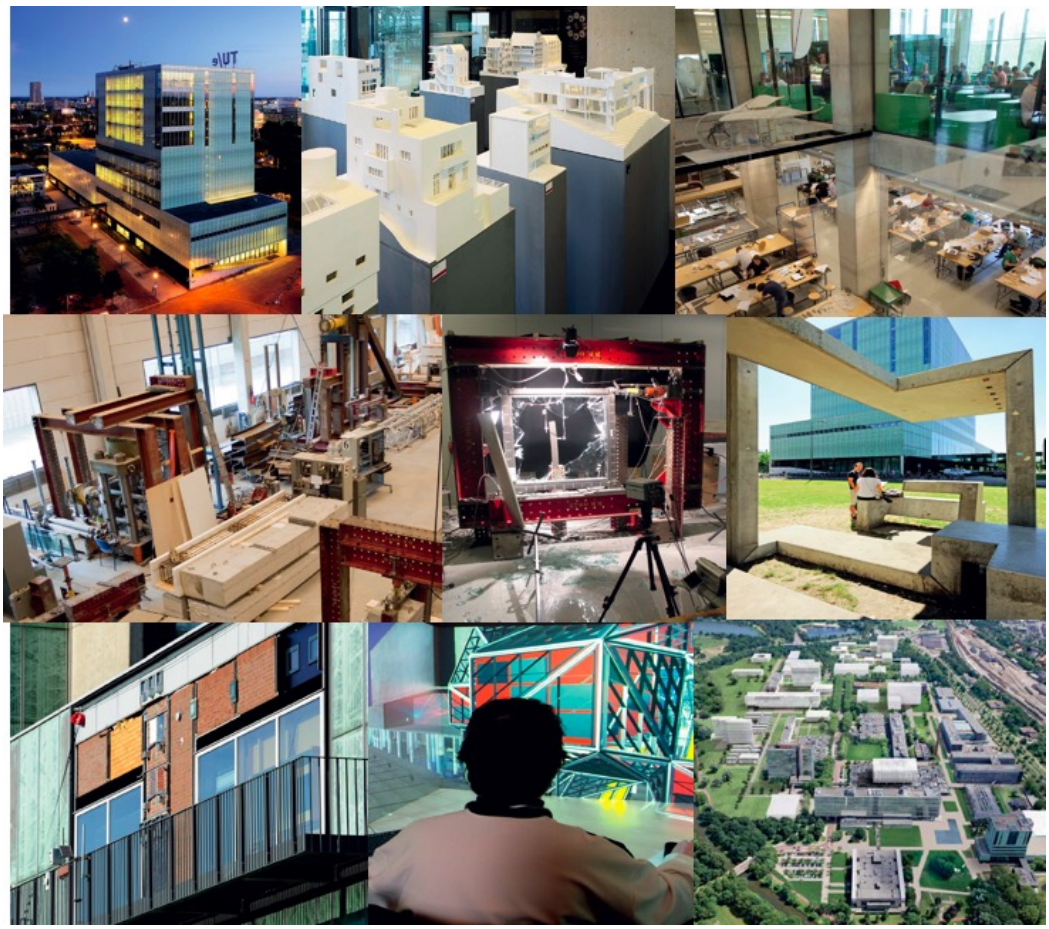
19 December 2016

Review Department Built Environment TU Eindhoven

Peer review report



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1 Preface

This document reports the results of a peer review of the research programs of the Department of the Built Environment at the Eindhoven University of Technology (TU/e) in 2016.

A committee of six people carried out the evaluation, supported by the secretary. The areas of expertise of the members covered building physics; history and theory of architecture; architectural design; urban design; structural engineering and design; transportation planning; and information architecture. For the review, the committee used the Standard Evaluation Protocol 2015 – 2021, the Protocol for Research Assessments in the Netherlands. The Department of the Built Environment and the research programs provided the Research Self-Assessment 2010 to 2015 as well as an appendix to the Research Self-Assessment: Design Artefacts for the Built Environment 2010 – 2015. In addition, the Department made available research papers and an exhibition, with explanations by PhD students and PostDocs.

The committee wants to express its gratitude to the Department, the research programs, the PhD students and the staff for organising the entire visit. We were met with openness, constructive ideas and enthusiasm. The committee thanks for the opportunity to evaluate such a competent and internationally known Department.

During the visit, four research groups gave short presentations, which were followed by discussions with the committee. These discussions were very helpful and provided a link between the documentation, the report of the previous visit, the exhibitions, the faculty and the reviewers.

Since the last evaluation in 2011, technical developments — especially the Internet of Things and ICT in general — have advanced greatly. It is therefore of importance that the Department has initiated the Smart Cities Centre. The Department has recognised that it is crucial to reflects and advances the non-technical and non-IT aspects of future cities in this Smart Cities Centre. And it has sharpened its focus on design.

Another welcome addition is the design and implementation of an exhibition of Design Artefacts for the Built Environment. The composition of the faculty, students and staff of the Department of the Built Environment is the best guarantee that the Department's goals will be achieved.

Prof. Gerhard Schmitt

Chairman

2 The review committee and the review procedure

2.1 Scope and objective of the assessment

The committee was assigned to perform an assessment of the research of the Department of the Built Environment of the Technical University of Eindhoven (TU/e). The assessment focusses on the four research programmes of the Department:

- Building Physics and Systems (BPS)
- Design and Decision Support Systems (DDSS)
- Living Cities (LC)
- Structural Design (SD)

The task of the committee was also to assess the design artefacts of the Department (Design Artefact for the Built Environment, DABE). Design is at the core of the Department, but design artefacts cannot be adequately assessed within the traditional evaluation framework for research. Therefore, the committee was asked to assess the design artefacts on their academic (are they research based?) and societal merits, using other indicators such as inter-subjectivity, transparency, reliability, reflexivity, valorisation, etc. It was the first time such an assessment was part of the review of the Department's research and it was an experiment. The committee was therefore also asked to assess the method used to assess the design quality of design artefacts (in line with methods used at peer institutes).

The assessment covers the period 2010 – 2015. In accordance with the Standard Evaluation Protocol 2015-2021 for Research Assessment in the Netherlands (SEP), the committee's task was to assess the research on the following criteria: research quality, relevance to society, and viability (the extent to which the Department is equipped for the future). The assessment encompassed two further aspects: PhD programmes and research integrity.

In addition, the committee was also asked to assess the following aspects:

- The alignment of the strategic ambitions of the Department with international trends.
- The alignment of the research programs of the Department with the international scientific trends in this field of research.
- The alignment of the strategic ambitions of the four research programmes with the departmental Strategy.

The committee scored the three main criteria of the SEP against four possible categories: 1 (world leading/excellent), 2 (very good), 3 (good), and 4 (unsatisfactory). For a description of the criteria and scores, see Appendix C.

2.2 Composition of the review committee

For the assessment, a committee of six experts was appointed. One of the members (Prof. Uwe Schröder) was – due to illness – unable to attend the site visit. During the site visit, he was replaced by Prof. Wim van den Bergh (RWTH Aachen).

The composition of the committee was as follows:

- Prof. Gerhard Schmitt, Chair of Information Architecture, ETH Zürich (chair)
- Prof. Uwe Schröder, Chair of Spatial Design, RWTH Aachen University
- Prof. John W. Polak, Department of Civil and Environmental Engineering, Imperial College London

- Prof. Werner Lang, Department of Architecture & Civil, Geo and Environmental Engineering, Technical University of Munich
- Prof. Phillipe Block, Institute of Technology in Architecture, ETH Zürich
- Prof. Simon Pepper, The Liverpool School of Architecture, University of Liverpool
- Prof. Wim van den Bergh, Chair of Housing and Basics of Design, RWTH Aachen University

Dr Frank Zuijdam (Technopolis Group) was appointed secretary to the committee. A short curriculum vitae of each of the committee members is included in Appendix A.

