordinates a network of collaborative researchers driven by multidisciplinary research topics and shared research interests. The Committee is of the opinion, that this requires more than an organizational structure. The combination of disciplines should be exploited in various ways, because this enables the Faculty to be really unique. The Faculty harbours a unique combination of disciplines across a very wide range, but in the view of the Committee the transdisciplinary objective can be pursued more effectively. This would make the quality stand out more, as long as the design core is maintained at the same time. The strength of the past research was in combining various views and being active in design: applied but scientific as well. The Faculty has to take care not to lose the design-touch as this can bring it all together. Some projects where the design-focus was lost were less convincing. A balance is needed between design and engineering. Industrial design engineering must have its basis in both fields. There is the opportunity to use design as a solu-

tion-focused process which provides the grounding for a transdisciplinary synthesis. Design can act as an integrator between different disciplines and knowledge.

The richness of topics is a strength of the Faculty, but requires attention. For example, the range of sensory research is a strength that has enormous potential when tied with the research on emotions, but it should also build on and integrate with other existing strengths, such as marketing research. Such areas should be given particular attention in terms of integration.

It has to be said that the requested integration is far from being common in other universities and faculties. IDE, however, not only has multidisciplinary as part of its mission statement and a topic of research that requires multiple views, but also a variety of knowledge, skills and expertise amongst its researchers that should allow it to be ahead and set standards.

Of the mentioned five most important goals, the enhancement of the scientific results, increased income, enhanced relation between research and education, and stronger collaboration with other faculties at TU Delft are discussed in separate sections.

3.4. Collaboration

The Faculty of IDE collaborates with other faculties and research organisations within TU Delft, and with institutes and organisations at national and international level. In 2006 a team was appointed to develop a basis for cooperation with the Faculty of Architecture. In 2007, cross-over topics for joint research were formulated. In addition to the collaboration with the Faculty of Architecture, IDE researchers started to work more closely together in various projects with researchers from the Delft Research Centre for Information and Communication Technology ICT. This collaboration took place in the research programme Product Intelligence. A third example of collaboration in TU Delft is the joint PhD project on service modelling with the Faculty of Mechanical, Maritime and Materials Engineering (3mE).

At the national level the faculty collaborates with the Faculty of Industrial Design at TU Eindhoven and the Department of Industrial Design Engineering at the University of Twente. The three faculties cooperated, together with several other institutes and companies, in setting up the Netherlands Programme for Product Development and are in the process of jointly organising PhD education. In the Life Cycle and Engineering Design programme there is close cooperation with the Cartesius Institute in the Dutch Province of Friesland aimed at sustainable solutions, together with the two other technical universities in the Netherlands and with local companies. Several PhD students from IDE are involved in this cooperation, which has positively contributed to the increase in external research funding in the last few years. Part of the research in the Design for All programme is embedded in the Health Science and Technology initiative of TU Delft, RU Leiden and Erasmus University Rotterdam. In this programme there is also some cooperation in a few PhD projects with Catharina Hospital Eindhoven.

In most research programmes there is an exchange of knowledge and expertise between researchers at the faculty and bigger companies, such as Philips, Unilever and Shell, but also with many SMEs. This exchange occurs mainly on a project basis and most of the contacts are through graduation projects and only to a lesser extent through PhD projects.

At the international level, the Faculty of IDE operates at the forefront of research in the field of industrial design engineering together with leading institutes, such as the Korean Advanced Institute of Science and Technology KAIST (Korea), Politecnico di Milano (Italy), National Cheng Kung University (Taiwan), IIT Chicago, USA and many others in editorial boards and in research societies. The faculty maintains close strategic contacts with strong institutes in developing markets in different continents, such as Hong Kong Polytechnic University (China), University of Budapest (Hungary) and Middle East Technical University METU in Ankara (Turkey). Several PhD students now working in Delft originate from these institutes. The faculty is preparing for double degree Master's programmes with METU and KAIST to be implemented from 2008 onwards. The faculty has recently taken the initiative to install a Design Research Alliance in Industrial Design Engineering, with some of the institutes mentioned earlier.

The Committee appreciates the extensive collaboration with external partners and is aware of the many additional informal contacts that exist and contribute to the visibility of the Faculty. Such collaborations should be further encouraged and maintained.

The Committee welcomes the collaboration with the sister faculties in Eindhoven and Twente in the setting up of the aforementioned NPPD and the joint organisation of PhD education. The Committee regrets that it was not possible to discuss the research strategy of UT and TUE with their representatives. This would have enabled the Committee to reflect on their recommendations in the light of the aims and missions of the Dutch IDE landscape. Nevertheless, the Committee is of the opinion, that the Delft Faculty, as the most established one, should take an active role in developing a common strategy for national complementarity and/or competition, also with a view to the international context. The regular meetings between the faculties of the three universities are important but may require a more explicit focus or underlying strategy.

3.5. *Resources, Funding Policy & Facilities*

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

Institutional level	2001	2002	2003	2004	2005	2006
Tenured staff	30,7	30,1	26	27,2	24,9	22,7
Non-tenured staff	3,3	2,6	5,4	3,4	3,3	2,8
PhD students	20,5	20,6	21,2	23,4	24	26
Total research staff	54,5	53,3	52,6	54	52,2	51,5
Research programme level	2001	2002	2003	2004	2005	2006
Programme Methodology, Tools and Techniques						
Tenured staff	13	12,5	9,8	10,3	9	8,1
Non-tenured staff	0,2	0,8	0,8	0,8	0,6	0,6
PhD students	8,6	7,2	6	6,8	4,4	3,6
Total research staff	21,8	20,5	16,6	17,9	14	12,3
Programme Life Cycle Engineering and Design						
Tenured staff	6,8	6,2	5,7	6,7	5,8	4,5
Non-tenured staff	2,1	1,1	1,4	0	0	0,4

PhD students	4,1	3,9	5,2	6,1	6	7,2
Total research staff	13	11,2	12,3	12,8	11,8	12,1
Programme Product Functionality and Experience						
Tenured staff	4,7	4,9	4,1	4,8	4,8	4,5
Non-tenured staff	0,6	0,5	1,2	0,9	0,6	0,4
PhD students	2,6	3	3,6	3,2	4,5	6,3
Total research staff	7,9	8,4	8,9	8,9	9,9	11,2
Programme Product Intelligence						
Tenured staff	4,4	4,4	4,2	3,9	3,6	4,1
Non-tenured staff	0,4	0,3	1,2	1,3	1,7	1,5
PhD students	4	5,8	5,7	6,4	6,8	5,8
Total research staff	8,8	10,5	11,1	11,6	12,1	11,4
Programme Design for All						
Tenured staff	1,9	2,2	2,3	1,6	1,7	1,5
Non-tenured staff	0,5	0	0,8	0,4	0,5	0
PhD students	0,7	0,7	0,7	0,9	2,3	3,1
Total research staff	3,1	2,9	3,8	2,9	4,5	4,6

During the period 2000–2006 a policy for the education and monitoring of PhD-students was developed. The start of the Ambition programme (2000; 17 PhDs) enabled the faculty to employ more PhD-students than in the previous period. The resulting critical mass warranted such a policy. In addition, it was decided to try to employ more MSc-graduates from the faculty. Graduates from the faculty had been primarily trained as designers and to a much lesser extent as researchers. Conversely, graduates from other disciplines in most cases did not have sufficient knowledge of design. An educational programme was set up in which both aspects could be taught. The PhD-policy includes such measures as a mentor system, a first-year evaluation (with go/no go-decision), a yearly PhD-day with presentations. The PhD-policy was recognised as an example of best practice within the TU Delft.

IDE follows the overall human resources policy set out by Delft University of Technology. Since 2002, this policy has encompassed a Results & Development cycle (R&O), which includes annual agreements on SMART goals related to scientific output, training, finance, career perspectives, sabbaticals and early retirement schemes. In 2005 the Dean began to evaluate the performance of all full- and part-time professors in formal appraisal meetings (R&O cycle). From 2007 onwards, in line with TU Delft procedures, the professors' overall results will be discussed in a preview and a review.

