Pilot Study at Faculty of Architecture TU Delft

Final report - confidential

Barend van der Meulen

Floortje Daemen

Leonie van Drooge

Stefan de Jong

Jack Spaapen

Frank Wamelink

Peter van den Besselaar

Rathenau Instituut

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ERiC publication 1002

March 2010

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Executive summary

The vice chancellor of Delft University of Technology, Prof.dr.ir. J. Fokkema, introduced a pilot Evaluating Research in Context (ERiC[1]) at the Faculty of Architecture. The Faculty of Architecture perceives a serious conflict between the demands and criteria in evaluation procedures and the ambition to be relevant for the practice of architecture, planning and building. The goal of this ERiC pilot is to develop an evaluation method that judges research in the Faculty of Architecture on all its merits and takes into account the specific characteristics of architecture research. A second goal is the improvement of the evaluation of research contributions to society. This report presents the full results of this project and gives recommendations how to use these results in an evaluation according to the Standard Evaluation Protocol 2009-2015.

Interviews and workshops with faculty staff have resulted in a set of seven dimensions of quality of architectural research and related indicators. These are listed in Table 1 and can be used in the context of a SEP evaluation.

These dimensions and indicators have been tested for two research programs of the faculty: “Housing” and “Randstad Centre for Strategic Spatial Planning and Design”. Performance data have been collected from the last mid term evaluation report and from the program proposals from late 2009. The continuous rearrangement of research at the faculty in new research programmes, however, has made it difficult, if not impossible, to relate past research performances to the new programmes. As a result, if we take the test result as indicative for the possibility to present the specific strength and weaknesses of architecture research at the TUD to a peer committee, it will be difficult for the peer committee to assess the research programs. The proposals provide more information about the future than the past, while the indicators - and the current SEP protocol - concern past performances.

Are publications in ISI journals a good indicator for research quality in architecture? In addition to developing the notion of research quality in a set of dimensions and indicators, we made an analysis of the scientific publication patterns for nine architecture departments. The study shows that there is no stable publication pattern nor a core set of scientific journals to make a valid bibliometric benchmarking of architectural departments. Only a small sample of scientific journals is covered by ISI databases. The publication presence of Delft in these journals is somewhat lower than the presence of Cambridge and MIT, comparable to that of Sheffield and higher than the other four. Results have not been controlled for the size of the respective Faculties. Although these data can be included in an evaluation report, clearly for an assessment of the research quality of the programs, information about program, other scientific outputs and good peer assessment will be required and are of more value.

Are there any additional indicators for research quality that can be used systematically in evaluations? Collaborations with stakeholders increase the likelihood that research is of relevance for society and will have an impact upon architecture related policies and practices. We have distinguished four types of colla-borations, which can be used to present evidence about contract research and collaborations with stake-holders and allow an assessment of the intensity of the collaboration.

1 Results of the ERiC pilot will be used to improve the regular university research audits organised according to the national Standard Evaluation Protocol (SEP). The ERiC pilot is part of the joint ERiC initiative of the KNAW, NWO, VSNU, QANU and the HBO Raad. The ERiC program includes a range of pilots in different fields of research, at different universities to improve the evaluation of scientific research and develop methods for evaluation of societal relevance of research.

Moreover, a wide range of possible outputs in addition to scientific publications has been presented and discussed in interviews with faculty staff. The perceived importance of these outputs for the dissemination of results is in contrast with the data we were able to collect. We could list professional publications. However we did not find much evidence of professional training activities, consultancy, artefacts, standards, which were considered to be important outputs.

Finally, we checked whether it is useful to interview stakeholders and include their perception of the value of research programs of the faculty. For two programs, the main stakeholders have been identified by the program leaders. We interviewed some of these stakeholders about their appreciation of the research program. These stakeholder interviews are a valuable source of information as evidence on several dimensions of research quality. Stakeholders have clear opinions about research programmes and provide interesting information on the interactions with the researchers. But we also noticed stakeholders regularly perceive that they are stakeholder of the programme leader, not of the research programme. Some researchers have a similar perception: they sometimes perceive their personal contacts as stakeholders of the whole program they are part of. In some cases, contacts with these stakeholders concern projects not directly related to the current research program. As a result, one should be cautious to use interviews with stakeholders to map the value of research programs in architecture for architectural practices.