2.3 Independence

To ensure a transparent and independent assessment process, all members of the peer review committee were asked to sign a statement of impartiality. In this statement, the members of the committee declared that they had no direct relationship or connection with one of the four research programs or design presentations of the Department of the Built Environment**.** Committee members were asked to reflect on affiliations or relationships that could lead to a biased assessment. All committee members felt that they were able to conduct an independent and impartial review.

2.4 Data provided by the committee

The committee was provided with all the necessary documentation a couple of weeks prior to the site visit. The documentation included the following:

- The terms of reference for the assessment
- The self-assessment report with appendices
- The Department's strategy 'Building the future'
- The program for the site visit
- The Standard Evaluation Protocol 2015-2021

For the assessment, the Department produced a self-assessment in which it reflected on the four research programmes and the Department's strategy. The self-assessment also included data about publications (articles, conference papers, books, etc.), staff, funding, and PhDs. In a complementary chapter on Design Artefacts for the Built Environment (DABE), the Department presented visual material and descriptions of 21 designs from different chairs.

2.5 Procedure followed by the committee

The committee proceeded according to the Standard Evaluation Protocol 2015-2021 (SEP). Before the start of the site visit, the committee could read the relevant documentation and each research programme was assigned to a reviewer (based on their expertise).

A site visit was organised for the afternoon of Wednesday 2 November, the entire day of Thursday 3 November, and the morning of Friday 4 November 2016 (see Appendix B for the programme of the site visit). At the start of the site visit, the secretary briefed the committee about the Standard Evaluation Protocol (SEP) and the Dutch science and innovation system (as the context in which the Department operates). The committee also agreed on procedural matters and aspects of the assessment. During the site visit, the committee interviewed the departmental Board and the leaders of the research groups. The committee also had the opportunity to examine the design artefacts and posters of PhD projects. After the interviews, the committee discussed the assessments of the research groups, the design artefacts, and the Department as a whole. At the end of the site visit, the committee presented the preliminary assessment to representatives of the Department.

After the site visit, the committee drafted an assessment report based on all the documentation, interviews, and the presentation of design artefacts and PhD posters. The report was finalised via e-

mail exchange and a video conference. The final report was sent to the Department of the Built Environment so that they could check it for factual errors. The comments were discussed by the committee. The final report was presented to the board of the Department and the Technical University of Eindhoven after their formal acceptance.

2.6 Remarks about the Standard Evaluation Protocol

As the review committee stated in 2011, the exclusion of information about the educational tasks and duties of the researchers, the programs, and within the Department appears odd. Most of the committee members come from universities where teaching and research are inseparable, and one cannot be evaluated without the other. The committee therefore took the liberty to interpret the key performance indicators and the numerical evaluation, taking into account both research and teaching. The committee recommends that this separation should be removed in the next review, especially given the ever closer relationship between research and teaching. Examining both together provides a better understanding of the Department and its contributions to the university and to society as a whole. This would require at least one more day for the evaluation.

The committee felt somewhat uneasy with the change in the numerical system used in the evaluation. Whereas previous committees had been asked to provide a score between 1 to 5, with five being the highest, this time the system was reversed. It now also only consists of 4 grades, with 1 being the highest. In addition, the specification of the highest grade has changed from the previous evaluation, which makes comparison between the two systems difficult. The highest score of 1 now stands for "The research unit has been shown to be one of the most influential research groups in the world and its particular field". As more than 5000 universities and even more subject areas are ranked every year, this definition might not be most helpful. The committee therefore decided to define the attributes for the score of 1 to include at least excellence, prominence, high academic and practical impact and PhDs with successful careers coming from the Department or research programme. The committee also learned that there was a certain uneasiness in the faculty and the research groups concerning this grading system and the results.

This was the first time the design artefact was a part of the research assessment, using the same format and scale as the four research programs. The committee was asked to comment on the suitability of the criteria used in the evaluation of the design artefacts (DABE). One of the difficulties was that the statistics underpinning the four established research programs were not available for DABE (although some could be "borrowed" from the Living Cities program). The committee was not expected to "mark" individual projects (or publications reported elsewhere), and as such, the design criteria were redundant. The committee had no problem with recognising the central importance of design project work, or its status as potential research. It greatly valued the opportunity to see the range of project work and to discuss it with the enthusiastic authors at the poster exhibition. However, it seems potentially misleading to treat final-year student MSc projects at the same level as the mature research of teaching staff and the efforts of full-time PhD staff. If it is planned to repeat a separate evaluation of DABE, the university might consider reporting MSc work (final projects and the work of Design Laboratories) under its own colours, with the staff design projects returned as part of the Living Cities Research Program (where many of them were also reported in 2016, introducing an element of double-counting). A simple narrative assessment could well suffice.

In terms of the parameters to measure the quality of the programmes' output and the academic reputation of its research staff, the committee recommend to extend (or refine) the list with the following parameters:

- Building Culture, with the following categories:
  - Prizes and Awards for buildings and Oeuvres
  - Competition results
  - Realisations of model projects and competition results
  - Competition Juries (chair, member, expert)

  - Commissions concerned with Building Culture (chair, member, expert/advisor)
- Publications on works in professional books and periodicals (of buildings, designs and artefacts) of academic staff members
- Exhibitions (curator, exhibitioner)
- Conferences/Symposia/Lecture series (organisation, keynote, lecture, poster)
- Scientific committees (chair, member, expert/advisor)
- Peer reviews (chair, member, expert/advisor)

3 Assessment of the Department

3.1 Assessment of the strategy of the Department

The Department's strategy design has advanced quite positively since Prof. Elphi Nelissen, began her term in 2011. The formulation of "Building the Future" in 2013 was a common effort of the entire Department, carefully prepared and guided by the new Dean. The focus on the three central themes "Quality of Life", "Smart Living Environments" and "Sustainable Transformation" led to significant developments: interaction between members of different departmental research groups and teaching groups improved, the respect for each other's work grew, and so did the international reputation of the Department of the Built Environment.

The Department decided to focus on quality, rather than quantity. It should be especially applauded for its success in attracting research money for a rapidly growing number of PhD students in all institutes. The building industry is traditionally split into many players and does not provide ample research funding, such as the life sciences or fundamental sciences funded by international organisations like CERN. At the same time, the building industry is in dire need of innovations in the planning, construction, and management process of buildings and cities. With its growing research and teaching program in these areas, the Department of the Built Environment makes one of the largest contributions in the Netherlands. Yet this financing scheme should not be seen as the only future model, as it may not place enough emphasis on fundamental or blue sky research.

For a department of this calibre, the inclusion of design output in the assessment is both brave and necessary. Although Design has a different meaning for each Institute, it can and should develop into a unifying activity that can also be assessed.

It is impressive how and with which consequence the Department followed up on the recommendations of the last full evaluation in 2011 and on the intermediate assessment in 2013. There are few departments worldwide that could make such drastic changes in the number and focus of the research units within such a short time while at the same time improving output and outcome when implementing the new strategy.

3.2 Assessment of the international position of the Department

The previous review in 2011 included research groups and programs in Architecture and the Built Environment at the Delft University of Technology (Architecture and OTB), the Eindhoven University of Technology (Architecture, Building and Planning) and the Berlage Institute. The combined international standing of those three institutions was, of course, significant. With the decision to evaluate each one separately, the competition between them will increase and, with this, the necessity to differentiate by defining and pursuing focus areas of research.

The Department of the Built Environment at the TU/e has done well in this respect. Two research programs clearly stand out: Design and Decision Support Systems, and Building Physics and Services. The meaning and importance of rankings is not undisputed in academic circles. However, it is a sign of quality if one particular department or institute surpasses the overall ranking of the university. This is the case with the Building Physics and Services program: it contributed most to the top 10 position of TU/e in the 2016 Shanghai ranking in the field of Civil Engineering. A professor from the BPS program is one of the most visible researchers of TU/e. The Design and Decision Support Systems program is internationally outstanding. Under its experienced leadership, it has a continuous and globally respected position in its field. It also boasts young and promising talent, already well-connected worldwide.