In 2007, the faculty began to develop a policy aimed at retaining and attracting high potentials. This is one of the key challenges for the faculty. The faculty appointed a talent coach to coach a group of high-potential promoted staff members (UD's or post-doctoral researchers), selected by their department heads. For each of these staff members a clearly defined career policy is made up.

In line with the Delft University of Technology HRM policy, the faculty is making plans to introduce a tenure track model. This means that staff members to be appointed directly after defending a PhD will receive a temporary contract and a clear career policy for five years. After that time they will receive a permanent position if they have proved to be a successful and promising member of the academic environment.

The yearly funding and expenditure of the faculty during the assessment period is presented in the self-evaluation. A substantial increase in funding came in 2000 as part of the Ambition programme. This programme included a major financial injection in the form of a temporary extra budget of 2,200,000 € from the Executive Board of TU Delft. The initial goal was to create a line of research that would be self-supporting within six years and delivering a return of € 1,200,000. Around 2003 it became clear that these ambitious goals for the programme would not be achieved, partly because of organizational issues, such as the decline in professorial staff, and partly because the defined areas in the research programme were not sustainable for the new directions in research that were being defined. However, the Ambition programme heavily influenced the definition of the research portfolio and drove many of the organisational changes. The years 2004 and 2005 are marked by the renewed independence as a separate faculty, which was accompanied by rising costs of housing and support personnel, which in turn was compensated with increased direct funding. In 2006 the income from second and third money streams is higher than ever before and has risen steeply as compared to 2005. The Committee wishes to underline the promising expectations for 2007 (in terms of PhD defences, output and funding). The steady and structural growth of PhD candidates over the years offers a strong assurance for the scientific development of the faculty in the future. Some of the improvements to the organisation are still fairly recent (such as the cooperation with the Faculty of Architecture) and are expected to have an effect on the scientific output from 2007 onwards.

The Committee is convinced of the enormous potential of the different research areas, but noticed a lack of resources in some areas to fully develop this potential: high-level potential is hampered by sub-critical size (for details see the reviews of the research groups in part B of this report). Overall the number of research staff has declined: in particular tenured staff has decreased in favour of PhD students. The Committee agrees with the Faculty that the prominent role in design research of the Faculty, combined with the rise of new design faculties around the world, results in the situation that many of our most talented researchers are increasingly invited to take on a position at other educational, commercial and academic research organisations. Therefore, the Committee welcomes the educational, monitoring, reviewing and career defining measures that have been put in place. These are considered excellent, in particular because of their coverage (*all* research staff) and range (various different measures). At the moment it is still too early to see the results.

The variety of disciplines attracted to the Faculty contributes to the type and quality of its research. For example, some of the disciplines bring in a rigour that used not to be common in the design research field. At the same time the variety of disciplines means that graduates are employed that do not have sufficient knowledge of design. This has been recognized by the Faculty and an educational programme was set up. The Committee very much appreciates this measure in the light of the lack of design thinking it observed in some of the projects (e.g. the solar mouse and the human-powered laptop are successful developments, but do not reflect the integration of design thinking, and the ergonomics and sustainability thinking that is available). The effect of the educational programme might not be visible yet, or it may be that additional measures are required.

Overall, the Committee is convinced that IDE combines in its staff a unique combination of disciplines and experiences that, when combined, has the ability to unleash a truly unique research focus, approach and results, and to realize leaps in understanding and innovative solutions that go well beyond what other competing institutes can, at the moment, offer.

According to the self-evaluation, the low amounts of external funding are partly inherent to the design discipline. The Committee agrees that many organisations funding scientific research (such as NWO and STW in the Netherlands) are set up to primarily support classical monodisciplinary research. Funding multidisciplinary design research, however relevant for society, appears to be more difficult. The Committee would like to point out that this situation, fortunately, is changing in many funding organisations and therefore strongly supports the initiative of the Faculty and the University to connect more closely with these organisations. The Committee is convinced that design research proposals can be interesting from a societal point of view, as well as in terms of academic underpinnings and challenges.

Given the societal relevance of the research, funding from companies should be a likely source. As the self-assessment report states, company R&D departments often focus on hardcore technologies. However, several companies do invest in design research and the Faculty has close contact with some of them. Still, obtaining funding for design research is generally more difficult than for engineering research. Here too, an initiative may be required, for example by involving the alumni of the Faculty.

3.6. Academic Reputation

The self-evaluation rightly states that in its field the Faculty has always been highly regarded by other academic institutions. In a recent publication in the Journal of Product Innovation Management the Faculty was quoted as the most frequently contributing international institute outside North America. The Faculty has been involved, often as the host institute, in the organisation of many international scientific conferences, symposia and societies, such as:

- The International Engineering and Product Design Education Conference (IEPDE)
- The Design and Emotion Society
- The International Symposium on Tools and Methods of Competitive Engineering (TMCE)
- The International Conference on Engineering Design (ICED)
- The international conference on Computer-Aided Industrial Design & Conceptual Design (CA ID&CD)
- The Design History Society Conference

Researchers of the Faculty are editors of several scientific journals:

- Creativity & Innovation Management (editorial board)
- Design Studies (editor)
- Journal of Design Research (publisher)
- The Design Journal (editor)
- International Journal of Design (editorial board)
- CoDesign (editorial board and guest editor)
- Research in Engineering Design (editorial board)
- Computer-Aided Design (editor)
- Concurrent Engineering (editor)
- Journal for Sustainable Product Design (editorial board)
- Information Design Journal (editor)
- Journal of Cleaner Production (editorial board)

- Applied Ergonomics (editorial board)
- Journal of Product Innovation Management (editorial board)

Apart from these societies and journals, the Faculty also aims to disseminate the research results by way of the products, methods and prototypes that result from the scientific work. This applies in particular to the research programmes that build upon the theme Design of Future Products. Examples for these future products resulted from the user-friendly restroom project and from the research in the Design for All programme. Currently, Delft University of Technology as a whole is looking for ways to value these products as scientific work. The cum laude PhD on a design by dr.ir. A.I. Keller is a good example of how products and prototypes can be rewarded as scientific output.

The Committee notes that overall the Faculty is internationally very visible through active roles in conferences and all major journals related to design research and in several conferences and journals of the disciplines of the individual researchers. In this context for its discipline the Faculty can be seen as an international leader. Of particular interest is the fact that several of those journals and conferences have a mechanical engineering focus. This clearly points at the acceptance of the research in various disciplines, which is a considerable achievement. However, there are large differences between groups.

Overall the number of publications has increased since the previous evaluation: in particular in book chapters and academic conference proceedings. The outputs in the research groups, however, vary and require attention (see part B of the report). The number of scientific journal articles fluctuates, but taking into account the reduced number of tenured staff, shows a considerable increase. The effect of the growth in the number of PhD candidates in the last few years on the output can obviously not be visible yet, other than in conference proceedings.

The Faculty states in the self-assessment that there are many reasons to be optimistic about the further growth of the research climate and scientific output, but that there are also some concerns. They mention that compared to most other faculties at TU Delft, the scientific output and the amount of external funding are not impressive. The Committee does appreciate the reasons that were mentioned, such as the fact that the student-staff ratio is relatively unfavourable, that research in the discipline of design is relatively immature (and even more so in the combination of industrial and engineering design), and that, therefore, few academic outlets are available for design researchers. However, the Committee also noted a considerable difference between the groups. Overall, they agree that for the moment, the average of 5 academic publications per year per FTE (based on 2006 figures) is still quite acceptable, given the fact that the last years were a transition phase. Publishing in A-journals must, however, be further stimulated and be the aim of *all* groups. In terms of research assessment and monitoring, the classic performance measures (PhD-theses and scientific journal articles and to some extent patents) play an increasingly important role and the Faculty will be measured against this. In this context, the Committee considers it inappropriate that in the present system Dutch national publications are awarded the same number of points as international publications and that different types of contributions to conference proceedings receive the same weight. A distinction is needed here.