Table 1 Dimensions of quality of architectural research

Dimension	Indicator / evidence
Scientific Quality	As defined in SEP: Quality and scientific relevance of the research: Originality of the ideas and the research approach Significance of the contribution to the field Coherence of the programme Quality of the scientific publications
Scientific Production	Articles in refereed journals or journals with a clear editorial strategy to select on academic quality Book chapters presenting new work (mostly subjected to editorial scrutiny) Books, monographs, catalogues Conference papers Edited volumes of conference proceedings Major reviews of literature or of exhibitions PhD Theses
Scientific Recognition	Visibility in the scientific community Editorships journals/international books or 'service to journals' Election to academies or academic professional associations Prices and awards, honorary positions Invited lectures, international conferences
Responsiveness of agenda setting	Societal concerns and issues are explicitly addressed in the research design/programme Interaction with stakeholders to establish relevance, ranging from occasionally to full dialogue Relevant recent experience of researchers as a practitioner in societal domain/ practice/government Positive evaluations or external funding related to societal/commercial issues
Collaboration with (potential) users	Commissioned research by societal actors Earmarked/structural funding related to societal theme Actual collaboration in research, testing, evaluation with stakeholders Establishment of consortia including non-academic organizations
Dissemination and knowledge transfer related to the mission	Production of texts/professional publications/non scientific publications/exhibitions Dissemination of technology/artefacts/standards Advisory and consultancy roles Popularization/education/contributions to societal debate Training of professionals/mobility/master theses
Actual results, impact and use of research	Convincing examples of use of outcomes of research Satisfaction/recognition of alumni and stakeholders Substantial returns or economic value of outputs of research Visibility in the public debate/media rankings

Recommendations

The Faculty of Architecture (and the university) is strongly recommended to make a firm decision about the unit of evaluation it wants to present in the next SEP evaluation, and the aims of that evaluation. If it wants to use the current research programs as units of evaluation, and wants the peer committee to assess the quality of these programs, it has to make a considerable effort to show how these new programs are based upon existing strengths in the faculty. This requires systematic data collection and analysis of past performances and attribution of these data to the new programs. If such a connection cannot be made, the faculty should either ask the peer committee to assess past programs, or concentrate on the viability and relevance of the new programs. Any further preparation of the SEP evaluation needs to be guided by a decision on this point.

The Faculty is also recommended to assess the possibility to collect data on the non-scientific outputs such as professional publications, training activities, consultancies, standards, artefacts. If the faculty considers such outputs as indicative performances related to its mission, it should take the collection and monitoring of such performances as a crucial part of its research management. There is a long time experience with collecting evaluation data at universities. From that experience we know that if databases are not regularly updated, a considerable effort and commitment of all faculty members is needed to collect such data. As such outputs are of importance to build reputation and recognition; we expect that individual faculty members have listed them in their curriculum vitae.

The Faculty seems to be well embedded in practices and policies such as architecture, housing and urban planning. Faculty staff is related to a wide range of stakeholders. The faculty is strongly recommended to exploit this strength in the SEP evaluation and use the self evaluation to systematically map existing inter-actions and collaborations with stakeholders and stakeholder appreciation of the research programs. Instead of interviewing a limited sample of stakeholders, the faculty may consider to collect stakeholder information through questionnaires. In addition, the university is recommended to consider the possibility to include experts from architecture practices in the evaluation committee and to organize a meeting between the evaluation committee and stakeholders as part of the site visit.

The formulation of ´Research by Design´ as a specific research approach appropriate for architecture is a major step into developing a research management approach for the Faculty. Next steps include the formulation of program missions and objectives in terms of this notion and related research activities, outputs, performances and stakeholder relationships. The four types of research we have distinguished in the conceptual phase can be taken as a reference for this exercise.