In the context of rising interest in Smart Cities, the Department can play a major role internationally in the future, as it actively embraces this development and at the same time introduces the important aspect of design. In this context, the programs Living City and Structural Design will be of significance, because they can deal with the cyber civil infrastructures of future cities.

3.3 Assessment of the research quality and relevance as whole

The Department of the Built Environment is a trend setter in that it combines science and engineering programs with architecture and the urban scale programs. It also stresses the overarching importance of design. In science, the assessment of research quality is a standard process that scientists have agreed on, and it is compatible worldwide. In design, this is not the case, and various attempts to relate or equate design to scientific research have failed. With its approach, the Department of the Built Environment has set an example to propose the possibility of a quantitative assessment of its design artefacts and relate the results to scientific output. This stretches the assessment definition space of both areas, but it is one necessary step on a continuous path towards cognitive design in computing. The exhibition of design artefacts the Department set up and the accompanying publication are milestones. Of course, each department of architecture in leading global research universities does this, but in the case of TU Eindhoven, the research aspects are more strongly represented than in other universities.

The most important measure of the future research quality is probably the presence, motivation, and enthusiasm of PhD students. In this respect, the committee was highly impressed with the young people it met during the lunch break and in the poster exhibition. They not only represented their own discipline or science area, but they were also collaborating with each other, in most cases even beyond the departmental level. This is not unusual in any top university, and a quite positive sign. The PhD students' ideas about the future and their own desire to set the coming research agenda was clear. This is an indication for an open, yet rigorous, research culture at the Department of the Built Environment.

3.4 Assessment of PhD training of the Department

A Research Management Team (MTOZ) coordinates the PhD program at the Department and guarantees coherence in the selection of candidates. The MTOZ also assesses each candidate's research proposal. It monitors and checks the progress of all PhD students. The word "PhD Training" expresses this process of selection, coordination, and monitoring. The success rate of the candidates is high, and an explanation was given for each person who did not complete the PhD.

The quality and motivation of the PhD students in the individual programs is high. It was obvious that the faculty successfully cross-linked teaching and also introduced PhD students from different programs to each other. The existence of a single large building in which the entire Department of the Built Environment is housed, including the extensive research facilities, is certainly an asset also for the PhD training that should be kept under any circumstances.

A positive development is that the Department could cope with the changing funding situation of the PhD students since the last research assessment. Whereas in the past, funds were available directly from the university–which is a reality for most leading research universities in the world–the funding now heavily depends on the capacity of the PhD supervisor and the prospective PhD student to convince external sources of their research ideas. While this is a commendable effort by the faculty that also helps to support the overall financing situation of the university, it should not be seen as the only long-term alternative to a balanced basic and competitive funding scheme. Total reliance on competitive, external and industry funding might lead to dependencies that are not in line with the strategic goals of universities.

3.5 Assessment of integrity policy of the Department

In the final report of the previous departmental review in 2011, the expressions "research integrity" or "integrity policy" do not appear. Today, the Department's research integrity policy is based on the TU Eindhoven's Code of Scientific Conduct, which includes five fundamental values: 1. Trustworthiness; 2. Intellectual honesty; 3. Openness; 4. Independence; and 5. Societal responsibility. The TU/e Code of Scientific Conduct is in turn based on the Netherlands Code of Conduct for Academic Practice.

The integrity policy of the Department of the Built Environment is in place and seems to be working. The self-assessment documentation states that "All PhD and PDEng-students attend a workshop on

Scientific Integrity, which is the single compulsory element of TU/e's PROOF program on research skill". It is a growing challenge for all researchers, especially PhD researchers, to maintain total integrity and avoid plagiarism in a situation where almost any piece of information is available worldwide in real-time. This is applicable in particular to emerging research areas, such as robotics in construction, Smart Cities, and new materials. The Department does and should take special measures to make sure that TU/e remains a leader in emerging fields, which in turn decreases the potential for plagiarism and challenges to the integrity of its research.

3.6 Recommendations

Strategy of the Department:

- Strengthen the integration between the research programs through common projects that share people and resources and through encouraging joint proposals.
- Increase the local, regional and national visibility of the Department as a whole and of the individual research programmes through communication of the viability of its results in research and teaching.
- Use design as a unifying framework for the Department.
- Make the Smart Cities Centre a beacon of TU/e research and valorisation.

International position of the Department

- Increase the international visibility of the Department by making its members and research programs an attractive partner for top global research universities.
- Reach out to the emerging global research regions, as the DDSS as program already does, for high-level knowledge exchange and best practice.
- Use the unique position of the Building Physics and Services, the Design Decision Support Systems, the Living Cities, and the Structural Design programs to offer solution strategies for challenges originating from rising sea levels, Urban Heat Island effects, rising noise and pollution emissions and decreasing livability.

Research quality and relevance

- Maintain and extend the close links between research and teaching.
- Maintain and strengthen the ability to do fundamental research for the built environment, in spite of the decreasing base funding.
- Use the ingenuity of students and faculty as well as the acceleration in global research production to generate spin-offs.

PhD training of the Department

- Maintain the high level of quality and enthusiasm in the PhD programs.
- Maintain the excellent level of competitive funding from external sources.
- Create funding possibilities for fundamental and blue sky PhD research from within the University or from external sources.

To the TU/e leadership

- Support the Department of the Built Environment financially in its transition to even more quality outcome in research and education.
- Support the Department of the Built environment in generating fundamental research in its domains, to avoid overwhelming dependence on external resources.

4 Assessment of the research programmes and design

This chapter contains the assessment of the four individual research programmes and Design Artefact for the Built Environment.

4.1 Building Physics and Services (BPS)

The research programme 'Building Physics and Services' mainly deals with aspects related to indoor comfort and a productive and healthy indoor climate. Relevant research topics include hydro-thermal, acoustical and visual comfort, air quality as well as user behaviour and healthy materials. These topics are reflected by the six chairs: building physics, lighting, materials, services, acoustics, and performance.

Since the last review in 2011 and the mid-term review in 2013, the research group Building Physics and Services (BPS) has increased its effort to widen and deepen its research activities related to the creation of a comfortable, healthy and sustainable indoor and outdoor built environment. In addition to dealing with the indoor conditions on a building scale, the scope of work has been continuously extended to the urban scale, including–among other topics–urban acoustics, urban physics, urban energy systems, and wind engineering.

With its wide range of important topics, the BPS research group is highly relevant for the design faculty. Indoor as well as outdoor comfort are critical for human well-being, but also for the resources needed (energy, materials, etc.) to create a positive environment on a building as well as urban level.

Due to the increasing need for zero-carbon, low-tech and low-cost solutions in a world with an increasingly changing climate, an integrated and interdisciplinary approach has to be taken for the future development of research within the group, reaching out to members within the Department and also other disciplines. As the group states in its self-assessment, "Designing and operating buildings and built environments that are sustainable, healthy and comfortable is an unprecedented challenge. [.....] This can only be achieved by a holistic approach to be able to tackle the complexity of the problems at hand".

To achieve the goals stated above, *"BPS has explicitly chosen a holistic research approach"*, which *"entails disciplinary research, within each area, as well as interdisciplinary collaboration between each of these areas"*.

The appropriate range of topics and the integrated, interdisciplinary research approach have been the key for the impressive development of the BPS group during the past six years with regard to its research staff and external funding.

4.1.1 Assessment of the quality of the research

Regarding the presentation the BPS group has given to the review panel it has to be noted that the relevance of the research areas, the achieved work and the future strategies have been presented in a very general manner, making it difficult to identify the specific achievements and the excellence of the group.