The Committee further strongly recommends (and this should be important for the university, who already recognizes the typical characteristics of science, engineering and design) that IDE should look into *additional* performance indicators, such as those related to societal relevance,

as an important incentive not to lose the core of the Faculty, the designerly way of thinking, the synthesis activities. These indicators should be on an equal footing with the classic ones as it is the combination of science and design that makes IDE unique and world leading. Care has to be taken that a good balance between the scientific and other (societal) indicators is maintained within each group and not only at Faculty level. The University should support these indicators while at the same time also provide an incentive for classical performance measurement.

IDE, being a definitely multidisciplinary faculty, is particularly affected by challenges frequently observed in such cases: in an interdisciplinary / multidisciplinary field it is difficult to meet all the criteria of all of the individual disciplines (e.g. in terms of publishing and publishing organs), and innovation in the interdisciplinary realm does not necessarily imply innovation in all of the adjoining disciplines. This has to be taken into account in the definition of performance indicators, which should emphasize and encourage interdisciplinary rather than monodisciplinary performance. IDE could set standards here too.

3.7. Societal Relevance

Knowledge obtained from the research activities is disseminated in the first place through the graduate students and alumni, who find their way into diverse positions in companies and institutes around the world and in their own start-ups. Alumni of IDE lead design groups at BMW (Adriaan van Hooydonk), Nike-Philips Alliance (Floor van Wingerden) and Microsoft Windows (Tjeerd Hoek). Almost all of the internationally renowned Dutch design companies (NPK, Well design, Fabrique) have been (co-)founded by IDE alumni. Currently the youngest generation of alumni are innovating with products such as the Senz Umbrella.

The Faculty has staff members who are also internationally renowned for their designs. Prof. Mijksenaar is regarded as the leading expert in wayfinding, having designed the signage for Schiphol Airport, New York airports and the New York Museum of Modern Art. Designs by Prof. Ninaber van Eyben, such as the pendant watch and the Dutch Euro coin, are featured among others at the New York Museum of Modern Art. In a 2006 BusinessWeek survey (with 24 experts from industry, education and research), the Faculty was regarded as one of the top 20 design schools in the world.

The Faculty has produced standard works used in design practice. For example, Roozenburg & Eekels (1995) is the standard work on the design process in companies and educational institutes around the world. Similarly, books by Muller (2001), Buijs (1984) and Mijksenaar and Westendorp (1999, translated into 6 languages) reach a wide audience in design practice and education.

Another way in which the research is judged by the outside world is through the designs set out in the world. IDE students and researchers have been involved in numerous design prizes, often with innovative and forward-looking concepts, which incorporate results and methods from IDE research. In the years 2003 to 2007 the Faculty has won 39 design prizes, 16 of which had strong ties to research. One of the research prototypes, Cabinet, was demonstrated as a TU Delft innovation to the Dutch Innovation Platform, a Dutch strategic team with members from the cabinet, including the prime minister and captains of industry and the scientific world. In their final conclusion, the Dutch Innovation Platform emphasised the

importance of our creative industry to the Dutch economy. As a result of this conclusion, the IDE Faculty has taken the initiative to start the Netherlands Programme for Product Development (NPPD), with the mission to strengthen the position of the Netherlands in the field of design and product development.

The societal relevance is prominent in the research that contributes to designs for the Base of the Pyramid¹. Not only governmental organisations, but also large companies such as Unilever and Philips recognise the role of industrial design engineering in this context. Even though Base of the Pyramid was not set out as a programme for research activities, the faculty did embark on many projects. As an example, the faculty contributed to the development of the LifeStraw, a product that offers a solution to the drinking of contaminated water. LifeStraw was named one of the top 20 innovations of 2005 by TIME Magazine. As another example, the World Bank awarded a major prize (USD 175,000) to one of the IDE alumni for his work on an inexpensive, sustainable and safe lantern for people living in rural Cambodia. These projects serve as good examples of the Faculty's integrative approach, in which aspects from different disciplines and an overall knowledge of technology, human and company aspects are channelled into sometimes simple and sometimes advanced solutions.

The Committee sees the effects of the work in IDE on society as a major advantage: a characteristic that has been there right from the beginning. No other Faculty at any Technical University paid so much attention to use and user throughout the product development process, which lies behind the success of their products. The Committee very much encourages the societal relevance of the research work in line with the mission statement of IDE, but at the same time has to warn IDE not to lose the balance between societal relevance and research.

Some of the groups in the Faculty have a considerable output that had an effect on society and on the working space. Examples are standards, product awards, commissioned documents advising government agencies and others on policy issues, etc. IDE should investigate how this "secondary" research output can be considered appropriately in the performance indicators (see the recommendation in the previous section). The Committee suggests, with reference to the classic types of quality measurement and to the mission statement, that high performance in these areas should indicate that the work is internationally competitive or even at the forefront, and that the work has made or is likely to make a significant contribution to 'sustainable well-being'.

3.8. *Relationship between Research and Education*

The Faculty expects that the new Bachelor's programme implemented in 2007 will strengthen the relationship between research and education. More than before, in this new programme emphasis will be put on academic skills, such as measuring product-related variables (such as energy output) and on simulation. In the relatively new Master's programmes "Strategic Product Design" and "Design for Interaction" students are trained to read academic papers and to set up small-scale studies under the supervision of leading researchers. The third Master's programme, Integral Product Design, offers a complete range of skills for future designers, but the Faculty feels that the connection between research and education can still be further improved.

¹ The BOP concept champions new thinking and new ways of doing business in the world's poor markets. The concept, also known as B24B (business-to-4-billion), was coined by business academics C.K. Prahalad and Stuart Hart in a series of important and well-cited articles.

The Committee is aware of the excellent reputation of the IDE education and of its effect on new courses worldwide. A strong relationship between research and education is essential for a University Faculty and the Committee therefore appreciates the importance the Faculty assigns to this relationship and the measures it has taken thus far.

4. Part B: Assessments per programme

The committee assessed the following programmes:

- Methodology, Tools & Techniques (MTT)
- Life Cycle Engineering & Design (LCED)
- Product Functionality & Experience (PFE)
- Product Intelligence (PI)
- Design for All (DfA).

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

An explanation of the scores and the criteria can be found in Appendix C.

4.1. *Methodology, Tools and Techniques (MTT)*

Programme Leader	Prof. dr. P. Badke-Schaub	
Research staff 2006	12.3 fte (8.1 tenured, 0.6 non-tenured, 3.6 PhD students)	
Assessments	Quality	Good to Very good (3.5)
	Productivity	Very good (4)
	Relevance	Good to Very good (3.5)
	Viability	Good to Very good (3.5)

The Methodology, Tools and Techniques (MTT) programme is working to develop knowledge for designers that will help them mastering complex product development tasks. This is a two-fold issue as the area strives to understand the work of the designers and to also explore advanced technologies and tools that will help designers in their work. The research programme consists of three sub-programmes:

- (i) Design Processes in Product Development (headed by prof. dr. P. Badke-Schaub),
- (ii) Methods and Techniques for the Conceptual Phase of design (headed by prof. dr. P.J. Stappers)
- (iii) Product Conceptualisation in collaborative Virtual Prototyping Environments (headed by prof. dr. I. Horvath).

Quality

The quality of the work done in the MTT area is current, substantive, and several of the faculty members in this group are recognized internationally for their research projects and international design activities. The students in this area have won major awards and the human-centred philosophy of the programme is in keeping with world-wide trends.

The cohesiveness of the group is on the rise. The investigation of the design process is approached in varied ways but shows promise of coming together to make a substantive body of work that will be a lasting contribution to the field.