Furthermore, both at the level of research programs and at faculty level appropriate management instruments need to be developed to stimulate the quality of architecture research. A full analysis of the possibilities goes beyond the current study, but our results suggest that there are opportunities to stimulate and improve the publication of results of research within the scientific domain, to appreciate and reward stakeholder interactions, collaboration and appreciation and develop ambitious goals in terms of impacts on architecture related policies and practices. This is not just an exercise for the SEP evaluation, but one that needs a long term commitment of the faculty and program leaders.

A related issue is the socalled BTA model which the TU Delft uses to allocate funding to its faculties and is based on the output performances of faculties. Considering the current output profile of the faculty, this BTA model is not in favour of the faculty. Whether this will change if the BTA includes other outputs is uncertain, as it is unclear whether the Faculty performs significantly better in these other outputs than the other TUD faculties. However, if the BTA model aims to stimulate research performance at the university, broadening the kind of outputs may considerably help the faculty to develop a research management appropriate for architecture research.
In addition, it will make clear that research activities of faculty members may fit within the universities objective to find solutions society's present and future demands.

1 Introduction

The vice chancellor of Delft University of Technology, Prof.dr.ir. J. Fokkema, introduced a pilot Evaluating Research in Context (ERiC[2]) at the Faculty of Architecture. The Faculty of Architecture perceives a serious conflict between the demands and criteria in evaluation procedures and the ambition to be relevant for the practice of architecture, planning and building. According to the faculty, these conflicts arise in the current national evaluation system for publicly funded research[3] as well as in NWO procedures for project proposals. The faculty claims that research hasn't been judged on all its merits and that specific characteristics are not included in evaluations. The goal of the ERiC pilot is to develop an evaluation method that judges research in the faculty of architecture on all its merits and takes into account the specific characteristics of architecture research. A second goal is the improvement of the evaluation of research contributions to society. The new Standard Evaluation Protocol (SEP 2009-2015) requires explicitly the evaluation of societal relevance, however there no specific guidelines are given.

Witness the last midterm evaluation, where the external evaluation committee (note: not demanded by the SEP, midterm is supposed to be a light procedure) emphasized the so-called scientific criteria over field specific criteria. The committee concluded not unexpectedly that the research outputs should be brought more in line with the national and international scientific standards. At the same time, the committee noticed that the research culture of Architecture, which they characterized as "the refusal or inability to adjust to accepted scientific standards, and the inexperience in submitting applications to research councils and the like" were part of the explanation of the perceived lack of scientific standards (QANU, 2007, p. 12). This is reflected in the relative small part of funding this discipline manages to obtain via NWO. In the self-evaluation report of the Faculty of Architecture it is mentioned that the faculty retrieved only 5% external funds in total (Faculty of Architecture, 2007, p. 17).

The Standard Evaluation Protocol (SEP 2009-2015) allows the use of bibliometric indicators; however it does not prescribe it for all disciplines. Moreover, it is stated that "It is of great importance that research activities are assessed according to the standards of the specific discipline. The specific character of each field may require emphasis on some elements of the SEP, while other elements may be less relevant to a certain discipline. The fields of (...) design & engineering (...) may each require different approaches to the evaluation".

The ERiC project consists of three phases.

1. In the conceptual phase the specific characteristics of architecture research have been reviewed through literature, policy document analysis and interviews with researchers and stakeholders. At two workshops on Research Quality of Architecture and Building Sciences, the results of the interviews and document analysis have been discussed. This resulted in a model for Research by Design.

2 Results of the ERiC pilot will be used to improve the regular university research audits organised according to the national Standard Evaluation Protocol (SEP). The ERiC pilot is part of the joint ERiC initiative of the KNAW, NWO, VSNU, QANU and the HBO Raad. The ERiC program includes a range of pilots in different fields of research, at different universities to improve the evaluation of scientific research and develop methods for evaluation of societal relevance of research.

3 The Standard Evaluation Protocol (SEP) is the current national evaluation system for publicly funded research. The primary aim of the SEP is, on the basis of assessments of quality and relevance, to improve the quality of research and of research management. Moreover, the evaluation system is a means for research organizations to report to higher levels of research organizations and funding agencies, government and the society at large (VSNU, NWO, & KNAW, 2009). Research organizations are externally evaluated once every six years. Once every three years research units have to produce a midterm evaluation.