However, the documents provided to the group clearly show that the scope and quality of research is excellent and internationally recognised. The BPS group is well connected on a national and international level. As stated by the Department of the Built Environment, the BPS research group has been instrumental to the success of Civil Engineering achieving a top-10 position in the recent Shanghai ranking. Highly regarded colleagues from the BPS group, such as Bert Blocken, Jan Hensen, Jos Brouwers, and Wim Zeiler are among the world's top-cited researchers, closely followed by younger, well-regarded peers, such as Maarten Hornikx and Alex Rosemann, demonstrating the strong and impressive leadership within all of the six chairgroups of the BPS group.

In addition to the outstanding international standing of its leaders, the research group has managed to continuously increase its quality of research during the past years. This can be seen by the substantial

increase and success in acquiring 2nd tier and 3rd tier funding during the past six years. 2nd tier funding has grown from € 30,000 in 2010 to € 747,000 in 2015 (a factor of 25), and 3rd tier funding has increased from € 900,000 in 2010 to € 1,765,000 in 2015 (factor 2).

As a result, the scientific output has also considerably increased, as the number of total publications has risen from 156 refereed articles, books, book chapters, PhD theses, conference papers and professional publications in 2010 to 236 in 2015. Furthermore, the number of PhD students has increased from 26 in 2010 to 68 in 2015. Further indicators of the quality of the work in the BPS group are the international prizes and awards, the editorships and memberships in editorial boards, as well the patents produced by members of the group.

With its outstanding quality work, the BPS group has to be regarded as one of the top research groups on an international level.

4.1.2 Assessment of the societal relevance

The field of Building Physics and Services (BPS) covers a wide range of central aspects of human well-being, including indoor and outdoor comfort as well as health-related aspects of the built environment on a building as well as urban level. To achieve a comfortable, productive and healthy indoor and outdoor environment, resources—such as materials, energy, and water—are needed. The consumption of these resources has a tremendous impact on the environment and our eco-system, as 40% of our demand for energy and materials are related to the building sector. Furthermore, 40% of the current CO_2 emissions are related to the building sector.

This demonstrates that research in the field BPS does not only have a tremendous impact on our society in terms of a productive and sustainable living environment, but it also has a major effect on the environmental impact of our buildings and cities. The societal relevance of the research done in this field is tremendous.

As stated in the self-assessment by the BPS group, the transfer of knowledge to society is recognised through collaboration with industrial partners. This includes local, regional, national and international governments, professional organisations, as well as national and international consultancy companies. These activities are complemented by sustaining a wide, national as well as international network of professional entities, such as universities and research institutes. On a societal level, BPD research has been covered by local, national and international media, and the group has organised and participated in various professional outreach events.

4.1.3 Assessment of the viability

Considering some of the major global challenges, such as CO_2 emissions and climate change, resource depletion, and the tremendous need for healthy living conditions within cities and buildings, research in the field of BPS has a rapidly growing importance for our global society. International policies and agreements, such as the 2012 European Energy Efficiency Directive and the 2015 United Nations Conference on Climate Change, are just some of the indicators that demonstrate that the research agenda of the BPS group is directly related to these issues. The group's work on developing solutions for a low-carbon built environment is impressive.

Some of the latest publications in 2015 show that in addition to their work in established research fields, such as climate protection, the BPS group has also turned to newly established areas like climate change adaptation as a recognized field for research in the future.

The well-known and highly regarded strengths of the BPS group in the fields of building physics, lighting, materials, services, acoustics, performance modelling and material sciences has been identified in the past as a sound base for research in the field of urban climate and related issues, such as urban physics and outdoor comfort in urban environments or urban energy infrastructure. Recent publications of the BPS group on climate adaptation of cities or the role of green for creating comfort within urban environments are just some of the indicators that the group is addressing, including some of the most pressing issues related to climate-change and sustainable urban environments,

paving the way for the creation of 'Resilient Cities'. Taking this path further, this offers the chance not only for the BPS group to use the experience, knowledge, and momentum to develop its own research agenda further, but to strengthen related activities and the close collaboration with the other research groups of the Department to become even stronger for the development of solutions for the current challenges our society is facing today as well as in the near future.

4.1.4 Recommendations:

In addition to the outstanding work of the BPS group with regard to its various research activities, it is recommended:

- To develop a clear understanding of its mission with regard to addressing global challenges, such as climate change, energy supply, resource depletion, and health. This concerns all scales, such as the building as well as the urban or even regional scale.
- To develop a strategy and skills for an effective communication of this mission and its societal relevance with regard to solving the key challenges. This communication should be addressed to the Department, the university as well as to the wider public in a clear manner.
- To develop a strategy for an integrated approach for the collaboration with related groups within the Department, such as 'Living Cities', 'Design and Decision Support Systems' and others.
- To communicate how the group is collaborating with its local, national and international network to solve the key challenges we are facing as a society.
- To communicate its self-understanding of being one of the global players within its field to the scientific community and the public to attract the best people (faculty and students) as well as research funding.

4.1.5 Scores

Table 1 Scores BPS

Criterion	Score
Research quality	1
Societal relevance	1
Viability	2

4.2 Design Decision Support Systems (DDSS)

The research programme *Design and Decision Support Systems* focuses on the development of computer models of the built environment and the behaviour of people in relation to the built environment. Models of this form are developed at a number of different scales, ranging from occupant behaviour in individual buildings to the mobility and consumption behaviours of whole populations at the urban and regional scale. These models can be used to support aspects of the decision making associated with design and planning in the fields of architecture, urban planning, and transport engineering.

The research programme comprises three research groups: Urban Planning, Real Estate and Information System. These three groups have complementary substantive and methodological interests, which give each a clear identity and research focus. Although interaction between the three groups appears to have been rather limited in the past, there are current initiatives to integrate activities more closely, for example around the topic of urban energy systems and transport. We believe that interactions of this kind are potentially highly beneficial and should be encouraged and expanded in the future. The work of the programme aligns well with the overall thrust of the three departmental themes (and the Department's new Smart Cites Centre) and also with two of the

university's strategic initiatives in the area of Smart Mobility and Energy. However, we believe that these initiatives should be seen as ways of enhancing and extending rather than disrupting or transforming what is an extremely successful research culture within the programme.

Over the period 2010-15, the average annual staffing comprised approximately 65 researchers (35 FTE), which is a substantial increase from that in the previous review period. Within this overall trend, the major area of growth has been in PhD student numbers, which have increased markedly from 21 in 2010 to 38 in 2015. The programme clearly provides an attractive research environment for PhD research. Research funding has been relatively stable over the review period averaging approximately €3.7 million per year, of which an average of approximately one third is from non-1st tier sources.

4.2.1 Assessment of the quality of the Research

The outputs of the programme are principally in the form of peer reviewed journal papers, books and book chapters, conference papers, and PhD dissertations. In the academic fields in which the programme operates, the output of peer reviewed journal papers is generally regarded as the prime metric, with conference papers also being of significance. Over the review period, a total of 224 peer reviewed journal papers were produced, amounting to an average of just over 37 per year, or approximately two per member of scientific staff per year. The equivalent statistics for the production of conference papers are 93 and five respectively. By international standards, this is a very good level of productivity, and we note that it has been sustained consistently over the review period. A total of 28 PhD dissertations were completed in the review period, an average 4.5 per year, with (as is common) significant variation on a year-to-year basis. Given the scale of the programme, there is scope to increase PhD throughput. Comparison with other leading international groups suggests that a figure of 8-10 PhDs per year should be achievable, subject of course to adequate funding being available. The recent increase in the number of PhD students recruited to the programme is a welcome move in this direction but more could perhaps be done to proactively generate industrial funding for PhD students. This could form part of a wider initiative to increase the practical real-world impact of the programme's work (see further comments on this matter under S*ocietal Relevance*)

The quality of the published research is outstanding, with a substantial proportion of the journal papers appearing in top (Q1) academic journals and the conference papers are almost exclusively presented at leading international venues. Very little of the output is disseminated in low ranked/low impact journals or conferences. Papers published by the programme are widely cited in the field and some of the senior academics from the programme (such as Professors Timmermans and Arentze) are amongst the most highly citied authors in their fields. Moreover, there is substantial evidence that senior academics in the programme are held in very high esteem by their international peers. This evidence takes the form of elected leadership positions in major international scholarly organisations, invitations to participate in international technical working groups, keynote presentations, and the award of prestigious international research grants, such as an ERC grant in the area of dynamic activity based models of travel behaviour, awarded to a team headed by Professor Timmermans. More junior academics from the programme also show evidence of increasing national and international influence and esteem, for example, through positions on the editorial advisory boards of leading journals. The outstanding quality of the research is also reflected in the award of national and international prizes to PhD students; a total of 13 such awards were received during the review period.