However, in the group working on Product Conceptualisation in collaborative Virtual Prototyping Environments there is a tendency towards technology-driven projects. These are sometimes remarkably detached from the generally more integral approach of the MTT programme and the IDE Faculty as a whole. Additionally, this type of work has a high reliance on combining a broad range of very expensive, complex and also specialised (and sometimes very particular) equipment and requires these technologies to be tightly integrated in order to serve the research objectives. Our concern is that there is not the technical depth (such as signal procession, image recognition, computer science, etc.) within the faculty to exercise deep control over these acquired (mainly) commercial technologies. The high overhead and inflexibility of the technological complexity may overly limit the flexibility of the team in exploring the intended design space.

This statement does not deny the fact that the utilisation and enhancement of computer tools is absolutely essential for Industrial Design Engineering. As the projects are run today, however, they are very similar to work usually being undertaken in various computer science labs (and, subsequently, the work is well reputed particularly in this area of science), thus contributing too little to the unique profile and reputation of the IDE Faculty.

Productivity

The productivity of the MTT Programme is varied. This is understandable as the research projects are at different levels of completion. The work of P.J. Stappers' group is quite mature and has become internationally known for its mix of human-centred investigation in conjunction with technological options for demonstrating design solutions. Both the research publications and design activities in this area are noteworthy. The work of I Horvath has a good international reputation and the group of P Badke-Schaub is well-known for its scientific rigour.

Relevance

There is no doubting the relevance on a topic basis of the work of this group. The knowledge about product development processes, methods and tools can nowhere else be collected, developed and tried out systematically. If this potential was taken on as the core competency of this group (which is not yet done to full extent) and these areas have a firmer grounding in the design process, the group would be able to develop greater utility for other research groups: it could integrate and stimulate all others.

Viability

The prospects for Methodology, Tools and Techniques remain very good. The sensory work done elsewhere in the Faculty on touch, vision, etc., combined with the auditory work provides additional research challenges in the field of processes, methods and tools, and could prove a strength that is not present in other universities around the world. We encourage the faculty to pursue their world-wide niche in sensory research in relation to design. If the related research groups grow in cohesiveness, they can serve as a model for other universities.

Conclusion

Conclusions are that the area holds great promise due to the prior work done in the area, and the expertise of the key members of the group will carry them into the next decade to solidify design research, methodology, tools and techniques for the field of industrial design engineering world wide. In light of the early stages of the design programmes around the world, MMT has a chance to carve a significant niche in the area of design and the senses. This, coupled with the work done on emotion and design of products, places and services can position TU Delft and IDE as a world leader in this area.

4.2. *Life Cycle Engineering and Design (LCED)*

Programme Leader	Prof. dr. ir. J.C. Brezet	
Research Staff 2006:	12.1 fte (4.5 tenured, 0.4 non-tenured, 7.2 PhD students)	
Assessments	Quality	Very good (4)
	Productivity	Very good (4)
	Relevance	Excellent (5)
	Viability	Good (3)

The research programme involves three constituent subgroups:

- (i) Personal Energy Systems (headed by ir. A. J. Jansen),
- (ii) Engineering Design with New Materials (headed by prof. dr. P.V. Kandachar)
- (iii) Design for Sustainability (headed by prof. dr. ir. J. C. Brezet).

The first goal in the programme has been the integration of these three areas of activity, with the intention of developing an international reputation. A further ambition in this integration is the implementation of research outputs into the Faculty's education programme, as well as its influencing more widely society, industry and government agencies.

Quality

The leaders of the subgroups are individuals of good standing and externally acknowledged reputation. These subgroups enjoy appropriate and proportionate access to the Faculty's laboratory resources, which are generally of very good quality in comparison with equivalent organisations elsewhere. The lead academic publications from the programme demonstrate the achievement of its ambitions through outputs of good quality. Their numbers have been steady over the review period. Overall this shows that there is an established and maintained science based strength and authority in the core activities. Impressively the groups are not afraid of tackling difficult questions such as hydrogen propulsion (including concrete proposals for the change to it within a practical technical, economical and societal framework) and materials re-cycling (including concrete proposals for substantial modifications of current practices).

Productivity

The good number and range of academic outputs are complemented by an impressive record in the production of commissioned documents advising government agencies and others on policy issues. As in other cases within the faculty, it should be investigated how this "secondary" research output can be considered appropriately. The scale of external funding and support is good. The external orientation of the programme through project activities such as those with developing countries in the aptly named 'Base of the Pyramid' scheme is very encouraging and welcome.

Relevance

The overall relevance of this programme is extremely high. However some of its processes require comment. The group sees PhD project work as being at the core of its programme, and this work covers a good range of relevant topics (such as medical design, design with bamboo, waste innovation and packaging design). The work sampled indicated however, that there is still a distance to be travelled in achieving the integration of approaches with the other programmes, based on design synthesis, which is the Faculty's ambition. Good research topic areas

demonstrated fundamentally flawed outcomes as the work was not grounded in established design approaches and values. The solar powered computer mouse and the human powered pc would not have survived an undergraduate critique session. It is important that all of the work of the faculty be grounded in design as that is where its identity lies.

Viability

The importance of this group for the faculty's development, with its proclaimed emphasis on design for sustainability, can hardly be over-estimated. It is at the core of 'Sustainable well-being'. This research stream has established authority, expertise and external visibility, and its members are recognised for their contributions. Currently, however, links with other research groups such as Methodology, Tools and Techniques, do not seem to be as strong as they might be, which will represent a lost opportunity if it does not receive attention.

There appears to be a perception in the group that it has less influence than that which is evident from the content of the faculty's research portfolio. This has led to a strong dissonance in the local leadership of this research area, which highlights the need for collegiality.

Conclusion

The group has a good track record in establishing this area of work as credible and respected design research. It has been very successful in internal integration (bringing together three formerly separate areas of activity), but considerably less successful in external integration (co-operation with other groups and programme parts). The developing research strategy for the faculty represents an opportunity to achieve the integrative approach which has been a core ambition for the Life Cycle Engineering and Design programme. It would be a great pity if this wider design research integration could not be achieved because of the lack of collegiality.

4.3. *Product Functionality & Experience (PFE)*

Programme leader:	Prof. dr. J.P.L. Schoormans	
Research staff 2006:	11.2 fte (4.5 tenured, 0.4 non-tenured, 6.3 PhD students)	
Assessments	Quality	Very good (4)
	Productivity	Very good (4)
	Relevance	Excellent (5)
	Viability	Very good to Excellent (4.5)

The research programme Product Functionality and Experience (PFE) consists of three sub-programmes:

- (i) Product Aesthetics and Experience, (headed by prof. dr. P.M.M. Hekkert);
- (ii) Usage Evaluation (headed by drs. H. Kanis);
- (iii) Consumer Preferences (headed by prof. dr. J.P.L. Schoormans).

Quality

The research carried out in the programme is both innovative and exciting. At the same time, the preconditions and hence the respective outcomes show some differences worth comment. Affective design is still a new and expanding research area. The researchers involved in the sub-programme Product Aesthetics and Experience have contributed to establishing the area on the international research agenda, for instance by founding the Design & Emotion Society (in 2000) and the biannual conference D&E. Furthermore, the programme and its researchers have managed to, in a relatively short time, generate new, theoretical knowledge on the experiential relation between people and (technical) artefacts, as well as to develop new methods and tools to support the design process.

In comparison the Usage Evaluation programme and the research on e.g. different methods and tools could be perceived as more traditional and less original. This should not be interpreted as though the research questions addressed concerning product use, product safety etc., are in any way outdated (cf. Relevance). The research on consumers' risk perception in product usage, for example, has some unique qualities. However, the area would benefit from a clearer profile and sharpening of research questions.

The sub-programme Consumer Preference is perhaps the most established research area with a solid basis in marketing and consumer behaviour. Even so, the research has some specifically interesting features. For instance, the programme has addressed the issue of product form and generated new knowledge on the way product form influences consumer preference. It has also carried out worthy research on consumers' perception and interpretations of different types of product representations, of significant importance in establishing an efficient communication between consumers/market and developers/manufacturer. Recent research has investigated consumers' acceptance and adoption of completely new and technically advanced products.