2. In the next phase, a set of criteria and indicators for research evaluation, in which the specific characteristics of Research by Design are taken into account, was tested. Evidence has been collected on research performance for two research groups. In this phase, we also had interviews with stakeholders. As a result, we have been able to elaborate the current SEP protocol in a way that research performances can be presented, and thus assessed, more in relation to the contexts of architectural research.
3. In addition to these phases, an analysis was made of the architectural research within ISI databases, to assess the possibilities of using bibliometric indicators for evaluations. The presence of TUD architectural research in this literature was benchmarked against a set of likewise international faculties.

The results of these phases are presented in chapter 3, 4 and 5 of this report respectively. Chapter 2 provides a short introduction to the faculty. In chapter 6, the concluding chapter, we present a main overview of the project results and its implication for the evaluation of architectural research. In principle one could read this chapter without having read the chapters 2-5.

Chapter 6 summarizes the results of the ERiC pilot. Implications for the evaluation of architectural research are presented.

We have tried to include both faculties of architecture in the Netherlands in this pilot. Despite initial support for this idea within both faculties, we had to conclude that this would lengthen the project even more. We therefore restricted the pilot to the TUD faculty. We very much appreciate the time and efforts of inter-viewees and other faculty staff to discuss with us the dynamics of architectural knowledge and help us with data collection. Especially since research evaluation is a high stakes issue in universities. The development of better research evaluation approaches is not felt by everyone as an opportunity for improvement. Some of the discussions seem to reflect more ongoing struggles within universities and faculties over resources and research strategies than insights in good evaluation practice.

2 Faculty of Architecture

The Faculty of Architecture of Delft University of Technology is one of the largest architecture faculties in Europe with more than 3000 students and around 250 fte (full time equivalent) scientific staff. Traditionally a high percentage of the scientific staff works in practice as well. Well known architects such as Aldo van Eyk, Herman Hertzberger, Francien Houben and Rem Koolhaas have conducted research and educated students at this faculty. This has resulted in innovative and revolutionary architects, who have realized buildings all over the world, which can be seen as a very important and socially relevant output. Besides architects, the faculty also delivers urban designers, managers and building engineers. Furthermore, the faculty conducts research on architecture, urban design, building technology and real estate. The faculty describes "design, construction and management of the built environment" as their three cornerstones.

The mission of the Faculty of Architecture aligns with the general mission of Delft University of Technology: "With its unique technological infrastructure, broad knowledge base, worldwide reputation and successful alumni, TU Delft is contributing significantly to the development of responsible solutions to urgent societal problems in the Netherlands and the rest of the world" (TU Delft, 2007, p. 5). The research portfolio of the Faculty of Architecture supports this mission and is based on the vision of "a strong relevance, meaning and impact on society, a high degree of experimentation and attention to sustainability" (Faculty of Architecture, 2007, p. 17).

Consequently, the Faculty of Architecture balances between conducting research and producing output in a way that is acceptable for the scientific community and which at the same time can be used to educate new generations of professionals on the one hand, and producing output that is relevant for the practice of the built environment on the other hand. In general, scientific demands are associated with objective, reproducible, and abstract knowledge. The practice of architecture and building sciences calls for unique, applicable, specific solutions. Research conducted at the Faculty of Architecture has a specific dynamic since scientific demands and professional demands have to be combined.

Rather unique in the research activities of this faculty is that they include artistic and cultural aspects in the design of artefacts and planning. Arguably, the assessment of results of these (artistic) processes and inventions demand a different approach than does the assessment of results of scientific research.

Research in the Faculty of Architecture is organized along four themes: Architecture, Urbanism, Building Technology, and Real Estate and Housing. The themes each focus on different domains of use and users (stakeholders) and produce as a result diverse types of research output. In the remainder of this chapter, we will describe each of the research themes of the Faculty of Architecture and its specific output and connections with stakeholders.