Given the outstanding research track record and international eminence of the programme, we fully agree with the programme's SWOT analysis that more could be done to project and exploit these reputational assets locally. In particular, we believe there may be scope to actively shape the research agenda of national funding agencies such as NWO and STW. Our experience in other national contexts is that this is often actively welcomed by national funding agencies, for example, by facilitating industrial co-funding arrangements or international collaborations that would difficult for funding agencies to create for themselves.

4.2.2 Assessment of the societal relevance

The programme works in areas that are of direct relevance to major economic and societal challenges such as urban efficiency and sustainability. There is evidence of good networking and engagement with relevant professional and practice-oriented bodies, both nationally and internationally.

Although there is evidence of good industrial engagement in some activities (e.g. BIM), the focus of much of the work is on the development of models and tools for public sector planning agencies. While this provides one important route to real-world impact and hence societal relevance, planning agencies are notoriously sclerotic and strategic planning studies are in practice often used as an excuse for inaction rather than a precursor to action. Moreover, given the role played by politics in strategic planning, it is always very difficult to quantify the real impact of modelling tools on actual outcomes. It would be useful exercise for the programme to ask itself "how could we quantify and increase the practical economic impact of our work"? In this context, we believe that it would be valuable for the programme to consider extending the scope of its work so as to place greater emphasis on addressing the modelling and decision support requirements of shorter-term system management and operations, as well as strategic planning. This would be consistent with the emerging departmental focus on Smart Cities, would create new channels through which the practical impact of the work could be realised, and would open up the possibility of establishing new forms of collaboration, including greater collaboration with the ICT sector, including the Eindhoven tech cluster.

4.2.3 Assessment of the viability

There are in our view three important dimensions to the long-term viability of an academic group: the domain, the people, and the funding. In common with all successful groups, the DDSS programme faces challenges in each dimension.

The nature of the urban built environment domain is undergoing rapid transformation, both in terms of the deployment and use of new technologies and the geographical focus of activities, which is increasingly shifting from the West to the rapidly developing economies of the Far East, the Middle East and sub-Saharan Africa. The programme shows excellent awareness of these trends and has been taking steps to respond, for example, by actively developing collaborations with various Chinese universities and other organisations. We believe that the programme is therefore well placed to respond to this dimension of the challenge.

A number of senior academics in the programme are nearing retirement age and hence the programme faces significant challenges of succession planning. This has, however, been fully recognised and has been addressed by the programme making a number of new appointments and by the active development of leadership skills in younger staff, such as the role of Dr Rasouli in promoting the programme in the Far East. We believe that the programme is also well placed to respond to this challenge.

The academic research funding environment is inherently uncertain and in these circumstances, it is prudent for groups to aim at a highly diversified funding base. The programme is clearly adept at managing its existing eco-system of (non-1st tier) funders but further growth and development (e.g. through further expansion in PhD numbers) will require new funding streams. Geographical diversification may achieve some of this but is unlikely to be enough by itself. As we have pointed out above, the programme has the potential to develop in new directions that would liberate new funding streams. We strongly encourage the programme to embrace this mission. The greatest threat is complacency.

4.2.4 Recommendations

The key recommendations can be summarised as follows:

- Enhance and extend existing and emerging collaborative links between the three research groups that comprise the programme and between the programme and wider departmental and University initiatives.

- Further expand the PhD programme so as to achieve a stable annual graduation of 10 PhDs.
- Develop a strategy for more active and strategic engagement with key 2nd tier funders, specifically to shape the emerging research agenda of these organisations.
- Make practical impact (including *financial* impact) a more visible and significant criterion in the design and management of research projects.
- Consider gradually broadening the focus of the programme's work to include greater emphasis on short term systems operations and management.
- Focus greater effort on cultivating strategic links to local and global industry (as collaborators and 3rd tier funders), especially around the Smart Cities domain.

4.2.5 Scores

Table 2 Scores DDSS

Criterion	Score
Research quality	1
Societal relevance	2
Viability	1

4.3 Living Cities (LC)

Within 'Architectural Urban Design and Engineering' (AUDE), the Living Cities Program brings together the broad spectrum of research projects from the chairs of Architectural History and Theory (AHT), Architectural Design and Engineering (ADE), Rational Architecture (RA), and Urbanism and Urban Architecture (UUA) thus combining a broad range of specific perspectives, expertise, and methods.

Within AUDE's Living Cities program, the city and its architecture are interpreted as an evolutionary and integrated process of urbanisation driven by various socio-economic, technological, environmental, and historical processes determining each other reciprocally and dynamically.

Aligned with the Department's strategic research agenda on Sustainable Transformation, the program focuses on exploring and understanding the development of the city and its architecture for reuse, adaptation, and new interventions in response to shifting societal challenges. The focus is on the spatial development of the city and its architectural fabric, especially on the production of new theories, concepts, strategies and models dealing with the paradigm shifts in urban economy, technology, ecology, society and governance.

As they write themselves, "The Living Cities Program seeks to contribute to discourses and design practices by exploring in its research heterogeneous actors, elements and perspectives that are inseparably contributing to redefine architecture and urbanism":

- Multi-disciplinary: to develop an integrated and comprehensive approach to architectural and urban practices and scholarship (fundamental and applied);
- Cross-scalar, integral and temporal: to increase insight and knowledge on architecture, cities, and their evolution (fundamental and applied) by exploring their constitutive practices, spatial coherence across various scales, societal goals, and temporal perspectives;
- Bridging discourse and practice using both qualitative and quantitative research methods: to develop and evaluate possible contributions for sustainable architectural and urban development through. This could be done by strategically focused thematic clusters, using case studies and living labs to bridge fundamental and applied research on artefacts, processes and practices

combining research methods from the social sciences (history and urban studies) as well as methods of design research from the spatial sciences (geography, urbanism and architecture).

Finally, the Living Cities Program strategic research agenda is focused on specific thematic clusters aligned with the research themes of the university as well as national and European research agencies, namely: (i) Cultural Heritage, (ii) Sustainability and Circular Cities, (iii) Active Mobility and Health, (iv) Smart Cities and Buildings, and (v) Emerging Materials and Building Technologies.

4.3.1 Assessment of the quality of the research

As is common in all assessments, to assess the quality of the research within AUDE's Living Cities program, one needs to take into consideration what the disciplines specific tradition is in gathering and developing disciplinary knowledge and what their specific methods and benchmarking parameters are. In the case of the Living Cities programme, we are mainly dealing with the discipline of spatial design, which like most designing disciplines, has developed its own specific parameters over a long period.

However, since the Bologna Process, we can see in most European technical universities a trend towards a more technocratically oriented form of benchmarking in terms of numbers of PhDs, publications in peer reviewed publications, second and third tier funding, etc. In other words, benchmarking parameters only cover a very limited part of how a discipline actually develops its own body of knowledge.

In the last years, this has unfortunately also led to most technical universities preferring research over teaching, so much so that the EU Report on Modernisation of Education already in 2013 stipulated "that the preference of research over teaching in defining academic merit needs rebalancing".[1] This should be taken seriously, since this seems to apply in the designing disciplines in which teaching is very time consuming, such as with AUDE.