Productivity

Overall, the productivity of the programme is very good. The number of PhD-theses is not high but in the light of the number of PhD-students and senior staff, the output must be considered more than acceptable. The number of publications from the research programme fluctuate somewhat but has increased over the period 2001-2006, in particular in terms of conference papers. The publications of the different sub-programmes are published through

different channels. Papers produced within the Consumer Preference programme appear to be published primarily in marketing and management journals/conferences while papers produced within the Product Aesthetics and Experience programme appear to be published primarily in psychology and design journals/conferences. The research carried out within the programme, and within the faculty of Industrial Design Engineering, is evidently of relevance for an engineering design audience too. It is therefore recommended that the researchers within these particular areas should consider publishing also through other channels, i.e. the more traditional engineering design conferences and journals, and make an effort to reach the engineering design community specifically.

Relevance

The research carried out within the programme the three subgroups is considered highly relevant for the education profile of the faculty, the industrial design research community, as well as to industry. This is evident in the increasing collaboration with industry. Referring to the comment made re Quality, it is here important to emphasize the role of Usage Evaluation in particular. Understanding users and product usage have re-emerged as a key issue in product development, not least in order to secure commercially successful products. The area is considered to have a very good potential to develop but would benefit from a somewhat clearer profile and sharpening of research questions (cf. Viability).

The programme is considered to contribute to fulfilling its mission statements by generating new fundamental knowledge as well as developing new methods and tools. In order to increase the usability of the research results, however, it appears essential that the programme explores further the applicability of the findings.

Viability

The research topics addressed by the programme are highly viable. With an increasing interest from the research community as well as from industry, the research carried out within the programme has considerable potential to expand and develop further. The researchers involved have beyond doubt the necessary capacity.

Given that the research carried out on product appearance and consumer preferences is highly related to the research on product aesthetics and experience, it is somewhat surprising that collaboration between the groups has not extended further. Considering the global trend towards an increased focus on (primarily ecological) sustainability, it is equally surprising that there at least appears to be very little collaboration between the programme and Life Cycle Engineering and Design. The ongoing 'restructuring' is expected to contribute to a positive development. Also it is anticipated that further collaboration with related research programmes within the faculty, for instance research on new types of smart, interactive products, will be beneficial.

Apart from the ever-present issue of funding, a critical prerequisite for the further development of the programme is staffing. It is considered important that the competence profile within the programme and its sub-programmes is multi-disciplinary and that this is maintained in the future.

Furthermore, it appears essential as a next step to develop further on the applicability of the findings, in particular on the relation between analysis and synthesis.

Conclusion

The research carried out in the programme is highly relevant and has resulted in new and innovative results. The research has a clear potential to develop further. However, it is essential to be able to incorporate and address both descriptive and prescriptive approaches, analysis and synthesis, in future activities. A critical prerequisite for the further development of the research is staffing. It is considered important that the competence profile is multi-disciplinary and that this is maintained in the future. In order to develop the research further, the number of staff must increase so that a more adequate balance can be achieved between teaching and research activities. Furthermore, although steps have been taken to increase collaboration across research groups/programmes, these efforts should be intensified.

4.4. *Product Intelligence (PI)*

Programme Leader	Prof. dr. H. de Ridder
Research staff 2006	11.4 fte (4.1 tenured, 1.5 non-tenured, 5.8 PhD students)
Assessments	Quality Good (3)
	Productivity Good (3)
	Relevance Good (3)
	Viability Good (3)

The research programme Product Intelligence focuses on smart or intelligent products. The research programme is divided into three parts:

- (i) Intelligence in products (headed by prof. dr. D. Keyson),
- (ii) Transparent interfaces (headed by prof. dr. H. de Ridder),
- (iii) Product advantage and market acceptance of intelligent products (headed by prof. dr. E.J. Hultink).

The sub-programmes differ with regard to the four assessment criteria; these differences are discussed below and separate scores are given in the conclusion.

Quality

Research focusing on the human-centred design aspect of intelligent products has been published mostly in conference proceedings with only a few journal publications. The visibility and quality perception of this group could be increased by targeting research to more scientific publications.

The transparent interfaces group needs to aim for higher quality, international journals which better fit their research focus.

Within the market acceptance programme, prof. Hultink is an internationally recognized scholar for his research on new product acceptance and launch.

Productivity

The productivity of the group is varied. The research of the “intelligence in products” group is limited in terms of publications. One reason for this may be the lack of clarity regarding the research problems being addressed. The “transparent interfaces” group is productive though it seems that they could target more appropriate journals or even create their own journal as a venue for their research. The “market acceptance” group has been very productive and regularly publishes in high quality, internationally renowned journals.

Relevance

The relevance of the “intelligence in products” research is questionable. Technology sometimes appears to be applied to non-problems or problems with little value, detracting from the important questions stated in the mission. Assumptions are being made about users needs without validating that these assumptions are indeed true.

The “transparent interfaces” sub-programme has some high quality, useful projects such as the deaf child computer and the surgeon’s cockpit. However, for other projects (e.g. P2P TV), it is unclear what research problem is being addressed.

The focus on “market acceptance of intelligent products” is important and necessary given the growth of such products in the marketplace. It also fits with the mission of IDE.

Viability

The viability of the research programme is mixed. The work done on market acceptance of smart products is relevant and provides a niche that differentiates IDE from other institutions. The focus on improving the quality and potential of medical care in coordination with the Medisign programme seems a place ripe for creating a strong identity for IDE. However, the “intelligence in products” sub-programme lacks coherence and some projects seem primitive.

Conclusion

The mission statement of the Product Intelligence programme is very important. However, in some cases, there seems to be inappropriate emphasis on technology push (i.e. technology for technology’s sake) rather than developing “products people love to use”. In other words, there is a disconnection between the mission and some of the work being undertaken in the programme. Clarification of research focus is needed in some areas. There is a hole in the centre of the research. Also, there is some concern that the labels being applied to the research programme do not fit with the actual work being undertaken.

Within the overall scores given for this programme (Good), the sub-programme “Intelligence in products” is assessed as Satisfactory, the sub-programme “Transparent interfaces” is assessed as Good, and the sub-programme “Market acceptance” is assessed as Very good on all four criteria.

Given the trend toward smart/intelligent products in many sectors of the global economy, it is appropriate that IDE focus research on this topic. To solidify IDE’s position in this field, the hiring of more research faculty/staff is needed. Increased FTE’s would also allow for closer links between the Masters programmes and the research programmes. More collaboration is desirable among the researchers in the three parts of the programme as well as with other programmes such as DfA (e.g. integrating ergonomics research into the design of intelligent products) and PFE (e.g. consumer preference impact on new product acceptance).

4.5. *Design for All (DfA)*

Programme Leader	Dr. ir. R.H.M. Goossens	
Research staff 2006 (fte)	4.6 fte (1.5 tenured, 0.0 non-tenured, 3.1 PhD students)	
Assessments	Quality	Excellent (5)
	Productivity	Very good (4)
	Relevance	Excellent (5)
	Viability	Very good (4)

The research programme Design for All deals with physical ergonomics including anthropometrics and biomechanics, and its applications in product and (work)place design. IDE has a long tradition and is highly respected in this field. The programme is divided into two groups focusing on medical ergonomics (headed by dr. ir. R.H.M. Goossens) and on anthropometry (headed by dr. ir. J.F.M. Molenbroek). The medical ergonomics group deals with designing equipment and work environments for surgeons, whereas the anthropometrics group focuses on collecting, understanding and applying anthropometric data in product and workplace design in general. Both sub-programme leaders are enthusiastic, very active and world leading in their respective fields. The programme fits well in the human-centeredness approach that is emphasized in the mission of IDE.

Quality

The chosen focus in this research programme has resulted in very high quality of the work done. Despite the very small number of researchers, and the absence for many years of a leading full professor, the work is current, meaningful in its application and uses superb, repeatable methodology. The group's strategy to increase the number of PhD-students and integrate Master-thesis projects in the research programme has been successful.