2.1 Theme Architecture

The research theme Architecture focuses on theory, practice and principles of design, materialization and engineering of modern and contemporary architecture from the perspective of sustainability, social quality and economic relations. It aims to consider the theory underlying architecture and the overall principles of architecture as one of their important objectives of study (Faculty of Architecture, 2007, p. 17). Buildings and the built environment are studied, in order to describe, classify and explain the object studied. Some researchers focus on one or several selected aspects with the goal to produce concepts, visions or manifestos that represent spatial reflections on living, working, recreation or a combination of these activities (Interview Avermaete; interview Schrijver), eventually resulting into new syntheses. Finally, the method of architectural design is studied.

Architectural research covers a broad range of subjects that study the built environment from diverse intellectual points of view. This involves a broad range of scientific disciplines: it deals with subjects of the humanities as well as with subjects of the physical sciences (Interview Avermaete; interview Graafland). Architecture therefore can be referred to as an integrating discipline (Interview Kaan; interview Eekhout). It integrates knowledge of design, history, humanities and construction in one single artefact (Interview Berens & Alkhoven).

Moreover, architectural research is intertwined with the practice of designing; they mutually influence each other (Interview Riedijk). However, the practice of designing and the practice of architecture research are two different practices, which are traditionally performed in two different contexts. A practicing architect has to act in a context with multiple social actors, with multiple interests and demands. The architect starts with a program of requirements and aims to produce a design that meets the demands of all the involved parties. This generally results in a compromise between different demands. In contrast, an academic researcher performs research without the aim of reaching a compromise between different parties and their demands. This typically results in innovative, spatial concepts or new insights, or new reflections on buildings and the built environment.

2.1.1 Stakeholders and output

Within the theme Architecture, researchers have to balance between dealing with stakeholders in the professional domain, stakeholders in the scientific domain (Interview Graafland), and stake-holders in the public domain, such as public authorities, organizations that are involved in building and the general public. This results in a variegated output. Descriptions, classifications and explanations are aimed at the professional or practice domain: the results are being used by practicing architects. But they are also of interest in the scientific domain. Vice versa, concepts, visions and manifestos coming from scientific inquiry can be of interest for policymakers in the public domain. And studies into the method of architecture research are of interest for both practitioners as well as scientists.

Visual representations, such as drawings, scale models and exhibitions, are very important in this field. Not only in analyzing and discussing architecture (Workshop Geiser), but above all as a product of research. This counts for all domains and stakeholders involved. Typology studies generally result in books. These are used in both the professional domain (in architecture practice) as well as in the scientific domain. With publications in professional journals, the researchers address the stakeholders in the practice and public domain and to a lesser extent their scientific peers. Finally, conference proceedings are considered a very common form to communicate within the scientific domain.

2.2 Theme Urbanism

Urban architecture, urban design, urban planning, spatial planning, environmental planning and landscape architecture are subjects covered by researchers of the theme Urbanism. Research of this theme aims “to deduct general theories, rules and regulations for the planning of complex cities and extensions as well as new mega cities” through focusing on major changes in world societies (Faculty of Architecture, 2007, p. 17). The knowledge gained from the Dutch experience of city planning forms the basis of this theme. The pivot of urbanism research concerns the mediation between planning and design on the one hand and the local situation and the research programme on the other hand, as well as between the existing physical spatial context and new socio-cultural processes.

As is the case with the research theme Architecture, Urbanism can also be seen as an integrating discipline, in

the sense that it uses a variation of other disciplines ranging from the humanities and social sciences to the physical sciences. In the context of urbanism research, administrative issues, cultural issues, social issues, political issues and economic issues can be part of the analysis. These different aspects play different roles on regional, national and international level (Workshop de Jong). Furthermore, urbanism research is concerned with worldwide developments, such as 'globalization' and deals with rather wide questions as: how does or can the government intervene or influence such developments? How can the State intervene in these processes (Interview van der Hoeven)? Finally, urbanism research focuses on the influence of geopolitical decisions on spatial developments, for example: what are the effects of European integration on spatial developments in the Netherlands (Interview Nadin).