The core of education and research in the designing disciplines is an extremely complex practice of design, which is traditionally taught by reputed practicing designers, who also ensure an important proximity to actual design practise. It is their core business to educate architects/urbanists to think criticially and not so much to educate students to become pure academics.

Design research is rooted in practice and normally develops its research questions, methods, and formulated reflexions on the design problem out of this epistemic practice. The results of such a design process (in terms of drawings, buildings, artefacts, writings, etc.) should be considered as research results and can be seen in relation to theoretical models at a higher level, complex spatial conceptualisations, and societal challenges and problems.

As such one would prefer that the results of this design research, which normally fall outside of regular academic benchmarking parameters (like designs, artefacts, and realised buildings that add something to the body of knowledge of architecture), should also be incorporated in a research assessment.

Furthermore, one should take into account that holding a PhD is uncommon among reputed architectural practitioners. To illustrate this, one can look at the Pritzker Price in Architecture (the equivalent of receiving a Nobel Prize in the Sciences), which up to now has 39 laureates, none of whom holds a PhD. Also most of the famous foreign Architecture Schools (like Harvard's GSD, MIT, ETH etc.) do not require a PhD for their appointment of tenured Professors in Practice, since they know that they have to be reputed practicing architects to be able to do their job.

One other aspect that needs to be taken into account is that so-called peer reviewed publications spatial design are very scarce. At the same time, publications that feature the products of spatial designers, their design research (in form of designs, artefacts and realised buildings that add something to the body of knowledge of architecture) are plentiful, but not (yet) recognised as a

[1] http://ec.europa.eu/education/library/reports/modernisation_en.pdf

significant parameter of design research. Also second and third tier funding is extremely difficult to come by because a design mostly fails to fit the parameters of the funding institutions or is in danger of illegaly competing with the work of regular practitioners.

In view of all this, one can say that the research competence and quality of the Living City program has been substantially expanded since the last assessment. The quality of the program's output and the academic reputation of its research staff, as well as the acquired research portfolio, attests to this. It resulted in a significant increase in academic output between 2010-2015:

Table 3 Overview output LC

Parameter	Total amount	Average increase output/year
Phd's	12	10%
Refereed Publications	50	5%
Non-Refereed Publications	20	1%
Academic Books and Monographs	20	2%
Academic Book Chapters	40	6%
Professional Publications	204	2%
Professional Books and Reports	55	4%
Professional Book Chapters	36	3%
Awards and Prizes	48	4%
Invited Keynotes	104	7%
Exhibitions	33	12%

This is even more significant if we take into account that the AUDE unit still has a relatively small group of academic staff and that within the faculty, the AUDE unit carries the largest share of teaching load.

The academic reputation of the staff is high as proven by the key roles and crucial positions they hold. The last three years also show a significant increase in acquisition of second and third tier research projects associated with PhD positions (NWO, Impulse 1, Impulse 2, UNESCO).

4.3.2 Assessment of the societal relevance

The Living Cities Program researchers have developed strong ties with practitioners, government, and society. Their knowledge and expertise is highly valued by a variety of boards, as are their contributions to public debate, policymaking on architectural and urbanist issues, and projects. Several academic staff members have long-time experience serving as architects or urbanists. They are regarded to be experts in their respective fields. Two of the full professors have leading practices: Prof. Juliette Bekkering at Bekkering Adams and Prof. Christian Rapp at Rapp & Rapp, Stadsbouwmeester Antwerpen. In addition, two part-time professors with design practices of international acclaim have been appointed in 2016, Prof. Paul Diederen (Diederen Dirrix) and Prof. David Gianotten (Office for Metropolitan Architecture). Further members of the academic staff also frequently play a role in various public debates, the media or events on architecture, urbanism, and planning.

The research platforms of the Bauhütte, Protected Urban Planet, and the Urban lab, deal with more policy and practice-oriented research, they as such represent another approach towards exchanging knowledge between academia and practice. The last years further show an increase in the number of projects within the respective thematic clusters, and an expansion of stake- and shareholders shaping the debate of how technology, design and planning meet administration, business, and society.

4.3.3 *Assessment of the viability*

The Living Cities research program conducts relevant and internationally recognised research, but should use its thematic position in the centre of the national Top Sector and the universities strategic themes to strengthen its viability further. The thematic foci of the programme are in line with national and international research and policy agendas, implying that opportunities for continued and additional funding are feasible. Their research areas are (i) Cultural Heritage, (ii) Sustainability and Circular Cities, (iii) Active Mobility and Health, (iv) Smart Cities and Buildings, and (v) Emerging Materials and Building Technologies are central to key challenges that current (and future) societies face. They should however increase their obvious (and necessary) link to and claim their (leadership) role in the Smart Cities initiative.

The fact that architecture and urbanism are not on the agendas of major funding organisations makes financing research through personal grants and PhD projects more complex. This further makes it very hard for the Living City unit to develop a human resource policy for their research staff to grow to the positions of Associated or Full Professorship, thus meeting the standard criteria of academic institutions. In that respect, it seems to be promising that both the university as well as the Department supports the current assessment of design output as part of this research assessment. This could be a meaningful contribution to overcome these traditional institutional perceptions, definitions, and procedures coming from other disciplines.

4.3.4 *Recommendations*

- Living Cities is the research group with the broadest scope and as such the committee recommend to regard Design more as a unifying activity that can also be assessed as research, so develop a strategy for an integrated approach and collaboration with related research groups.
- Further we recommend to regard the outcome of research by design not purely as a product that solves a specific design problem, but one that also generates new and/or further research questions that might be disseminated to the other research programmes.

Moreover, the recommendations for DABE are also applicable for the LC programme (see paragraph 4.5)

4.3.5 *Scores*

Table 4 Scores LS

Criterion	Score
Research quality	2
Societal relevance	1
Viability	2

4.4 Structural Design (SD)

The Structural Design (SD) research programme is composed of three chairs, Innovative Structural Design (ISD), Applied Mechanics and Design (AMD) and Material-related Structural Design (MSD), covering a wide spectrum of structural engineering research from structural design, material-specific structural engineering and mechanics, and modelling of materials, ranging from fundamental research to the development of systems. The programme was presented to have as a strategy of “design complexity”, addressing energy efficiency, sustainability, durability, retrofitting, safety and optimisation, and “research for design”.

4.4.1 *Assessment of the quality of the research*

The programme has a good publishing record, of which a large percentage (almost two-thirds) is in ISI journals. The impressive civil engineering ranking and national (student) prizes indicate that the

outcome of the programme is of high quality. Furthermore, the group makes active contributions to most committees of the Eurocodes. The group is reasonably visible internationally, having recently increased its reputation through initiatives like the realisation of a new large-scale concrete 3D printer.

A shift to more fundamental material and mechanical research has led to more research publications, which raises the overall output, but some of the programme's central topics—such as the more design-oriented, use-inspired research—should be disseminatated in more channels, and not necessarily just in ISI publications. Several convincing physical demonstrators and prototypes have recently been built, such as the ice dome, eco-materials bridge, and a 3D-printed concrete pavilion, which represent a very effective form of research output, significantly adding to the unit's visibility and recognition.

4.4.2 Assessment of the societal relevance

Structural engineering is an unavoidable field for the building/construction industry, but is not an unavoidable area of research. It will become increasingly important for SD to develop a clear vision, attitude, and strategy to make sure the field stays relevant. It can even instigate paradigm shifts for the design, material and construction processes of the future. The directions identified as an opportunity, connected to strategic new hires (e.g. of the three new chairs) have the potential to do exactly that.

The programme could be more (pro-)active in sharing their accomplishments and impact. As identified in the self-assessment, efforts in PR are needed. This should go beyond increasing media coverage. More importantly, it demands a clear statement of the unit's vision and strategy for each sub-group. A new website is overdue.