Productivity

Given its size, the programme has a very high productivity of publications, and regularly publishes in first-tier biomedical engineering and ergonomics journals, although the contribution from IDE-resources in some joint publications with external groups is not always clear. The distribution of publications amongst researchers could be more equal; the work of the anthropometrics group has a potential for more publications. The international visibility of the group could be further strengthened if the publication activities focus more on international top scientific journals rather than in national journals and professional publication, even if this is not always encouraged by the IDE internal financial reward system, which allows equal points to national and international journals (see remarks in Part A: Academic Contribution of the report).

Relevance

The relevance of the work is high as ergonomics relates to all areas of design. The research is a very important tool to make products and places better for people. Manufacturers and designers recognize the importance of fit, safety, comfort and user control, etc. The engagement of the group in the ergonomics in the East (China), is significant as those world markets emerge. The focus on medical technologies is admirable as work needs done in this area.

Viability

In the past period, it was a right strategy to focus with such a small group. For keeping the research standards in anthropometrics high, an investment is needed in the groups' anthropometric equipment, which is now below international standards.

Conclusion

Given the tradition and continuous strength of the ergonomics research in IDE over the time, and given the fact that this content area is needed throughout all design and in all IDE, the scope of DfA should enlarge. For example, more collaboration is desirable with researchers from MTT (e.g. research on integrating ergonomics in design methodologies) and PFE (e.g. integrating ergonomics research on human health, safety, comfort and performance, into research and design on human experiences), and the group could participate in more PhD projects. However, the current staff is too small to realize this ambition, although a more pro-active approach seems possible. New faculty members and new research staff are needed in this programme to realize its full potential. In the next period, the groups can be stronger represented internally and externally by the recently appointed leading full professor, which can help to correct the situation of lack of resources.

APPENDICES

Appendix A: Curricula vitae of the committee members

Lucienne Blessing (committee chair) is vice-rector of research, University of Luxemburg. She studied Industrial Design Engineering (1978-1984) at the Delft University of Technology (NL) and received her PhD in 1994 from the University of Twente (NL). From 1984-1992 she was employed at the Department of Mechanical Engineering of the University of Twente as lecturer. From 1992-2000 she worked at the Engineering Design Centre (EDC) of Cambridge University (UK): until 1995 as Senior Research Associate, until 2000 as Assistant Director of the EDC, and from 1998-2000 also as Assistant Director of the British Aerospace – Rolls-Royce University Technology Partnership for Design. From 1997-2004 she was director and principal consultant of Upton Blessing Ltd, Cambridge UK. From 2000 until 2007 she was professor and chair of Engineering Design and Methodology at the Faculty of Mechanical Engineering and Transport Systems, University of Technology Berlin (D), where she was vice-president for research and international relations from 2002-2004. Her main research areas are empirical studies of engineering design processes in laboratory and industrial environments; innovation; design methodology and design theory; methods for the early design phases; user interface design; diversity in product development (gender, age, culture); fatigue testing of plastic gears, connecting elements and shaft-hub connections; design research methodology.

Gloria Barczak is professor of Marketing and Chair of the Marketing Group at the College of Business Administration, Northeastern University. She holds an MBA from the State University of New York at Albany, and a PhD from Syracuse University in Marketing and Innovation Management. Professor Barczak's research interests center around the new product development (NPD) process and the use of teams in this process. Her current research focuses on NPD best practices and the use of IT tools in the NPD process. Through her research, teaching and consulting, Professor Barczak has worked with a variety of companies including: SBC, WR Grace, Pearson/Prentice-Hall, Compaq, Modine, Eastman Kodak, AARP, American Red Cross, and the American Cancer Society. She is on the editorial boards of the *Journal of Product Innovation Management*, *IEEE Transactions on Engineering Management*, and *Creativity and Innovation Management*. In May 2007, she was ranked as one of the Top 25 Innovation Management Scholars in the World in an article in the *Journal of Product Innovation Management*.

Bill Buxton is a designer and a researcher concerned with human aspects of technology. He is principal researcher at Microsoft Research and professor in the Department of Computer Science at the University of Toronto. His work reflects a particular interest in the use of technology to support creative activities such as design, film making and music. His research specialties include technologies, techniques and theories of input to computers, technology mediated human-human collaboration, and ubiquitous computing. From 1994 until December 2002, he was Chief Scientist of Alias|Wavefront, (now part of Autodesk) and from 1995, its parent company SGI Inc. He has consultant to a number of technology companies, and had a long association as a consulting research scientist with Xerox PARC. In 1995, Buxton became the third recipient of the Canadian Human-Computer Communications Society Award for contributions to research in computer graphics and human-computer interaction, and was given the New Media Visionary of the Year Award at the 2000 Canadian New Media Awards. In 2001, The Hollywood Reporter named him one of the 10 most influential innovators in Hollywood. In 2002, Time Magazine named him one of the top 5 designers in Canada. In June, 2007, he was named Doctor of Design, Honoris Causa by the Ontario College of Art and Design.

Jan Dul is professor of Technology and Human Factors, Rotterdam School of Management, Erasmus University Rotterdam. From 1997-2004 he was director of the Erasmus University Centre for Contract Research and Business Support. From 1999- 2001 he was vice-dean of the Rotterdam School of Management. His research interests are in the area of human factors, human-centered design of product and processes, embedding human factors in organizations, human factors and performance, human factors standardization, creative work environments, case study methodology. He is member of the Executive Committee of the International Ergonomics Association, member of the editorial board of *Human Factors and Ergonomics in Manufacturing*, (Wiley), *Theoretical Issues in Ergonomics Science* (Taylor and Francis), and *Tijdschrift voor Ergonomie*, *Nederlandse Vereniging voor Ergonomie*, and Member of the Advisory Board of the Office for Risk Assessment of the Dutch Food and Consumer Product Safety Authority (VWA).

Lorraine Justice is director of the School of Design, Hong Kong Polytechnic University. Fellow of the Industrial Design Society of America (IDSA). Formerly head of Georgia Tech's industrial design programme. Professor Justice is an influential designer with a special interest in using design to effect transformational change in every area of modern life. She was responsible for co-organizing the First China-USA Industrial Design Conference in Beijing. The design research programme has multidisciplinary partnerships, sponsorship from global companies, and a focus on ethnographic research.

MariAnne Karlsson is professor of Human Factors Engineering at the Department of Product and Production Development, Chalmers University of Technology, Göteborg, Sweden. She holds an MA in education from Gothenburg University and a PhD in Consumer Technology from Chalmers University of Technology. She is head of the Division Design and responsible for the two Ph.D. programmes Product and Production Development and Human–Technology–Design. Her research has its basis in the tradition of user-centred design and has had a particular focus on the development and evaluation of methods and tools for eliciting user requirements and for evaluating design solutions. She has also carried out action research associated with implementing new, and more use centred development approaches in companies. Recently, research on affective design has been included in her research portfolio. She has been involved in a large number of research projects and collaborated with a number of leading companies including Electrolux, Saab, SCA, Volvo Cars, and Volvo Trucks.

Michael Tovey is professor and director of design education and applied research at Coventry University. He is Director of CEPAD, (the Centre of Excellence in Product and Automotive Design), with strong links with the Industrial Design Department, and with the Coventry School of Art and Design, of which he was Dean for 18 years. His discipline base is in Industrial Design. Following a period of practice in industry, he came to Coventry and was responsible for the establishment and development of transport design. Much of his research work has been concerned with how designers think and on the use of computer support for the creative aspects of design. The context for this work has been concept design in the automotive industry and the development of novel techniques to support the design activity. He is a member of the Art and Environment Committee, University Hospitals, Coventry and Warwickshire (2004-current), a member of the City of Coventry Ambassadors Group (2003-current), associate editor of *Design Journal* (1997-current), member of the editorial advisory board of *Design Studies* (1992-current).