As in Architecture, a further distinction is made in Urbanism between the study of existing or determined objects, like spatial development patterns, urban areas, cities or building blocks, and the study of undetermined objects that regard future possibilities. The former can result in formal comparisons or historical reviews, the latter may result in new spatial concepts of living, working, recreation etc. When empirical research is done into determined objects, it may result into insights into the origin of these objects, or how they play a role and have specific effects (Interview Hulsbergen; Interview Nadin). Both forms of research can result in general concepts, visions, grand designs and theories about building patterns or the use of public space (Workshop de Jong). These visions and theories can be 'tested' through realizing specific designs in practice. This process can be seen as a cycle which can lead again to the study of these specific designs, resulting again in concepts, theories or overviews (Workshop Bertolini).

2.2.1 Stakeholders and output

Research in theme Urbanism and the practice of urban designing are strongly connected to each other (Workshop Sijmons). Urbanism research provides input to the practice of urban design and the practice of urban design provides input to research.

Urbanism research can play an important role in the policy domain: by contributing views on the different levels of spatial planning, from the level of the municipality to the level of regions and on national and international level (Workshop Gerretsen).

Again, visual representations, such as drawings and scale models, are a very important way to present general concepts and visions. Description and typology studies generally result in books (such as atlases). With publications in professional journals, the researchers address the stake-holders in the policy and practice domains and to a lesser extent their scientific peers. Finally, conference proceedings are considered a very common form to communicate within the scientific domain.

2.3 Theme Building Technology

Building technology is inseparably linked to civil engineering and architecture as this research theme focuses on the technical details of buildings. Developing innovative, inventive and science-based technical solutions is the challenge that Building Technology faces. The aim is to be at the forefront of developing new theories, designs and prototypes for the international building practice (Faculty of Architecture, p. 247). In order to achieve this, fundamental and technical research is done in order to develop applied technologies and design (Faculty of Architecture, 2007, p. 247). The output of this theme can be found both in the more traditional scientific categories (SCI publications) and in more applied contexts (STW applications).

Building Technology plays an active role in the formation of the 3TU spearhead Building Innova-tion. This spearhead is geared towards cooperation between the different themes, between different faculties of Delft University of Technology and between the different universities. The 3TU spearhead Building Innovation sets the goal to knowledge and products so the building industry can work better, faster, more flexible, more transparent and more innovative (Eekhout, 2008).

2.4 Theme Real Estate and Housing

The theme Real Estate and Housing aims to steer and support the interaction between the supply of real estate and the demand for accommodating people. Real Estate and Housing focuses on the management side of the building process. This includes research into the 'product side' of real estate: the development and management of real estate. In addition, this theme pays attention to the process of initiation, preparation, development, design and construction of real estate, the so-called 'process side'. With regard to research, the department "aims to develop and test scientific theories and tools, based on empirical data collection that can be used to steer and support harmonisation of a relatively inflexible supply of real state with the dynamics demand for accommodating people" (Faculty of Architecture, 2007, p. 335).

Research on the subject of real estate and housing does not aim to produce designs themselves (interview Hobma). The process of the design and realization of buildings form the subject of research of this theme. Existing building (plan)s are studied and evaluated to gain insight into development and management of design and building space. These insights are used as input for the design process of new buildings. Thus, the study of the existing building stock is used as input for designing new buildings. Results of the research are theories, tools and best-practice models to improve cooperation between different parties, to increase efficiency of the building process and to gain insight into the use of buildings and the demand of different types of buildings.

3 Research by Design

In this chapter we explore the concept of Research by Design which is used to describe the specific form of the research-activities in this field. This specific form is frequently mentioned as the reason why architectural research has difficulties with gaining academic recognition. The complaint is that existing evaluation procedures in general are not capable to judge Research by Design on its merits. Therefore, we need first to explore the characteristics of that kind of research in the Faculty of Architecture. Next we develop a model of typologies of research that will inform us in the design of the evaluation procedures that fit this type of research activity.