It is recommended to consider the establishment of a PDEng in Structural Engineering and Design. Such a program seems to be potentially very appropriate and relevant for SD. Very close ties to industry would allow an intensification of the contact, visibility and impacts with and in practice, and represent an additional effective vehicle to transfer knowledge and technology, and thus societal relevance.

4.4.3 Assessment of the viability

It has to be commended that the SD programme does not just cover the classical/traditional fields in structural engineering, such as concrete, steel and timber research, but addresses important challenges at multiple scales and in newer fields of application, but also supports sustainable technologies. Through this, the programme aims to stay viable.

In the Department, SD interacts well with other units and also has influence and makes contributions to design studios, which not only ensures that new research can be introduced early in design teaching, but also allows emerging needs to be spotted.

Mechanisms have been put in place to support younger faculty to prepare applications for necessary second and third party funding by temporarily reducing teaching responsibilities. Such efforts should be continued in order to allow a new generation of researchers to establish their own research agendas and thus increase high-quality capacity to the research programme.

There was a strong focus on arguing that this unit does "research for design". A careful reflection on what that really means for each sub-group is recommended. Fundamental research that feeds, refines, extends, and improves codes and norms is different than research that impacts or even influences the design process. Is this field just reactive and service providing or can it have a more profound impact? The unit's name "structural design" does not reflect its broad research and has a different connotation in English, which is confusing for an outsider, particularly when this is a programme in a department of "Built Environment". Specifically, the term "Engineering" is missing.

4.4.4 Recommendations

In summary, the Structural Design research programme stands for high quality of research and impact. Recommendation for further improvement are:

- The SD programme should try to extend their publishing record from fundamental areas to more design-oriented fields. Demonstrating research through doing, i.e. the research prototypes, is very effective and relevant. It should be argued that such dissemination is equally important, if not more, than ISI journal publications. More efforts in clearly communicating the bigger-picture vision and strategies is recommended.
- The SD programme should start a discussion on how "research for design" is filled in by all chairs and sub-groups.

4.4.5 Scores

Table 5 Scores SD

Criterion	Score
Research quality	1
Societal relevance	2
Viability	2

4.5 Design Artefact for the Built Environment (DABE)

DABE was a new element in the peer review committee agenda, introduced at the request of the university because of the central role in the school played by studio-based design. It is not a "research program" per se, but a broad range of design work from final year MSc projects, design laboratories (student group projects for external clients, sometimes leading to implemented schemes) and examples of built professional projects by leading members of the design teaching staff. A short account of this work was provided and illustrated in the Research Self-Assessment document. A much more extensive and detailed presentation of both designs and built schemes was presented in an Appendix to the Research Self-Assessment covering the period 2010-15. The poster exhibition gave the committee an opportunity to discuss the work of final year MSc students, as well as that of current PhD candidates and recent PhD graduates.

Unlike the Department's four established research programs, the DABE material was not supported by the statistical summaries that would allow the committee to assess research progress over the review period. However, there was a strong overlap between the staff whose research is reported under the Living Cities program and those delivering or supervising design work presented under DABE. Thus many of the committee's remarks directed at the Living Cities research program apply equally to DABE, and vice versa. The DABE numerical assessments should also be read in this context and with this note of reservation in mind. More important, perhaps, is the committee's response to the presentation of design in a research review and the questions this poses about the contribution design can make to a research-intensive department and the knowledge-based professions it serves.

4.5.1 Assessment of Quality of the design artefacts

It was clear from the evidence of major awards and critical attention gleaned that professional designs from senior departmental staff achieved external recognition at the highest international level (see also the remarks under Living Cities). Some Design Laboratory projects had been implemented (see also below under Societal Relevance). The great majority of the DABE material, however, was drawn from final year MSc projects (mostly in Architecture). These were loosely grouped under a number of pedagogical topics: (a) morphological studies, (b) application of classical grammar, (c) sustainability, (d) infrastructure and (e) socially inclusive programming. We must be careful here not to allow what is primarily a research review to open a discussion on professional training. These topics together represent a typical spectrum of design activity in modern schools of architecture (although there were notable gaps, such as digital architecture). This said, our examination of the highly competent work presented in the Appendix and the poster exhibition, persuaded us that:

1. The DABE projects are (in many different ways) designs based on research;
2. Together they meet the listed Netherlands criteria for Design as Research;
3. Many of them serve effectively as launch pads for subsequent PhD level research.

Collectively they demonstrated considerable quality, creativity, and vitality in a rich variety of investigations. Across the full range of the inspected projects, it was also clear that all of the key research themes of the university and the Department were addressed.

4.5.2 Assessment of the societal Relevance

The DABE self-assessment asserted an agenda-generating role for present and future development in the built environment consistent with the broad MSc pedagogical topics (above, a-e). This was substantiated with examples of group design laboratory projects which had delivered, *inter alia*, a bridge over a small river in the campus and, at quite another scale, a Campus Master Plan which is continuously updated and which now forms a working template for the university's development. A rural landscape group project was funded by the Noord-Brabant province (although not finally implemented). A number of the MSc and PhD projects also demonstrated public engagement, which in a few cases prompted collaboration and subsequent funding from public bodies (such as the municipality of Amsterdam). It would be a mistake, however, to judge relevance only by evidence of such immediate impact. We need to remind ourselves that most of the Eindhoven MSc Architecture graduates will go into professional practice (and these days probably also into the construction industry and property development) and will deliver impact many years from now.

4.5.3 Assessment of the viability

DABE, in all of its variety, is at the core of any architecture, planning or engineering department. Thus the fundamental viability of the sub-field turns on society's continuing need for highly-trained professionals and their recruitment. Within the context of a Technical University, however, the SWOT analysis for DABE (together with that of the Living Cities program) sees its staff handicapped by difficulties in securing funding for PhD posts, shortage of design staff PhDs, and a generalised lack of credibility when compared with "traditional" research fields. The committee felt that this concern was exaggerated (see also remarks under the Living Cities program). The number of PhD-qualified design staff is currently about 30% but this figure has grown rapidly in recent years and can be expected to continue to grow, progressively closing the perceived skills-gap between design staff and those from conventional (i.e. non-design) academic backgrounds. For some recent MSc graduates, moreover, a career in research has already beckoned. The committee saw examples of PhD work in progress or recently completed which clearly grew out of MSc projects. Although today there are financial constraints on PhD admissions (seen as employment in the Netherlands), the committee was told that the university had recently introduced a PdEng degree, a two-year professional doctorate involving one year in the University and a second in research-focused practice. The degree is aimed at those who wish to combine further academic work while retaining a foot in practice. The PdEng can also be used as a stepping stone to a PhD. This university initiative may offer a route into research for some of the MSc graduates as well as for some of the many part-time design teachers who may wish to develop an academic career.

4.5.4 Recommendations

- Ensure that the centrality of design (both architectural and engineering based) is retained as a central feature of the Department's broad academic program.
- Amongst the staff teaching design, ensure that a balance is maintained between those holding full-time academic appointments and the part-time staff who contribute so heavily to the professional credibility of the teaching program.
- Continuing efforts to raise standards and to support the career development of staff (both full-time and part-time) should not focus entirely on PhD-qualifications. Healthy progress has been achieved at PhD-level in recent years, but the potential for the newly-introduced PDEng should

not be overlooked and the potential for what the Americans call “reflective practice” is very considerable.

- If DABE is to be included in future Peer Reviews, we recommend that a clear distinction be drawn between (1) the work of research staff (which was recorded in 2016 under Living Cities) and (2) that of MSc students and participants in Design Labs. A narrative report might prove potentially more useful than a marking scale devised for fully-formed research groups of staff and PhD candidates.