Christian Weber is university professor for Engineering Design (Konstruktionstechnik), Technical University Ilmenau. He was university professor for Engineering Design/CAD (Konstruktionstechnik/CAD) at Saarland University, Saarbrücken, since 1989, where he taught courses in several areas (Machine Elements, CAx, Design Theory and Methodology) for a variety of studies (Mechanical Engineering, Mechatronics, Material Science, Computer Science, Technical Biology/Bionics). Was Director of the Zentrum für Innovative Produktion der Universität des Saarlandes (ZIP/UdS), 1995-1998. Today, his research interests focus on a new approach to product and process modelling in engineering design; advanced technologies in Computer-Aided Design (CAD); feature-based modelling; representation and processing of geometric tolerances in 3D CAD-systems; knowledge management in CAD; machine elements as components of mechatronic products; simulation in the development of mechatronic products. As the scientific leader of TU Ilmenau's Competence Centre Virtual Reality, Weber also is responsible for research projects in VR-modelling and simulation in early stages of product development,.

Appendix B: Site Visit Programme

Programme for site visit research evaluation committee IDE, November 19 - 22, 2007

Monday November 19th

17.00h	Hotel De Plataan (meeting room)	Meeting of committee members including secretary Bennink, incl. internal deliberation committee
19.00h	Restaurant	Dinner for committee

Tuesday November 20th

8.45h	PEL	Meeting committee with Rector Magnificus and Faculty Board
9.30h		Internal deliberation committee
10.00h		Introduction by faculty board and presentation by New Portfolio Team (Horváth, Hekkert, Hultink)
11.00h		Break
11.15h		Interview session with programme leader (and others) on programme MTT
12.30h	4B-01	Lunch
13.30h		Interview session with programme leader (and others) on programme LCED
14.30h		Break
14.45h		Interview session with programme leader (and others) on programme PFE
15.45h		Tour along labs / facilities with some explanation
17.30h		End of programme
18.00h	Restaurant	Dinner for committee

Wednesday November 21st

9.00h	PEL	Interview session with programme leader (and others) on programme DfA
10.00h		Interview session with programme leader (and others) on programme PI
11.00h		Break
11.15h		Interview session with PhD mentors René van Egmond (2001-2006) and Zoltan Rusák (since 2006)
12.15h		Tour along labs / facilities with some explanation
13.15h	4B-01	Lunch
14.00h		Interview session with faculty board on part A
15.00h		Break
16.00h	Faculty room	Poster session with (selected) PhD-candidates + drinks (All PhD-candidates and their promotors/supervisors are invited)
17.30h		End of programme
18.00h	Restaurant	Dinner for committee + faculty board

Thursday November 22nd

08.30h	PEL	Internal deliberation committee: scores per programme, main conclusions and recommendations on programme and institute level, task division towards report
11.45h	PEL	Presentation of first findings to Rector Magnificus and faculty board
12.30h		Departure of the committee (and/or lunch)

Appendix C: Explanation of the SEP-scores

<i>Excellent (5)</i>	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 .
<i>Very Good (4)</i>	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 .
<i>Good (3)</i>	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 .
<i>Satisfactory (2)</i>	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 .
<i>Unsatisfactory (1)</i>	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 D: Strategic overview of IDE at TUD, UT, TUE

A. IDE TU Delft: the new research portfolio

Disciplinary development

IDE is evolving from a set of monodisciplinary sciences to a transdisciplinary field of knowledge by developing its own body of knowledge, research and design methods, and its own practice. IDE is based on four fields of study, each with their own related disciplines:

- marketing/innovation management
- ergonomics
- design/aesthetics
- engineering.

Through scientific research, the disciplinary boundaries must be broken down to create synergy in terms of research methods and the contextualization of knowledge.

People-centred technology

The overall objective of the IDE-TUD research for 2008-2012 is defined as:

“Fostering sustainable well-being by exploring, generating and transferring knowledge and technologies for industrial design.”

The sustainable well-being is meant to refer to an array of desirable states that are not at the cost of others but address the importance of the ecological, social, cultural and economic context, including diminishing resources, inequality of wealth and access, and global competition. Knowledge will be developed in the form of theories, models, principles and conceptual solutions. Technological developments will include design tools and instruments.

The designer should be human-centered and take issues of value, usability and meaning into account. The designer translates ideas into the best possible manifestation (product, application, service, etc.), with an understanding of the possibilities and limitations for realization and production.

This research objective is in harmony with the current strategic choices of the TU Delft and allows participation in a number of Delft Research Centres, with ‘sustainable well-being’ as a distinctive IDE-dimension.

Bridge between fundamental science and industrial product development

Three complementary methodological approaches are defined:

- *research in design context*: based on the knowledge and research methods of design-related disciplines such as engineering, psychology and ecology, but contextualized by taking people, artifacts and environment into account;
- *design inclusive research*: using an evolving artifact or process as a means of doing research;
- *practice-based design research*: aimed at identifying general principles and patterns, based on design activities and product developments.

Five research programmes

The research programmes for 2008-2012 are based on the theme of ‘fostering sustainable well-being’ and the envisaged ‘academic designer’, and on the new methodological approaches. The

new programmes contain elements of the current programmes, but also add new elements. A programme committee will elaborate the programmes in further detail.

The new programmes are:

1. ***'Enablers of conceptualization'***, with the objectives:
 - to develop methods to support conceptual design processes and communication/cooperation in multidisciplinary design teams
 - to construct techniques for enabling designers to express their ideas efficiently and increase their creativity
 - to develop advanced design tools and collaborative virtual design environments for industrial design engineers.

2. ***'Strategic design'***, with the objectives:
 - to explore the strategic context of new product design
 - to generate knowledge on the relationships between new design and the existing range of a firm, customer needs, sustainability issues and market success.

3. ***'User experiences'***, with the objectives:
 - to understand how well-being (comfort, attachment, satisfaction) can result from interactions with designed artefacts
 - to study how these interactions are influenced by their physical, social and cultural context
 - to study how new technologies correlate with new ways of interacting and shift the boundaries of physicality, functionality and usability of products.

4. ***'Artifact manifestations'***, with the objectives:
 - to explore novel product concepts and sustainable forms of realization of products for human and social well-being
 - to develop integral technological solutions and processes in context
 - to find optimal solutions by exploring numerous artifact manifestations in order to optimize human and social aspects and full system performance from a sustainability point of view.

5. ***'Exploring innovative applications'***, with the objectives:
 - to apply foundational knowledge in solutions for specific application areas (such as health care, personal mobility, living/working, developing countries)
 - to formulate fundamental research questions on the basis of operative research and knowledge development.

The relationship between the new programmes and the programmes in this review, are described as follows:

New programmes	Closely related current programmes or themes
'Enablers of conceptualization'	Methodology, tools and techniques (MTT)
'Strategic design'	Subprogrammes 'Design for sustainability' and 'Product advantage and market acceptance'
'User experiences'	Product functionality and experience (PFE)
'Artifact manifestations'	Parts of 'Life cycle engineering and design' (LCED)
'Exploring innovative applications'	For the health care-application area: Design for All (DfA) For the living/working application area: Intelligence in products

For the organization of the research, a Faculty Research Board is envisaged. This board will make all strategic and operative decisions regarding research within the faculty. Members of this board should be the Research Director and the five Programme Coordinators. Each Programme Coordinator leads and coordinates a network of collaborative researchers driven by multidisciplinary research topics and shared research interests.

B. IDE at the University of Twente (UT)

The review committee received a document describing the research projects and plans of IDE at the University of Twente, which is not subject of this review but will be reviewed in 2009. The committee appreciates this background information and understands that it is not considered to be complete and that it was only intended for the committee in the context of the review of IDE TU Delft.

The Faculty of Engineering Technology (CTW) consists of three departments: Civil Engineering, Industrial Design Engineering, Mechanical Engineering. The research of the five UT-faculties is organised in six research institutes. For Industrial Design Engineering the most relevant research institutes are:

- IMPACT (Institute for Mechanics, Processes, and Control Twente),
- CTIT (Center for Telematics and Information Technology),
- BMTI (Institute for Biomedical Technology)
- IBR (Institute for Behavioural Research).