When using the concept of Research by Design it helps if we have a clear and unambiguous understanding of it. However, as we already have seen, it is used in various ways in different contexts. Moreover, Research by Design is often used as a panacea for explaining the relation between science and designing without further explanation or interpretation. Also, the term is easily interchanged with terms as 'design oriented research', 'design research', 'research through design', 'study by design' or 'inquiry by design', which seem to hint at the same interaction between design and research but does not get the further explanation it deserves. Finally, the literature that reflects on the dynamics and organization of knowledge production in design disciplines is very scattered and does not have a solid body of standard works. This makes it hard to draw a clear picture of research by design and the position of architecture and building sciences with regard to science and society. According to Nigel Cross, who spent a big part of his life analysing design activities, the biggest challenge for research by design is "to construct the paradigm of research activities and examine what we mean by that in the design world. Those are the challenges that we've had to face for the last 20 odd years, and they are not yet resolved."[4]

A small selection of visions on Research by Design and related concepts may help to organize the issue despite the fact it is interpreted in many different ways. Remarkably, most of these definitions don't take an epistemological stance but rather an instrumental. Nigel Cross literally stated that it doesn't matter, in a way, how the designer works, as long as he or she delivers a description of an artefact (Cross 2008). Apparently, it is seen as a means to achieve something. According to the Presidents of the Dutch Technological Universities, Research by Design is research oriented towards the ability to turn fundamental knowledge into useful products, processes and services, taking physical and economical conditions into account, (Duijn, Fokkema, & Zwijm, 2007). Daniel Fallman (2007) of the Umeå Institute of Design & Department of Informatics in Sweden describes design oriented research from the area of human computer interaction. He sees design oriented research as the area of research where design is a manner to produce new knowledge through involving typical design activities in the research process. Pieter Jan Stapper of the Faculty of Industrial Design in Delft University of Technology envisions a design as "a vortex which sucks in insights from other disciplines" (Stappers, 2005, p. 13). He describes this part as 'the research part of designing'. At the same time, the 'design vortex' also throws out insights which can be useful for other disciplines. Through confrontation, integration, and bridge-building, design produces outcomes valuable for other disciplines.

While definitions like the above help us to get some idea of what research by design aims at achieving, we need also to review the science system itself to further position research by design. This is quite a daunting task due to the variety and multitude of scientific disciplines. Nevertheless, we give it a try, be it short. In everyday speak, science and research are often equated with 'natural sciences', which leads to a dominant idea that the mission of all sciences is to do what the natural sciences do: to describe, explain and predict natural phenomena, and produce research that is replicable. And also that such knowledge is (ultimately) sufficient for practitioners to

4 Surprisingly ambidextrous, Spring 2008, pp 28-29. See also: Nigel Cross and others, 1996

solve their problems. Van Aken goes a step further when he distinguishes 'explanatory sciences' 'formal sciences' and design sciences (Van Aken, 1994, 1996, 2004). Philosophy and mathematics are examples of 'formal sciences'. Those sciences build on internal logic and are empirically void. The natural sciences and major sections of the social sciences are part of the 'explanatory sciences'. The explanatory sciences describe, explain and sometimes predict observable phenomena within their field. This can result for example in a causal model (Van Aken, 1994, 1996, 2004). Design sciences, in his view, are a separate category. They develop knowledge for professionals in their field: like faculties for business and economics develop knowledge for managers, faculties of public administration for policy makers and the faculties of architecture produce knowledge for architects and urban designers. These professionals use their skills, creativity, and scientific design knowledge to solve real-world problems. Consequently, the mission of design sciences, such as engineering sciences, architecture and building sciences, is to develop knowledge for the design and realization of artefacts (Van Aken, 1994, 1996, 2004). Also, the interaction between researchers and practitioners in design sciences is much more direct and overlapping than in most other fields. It is important to note that design sciences produce knowledge that can be used in the design process, but design sciences do not perform design based actions (this is what the client does).

So, we now have two characteristics for design sciences, one is more instrumental (a means to achieve something in practice, a description), the other epistemological (the development of design knowledge for professionals in the field). Indeed, research in architecture and building sciences can be understood as design sciences in this sense.