4.5.5 Scores

Table 6 Scores DABE

Criterion	Score
Research quality	2
Societal relevance	2
Viability	2

Appendix A Curriculum Vitae committee members

Gerhard Schmitt is Professor for Information Architecture at ETH Zurich and Senior Vice President ETH Global. He is the Founding Director of the Singapore-ETH Center and leads the Responsive Cities Scenario in the Future Cities Laboratory in Singapore and Zurich. His research focuses on urban simulation, Smart Cities and linking Big Data with urban design. He and his team developed and taught a first Massive Open Online Course series on Future Cities. He pursued Computer Aided Architectural Design (CAAD) research and teaching at Carnegie Mellon University from 1984 to 1988. He was Visiting Professor at the Katholieke Universiteit Leuven, Belgium, at the Technical University of Denmark in Lyngby, at the Technical University of Delft, and at the Harvard Graduate School of Design where he chaired the Visiting Committee from 2004-2007. He holds a Dipl.-Ing. and a Dr-Ing. degree of the Technical University of Munich, TUM, and a Master of Architecture degree from the University of California, Berkeley. Gerhard Schmitt and his team initiated and conceptualized the virtual Campus ETH World in 2000 and the sustainable ETH Science City Campus in 2004. He received for this work the 2010 European Culture of Science award.

Wim van den Bergh is a practicing architect, a scholar and a teacher. He studied building engineering and architecture at Eindhoven Univeristy (NL). As an architect next to other awards he received the Gold Medal of the 'Prix de Rome for Architecture' in 1986 and his designs have been published and exhibited widely. Between 1988-93 he was Diploma Unit Master at the Architectural Association School of Architecture in London, in 1992/94/97 he was Carnegi/Mellon Professor at the Cooper Union in New York and as a guest Professor he was active in Denmark, Finland, Germany and Switzerland. From 1993 to 2002 he was the head of the Academy of Architecture in Maastricht, from 1996-99 he was Professor for architectural design at Delft University and from 1997-2001 also at Eindhoven University. From 2001-2006 he was guest Professor at the Mackintosh School of Architecture in Glasgow. Since 2001 he is full time Professor at RWTH Aachen University (D), where he holds the chair for Housing and Design.

Philippe Block is Associate Professor at the Institute of Technology in Architecture at ETH Zurich, where he directs the Block Research Group (BRG) together with Dr. Tom Van Mele. The BRG focuses on equilibrium analysis, computational form finding, optimisation and fabrication of curved surface structures, specialising in unreinforced masonry vaults and thin concrete shells. Within the Swiss National Centre of Competence in Research (NCCR) - Digital Fabrication, the BRG develops innovative structural design strategies using bespoke prefabrication. Block studied architecture and structural engineering at the VUB, Belgium, and at MIT, USA, where he earned his PhD in 2009. With the BRG and as partner of Ochsendorf DeJong & Block (ODB Engineering), he applies his research into practice on the structural assessment of historic monuments and the design and engineering of novel compression structures. He has won numerous awards for his research, has lectured at top universities and leading engineering and architecture offices worldwide, and is regularly invited as an expert consultant and reviewer.

Werner Lang is Professor for Energy-Efficient and Sustainable Design and Building at the Technical University Munich (TUM). He is a joint appointment of the Department of Civil, Geo and Environmental Engineering and the Department of Architecture at TUM. Furthermore, he is coordinator of the interdisciplinary Centre for Sustainable Building and the trans-disciplinary Centre for Urban Ecology and Climate Adaptation at TUM. His focus in research is on resource-efficient building design, life-cycle assessment, circular economy and the impact of the built environment on our ecosystem. Prior to his appointment at TUM he had been Associate Professor for Sustainable Design and Director of the Centre for Sustainable Development at the University of Texas at Austin School of Architecture. He holds a Dipl.-Ing. and Dr-Ing. degree of the Technical University of Munich and a Master of Architecture (M.Arch.II) degree of the University of California at Los Angeles. In addition to his professorship at TUM, he is the Director of the Oskar von Miller Forum in Munich, and co-director of the architectural firm Lang Hugger Rampp GmbH Architects.

Simon Pepper is Emeritus Professor of Architecture at the School of Architecture, University of Liverpool. He trained as an architect at the AA School, London, and took his PhD (1972) in Renaissance Italian architectural history at Essex University under Joseph Rykwert. His research also includes the history of 20th century British social housing and planning. He was Head of the Liverpool School (1990-96 and 2000-05), and has served on numerous professional and educational bodies including the Architecture panel for the UK national Research Asssessment Exercise (2008) and the Research Excellence Framework (2014). He has held teaching and research posts at the AA, the University of Virginia, and the University of Minnesota as well as working in architectural private practice and in a central government housing policy division (DoE).

John Polak is Professor of Transport Demand and Director of the Urban Systems Laboratory, Imperial College London. Prior to establishing the Urban Systems Laboratory in 2016, he was Director of the Centre for Transport Studies and Director of Research in the Department of Civil and Environmental Engineering at Imperial. Professor Polak is a mathematician by background specialising in transport modelling and analysis. He is a member of the Mayor of London's Smart London Board, and a Member of the UK Department for Transport's Strategic Roads Reform Expert Group. He is a past President of the International Association for Travel Behaviour Research and serves on the editorial advisory boards of a number of leading international journals. He has served as an advisor to central and local government and industry on a wide range of transport issues, both in the UK and overseas.

Appendix B Programme site visit

B.1 Programme site visit

The site visit at the Department of the Built Environment (Eindhoven University of Technology) will took place from the afternoon on Wednesday 2 November, Thursday 3 November whole day, and the morning of Friday 4 November 2016.

Wednesday 2 November 2016

15:00-16:00	Arrival and hotel
16:00-18:30	Presentation by Frank Zuijdam & Acquaintance commission and working mode
19:00	Dinner with Dean and senior staff of Department of the Built Environment

Thursday 3 November 2016

8:00-9:00	Breakfast meeting with the Board of the Department and Rector Magnificus TU/e

Presentations by the coordinators of the four research programs

9:00-10:15	Presentation & questions DABE
10:15-10:30	Coffee break
10:45-12:15	Presentation & questions BPS
12:15-13:45	Presentation & questions SD
13:45-15:15	Research projects (PhD posters) and Design presentation during walking lunch meeting
15:15-16:45	Presentations & questions LC
16:45-18:15	Presentations & questions DDSS

Dinner

19:00	Dinner and internal deliberation of the assessment committee and concept report writing

Friday 4 November 2016

9:00-12:00	Breakfast meeting committee – finalising report writing
12:30-13.30	First feedback by the assessment committee to Dean and Rector with lunch
13:30	Presentation of outcomes for the board, research coordinators and other interested staff of the Department of the Built Environment

Appendix C Criteria and scores Standard Evaluation Protocol

C.1 Criteria

The Standard Evaluation Protocol contains the following criteria:

- **Research quality**: The committee assesses the quality of the unit's research and the contribution that research makes to the body of scientific knowledge. The committee also assesses the scale of the unit's research results (scientific publications, instruments and infrastructure developed by the unit, and other contributions to science).
- **Relevance to society**: The committee assesses the quality, scale and relevance of contributions targeting specific economic, social or cultural target groups, of advisory reports for policy, of contributions to public debates, and so on. The point is to assess contributions in areas that the research unit has itself designated as target areas.
- **Viability**: The committee assesses the strategy that the research unit intends to pursue in the years ahead and the extent to which it is capable of meeting its targets in research and society during this period. It also considers the governance and leadership skills of the research unit's management.
- **PhD programmes**: The assessment committee considers the supervision and instruction of PhD candidates. The relevant subjects include the institutional context of the PhD programmes, the selection and admission procedures, the programme content and structure, supervision and the effectiveness of the programme plans and supervision plans, quality assurance, guidance of PhD candidates to the job market, duration, success rate, exit numbers, and career prospects.
- **Research integrity**: The assessment committee considers the research unit's policy on research integrity and the way in which violations of such integrity are prevented. It is interested in how the unit deals with research data, data management and integrity, and in the extent to which an independent and critical pursuit of science is made possible within the unit.

C.2 Scores

The assessment has to match the following scores.

Table 7 Overview scores SEP

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