The mission of Industrial Design Engineering related research in the Faculty of Engineering Technology of the University of Twente is *to develop qualitative and quantitative knowledge on all phases of the life cycle of (consumer) products, i.e. initiative, design, production, use, maintenance and recycling, all with a strong focus on the user, in a societal and environmental context.*

The IDE-oriented research of the University of Twente is embedded in a new 3TU research school², together with the IDE-departments of Delft and Eindhoven. The recently granted

² Netherlands Research School of Integrated Manufacturing (Integrale ProductVernieuwing IPV), see <http://du-toce.io.tudelft.nl/~jouke/ipv/doc/Resarch2004.pdf>

Netherlands Programme for Product Development forms an excellent basis for further cooperation.

The IDE-oriented research of the University of Twente can be summarised as follows:

IDE-related research at UT	Specific links with IDE
Design Engineering (Product Design; Packaging Design and Management; History of Design)	Integrated Product Creation and Realization. Innovative product creation process (T-Xchange, virtual reality, 3D scanning and printing facilities). Product life cycle management. Integration of product and packaging design.
Surface Technology and Tribology	Interaction between human skin and objects, both static and dynamic, with applications varying from medical and leisure to design and engineering. Submicron level texturing of surfaces.
Production Technology	Links with product development
Structural Dynamics and Acoustics	Application in consumer products of theory and methods developed in the SD&A group.
Biomechanical Engineering	
Engineering Fluid Dynamics	
Mechanics of Forming Technology	Balance between material behaviour during processing (deep drawing) and (visual) product, especially car body panels.
Mechanical Automation	Mechatronics control and construction principles
Thermal Engineering	A joint project for fuel cell integration in consumer products is in preparation.
Elastomer Technology Engineering	Elastomers are typically suitable for use in consumer products. This research group is unique in the Netherlands
Construction Management and Engineering	Links with MSc programme Architectural Building Construction Design Engineering.
Center for Transport Studies	The knowledge centre Applications of Integrated Driver Assistance (AIDA) is realised by TNO and UT.

To strengthen the design and production profile of the Faculty, the four fulltime chairs 'Design Engineering', 'Product Design', 'Surface Technology and Tribology' and 'Production Technology' are clustered in the chair group 'Design, Production and Management' (OPM). Each chair has its own main line of research.

The research plan of the Product Design Group states that the linear model for product development could not explain economic phenomena such as partial path dependencies, technological lock-in and dominant design, and that an evolutionary product development model is used as guideline for the planning of the research.

Education

The five year educational programme in Industrial Design Engineering (IDE) started in 2001 and the programme now has over 400 students. An MSc programme in the area of Architectural Building Construction Design Engineering is under development as a joint effort with the UT Department of Civil Engineering. Cooperation also exists beyond the borders of faculties: a possible ICT coloured BSc variant of IDE together with the Department of Electrical Engineering, Mathematics and Computer Science is under consideration. In 2001-2003, an international programme Industrial Design and Manufacturing was developed jointly with the

University of Dortmund. A master programme Sustainable Energy Technology was developed in 2005-2007 within the 3TU framework.

C. Industrial Design at Eindhoven University of Technology (TUE)

The Department of Industrial Design at the Eindhoven University of Technology was founded in 2000 as a result of discussions with high-tech product creating companies in order to educate a new type of graduate for this cross-disciplinary knowledge industry. In this way Industrial Design is aiming at bridging the gap between knowledge from different fields and the market. The education programme started in 2001 and employs an innovative competency based education concept.

The mission of the Department is “*creating intelligent systems, products and related services*”. By integrating paradigms from Engineering, (Social) Science and Design, the department aims at defining a new content of Industrial Design in a university environment with balanced relations to the professional and industrial field.

An intelligent system and product is characterized by adaptive behavior based on the situation, context of use and users’ needs and desires. In particular focus is on problems and opportunities that are of benefit to individuals, societies and different cultures worldwide.

The intelligent products are connected to each other and the surrounding system to achieve a new type of user experiences. To create such interactive and intelligent environments, expertise is needed for the context of use, the conceptual design, the implementation and realization, and evaluation. Expertise concerning production processes is needed to realize all this in an industrial and commercial setting. The main target of TUE-ID design expertise is the interaction between users and systems in a context of use.

The research is organised in four capacity groups:

Capacity group	Main research topics
Designed Intelligence (DI)	Autonomous systems (robots, human-robot interaction, mental modelling) Adaptive systems (bio-signal processing, learning algorithms, smart sensors) Aware environments (cultural computing, dynamic processes, medical applications, sensing)
User Centered Engineering (UCE)	Design and evaluation methods for close coupling between concept development and the goals, needs and desires of the users.
Designing Quality in Interaction (DQI)	Ambient intelligent systems (highly complex interactive systems) to enhance interpersonal and societal values.
Business Process Design (BPD).	Design/use scenarios in an application oriented experimental environment International network of design labs to study the effects of globalisation on the design of intelligent systems

To stimulate integration, the research infrastructure has facilities that are used by all capacity groups in joint projects with a ‘research through design’ approach. These labs are practice-equivalent design spaces where staff and students work together on projects covering the entire

product creation process from idea creation up till building and testing of prototypes and user testing. There are brainstorm facilities, extensive computer infrastructures for design and analysis, mechanical and electronics building facilities for prototypes, rapid prototyping, testing equipment and video-meeting facilities for project group meeting with overseas partner groups.

From the start in 2001, the Department of Industrial Design TU/e started building an international network of strong partner universities and (multinational)-company research groups for staff and student exchanges, and cooperation in research. The aim of this network is to develop a Global Research Agenda for designing intelligent systems, products and related services.

Appendix E: Reaction of the Executive Board and the Faculty

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Onderwerp **Research Review Industrial Design Engineering**

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CC. Prof.dr. C.J.P.M. de Bont (decaan IO)

Geachte heer Bennink,

Het College van Bestuur en de faculteit Industrieel Ontwerpen spreken waardering uit voor het goed gefundeerde, weloverwogen, zorgvuldig samengestelde rapport van de onderzoeksbeoordelingscommissie. Ook de opmerkingen die de faculteit IO bij u neergelegd heeft in reactie op het concept rapport, blijken door de commissie in goede orde in het voorliggende rapport te zijn verwerkt, waarvoor dank. Wel vindt de faculteit IO het spijtig dat de commissie de suggestie, ten aanzien van de gerealiseerde *joint projects* in het subprogramma 'Intelligence in Products', niet in het rapport heeft opgenomen.

De aandachtspunten en aanbevelingen uit het rapport bieden handvatten om op een constructieve manier het eerder gestarte proces om te komen tot een nieuw onderzoeksportfolio voort te zetten.

Wij delen de mening van de commissie dat het te betreuren is dat het niet mogelijk is gebleken om de onderzoeksstrategie van de Universiteit Twente (UT) en Technische Universiteit Eindhoven (TU/e) mee te nemen in de evaluatie. Waardering wordt uitgesproken voor het feit dat de commissie, ondanks dat er geen uitspraken kunnen worden gedaan over complementariteit, synergie en overlap, de commissie er wel voor gekozen heeft om een samenvatting van de belangrijkste strategieën in appendix D op te nemen.

Wij kunnen u dan ook melden dat de TU Delft het voorliggende rapport formeel aanvaardt. Wel verzoeken wij u vriendelijk deze brief als zogenoemde instellingsreactie aan het beoordelingsrapport toe te voegen bij het publiceren van het definitieve beoordelingsrapport.

Tot slot wil ik u, de voorzitter en de commissieleden hartelijk danken voor de geleverde inzet. Met het aanvaarden van het eindrapport gaat het College van Bestuur tevens tot decharge van de commissie over. In dat kader willen wij u en de commissieleden herinneren aan de mogelijkheid om gemaakte reiskosten, met betrekking tot de onderzoeksvisitatie bij de faculteit Industrieel Ontwerpen, ter declaratie in te dienen.

Hoogachtend,

Prof.dr.ir. J.T. Fokkema
Rector Magnificus

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