From the interviews, it appeared that Research by Design can be further divided into a number of subfields that connect to a variety of other scientific research fields. This also becomes clear from the work of Theo van der Voordt and Taeke de Jong on scientific study and design as departure point for discerning different types of design science within architecture and building sciences (Breen, 2002; De Jong & Van Duin, 2002; Faculty of Architecture, 2007; Hulsbergen & Schaaf, 2002; Jong & Voordt, 2002; Van der Voordt & De Jong, 2002).

The review of the literature, document analyses, the interviews (see appendix) and the workshops resulted in the following categories:

- evaluation research
- historical research
- conceptual research
- practical research.

These different categories of research all feed into research by design, but have different research practices and they relate differently to each other and to the practice (social context). There are also differences in types of output and in the social domains and stakeholders which are addressed. They will affect the model we develop for this faculty. In the following, we will review these four subfields of research and the consequences for output and interaction with stakeholders.

3.1 Evaluation research

Evaluation research is characterized as the empirical study of existing objects and processes. It concerns ex-post evaluation, studying realized or determined objects. It deals with the effects and consequences which become manifest when an object or process is realized (Jong & Voordt, 2002). The studied objects represent a coherent set of design problems or objects, so the distracted solutions answer a set of problems and not just one specific case (Weert & Andriessen). Reliability and validity are the basis of evaluation research. Evaluation research can

also be ex ante. This type of research tries to predict the consequences of design interventions. This can for instance be done for a building with regard to direct sunlight, wind and other weather conditions.

In theory, evaluation research can be found throughout the Faculty of Architecture in all fields and sub-disciplines. Clear examples are the study of the original intentions and actual use of the Bijlmer area in Amsterdam Zuidoost (Urbanism), the evaluation of the performance of an existing climate system (Building technology) and the research into success factors of the cooperation between various partners in a specific building process (Real Estate and Housing).

3.1.1 Output

Publications in peer-reviewed magazines as well as in professional journals are an important form of output, as are policy reports.

Tools are another form of output. An example of a tool is the 'urban decision model', developed by the research theme Real Estate and Housing of Architecture Faculty. The 'urban decision model' is a model which enables decision and policy making when different stakeholders with different demands are involved.

3.1.2 Stakeholders

The products of evaluation research are principally addressed to stakeholders in the professional domain, like architects, urban designers, spatial planners, building contractors.

Also stakeholders from the public domain are part of evaluation research. Knowledge produced with this type of research can be input for evidence-based policy. Municipalities, provinces, departments and other government bodies are the main stakeholders.

Interactions with stakeholders in the scientific domain are less frequent, but the results of evaluation research are potentially of interest to scientists. Especially since the solutions answer a set of problems and can therefore contribute to the scientific body of knowledge.

Finally, the output of evaluation research might serve as an input for (further) exploration and for the design of novel concepts. This concerns all stakeholders.

3.2 Historical research

Historical research is the study of determined objects within a determined (historical) context (Jong & Voordt, 2002). The objects can be studied through analyzing the actual building and/or the maps, plans, scale models, and other visual representations of the specific object. Historical research interprets, tries to understand and explains designs, while paying attention to site characteristics. This means that attention is paid to the social, cultural, historical and economic context in which a design was developed and realized. Historical research usually results in descriptions and overviews; this can be a morphological overview, a typological overview or an overview of a certain period.

Historical research is typically found in the theme Architecture as well as in theme Urbanism. The study of a single building, of the work of a specific architect or of a specific building style are examples, as is research into the Dutch 'bouwblok' or 'waterstad'.

3.2.1 Output

Books form a large part of the publication output of historical research. 'Atlases' (in the field of Urbanism) are a good of example of a typical output product of historical research.

Another way of presenting the results is through an exhibition and accompanying catalogue.

Not only publications from researchers or architects themselves are an important output product, but publications about the work of a researcher or architect are seen as important indicators for the quality of an architect or researcher. For example: 'El Croquis' is mentioned as one of the highest profile and prestigious architectural publications in the world.

3.2.2 Stakeholders

Stakeholders include the scientific domain, the educational domain and the practice domain. In the latter, the output products are used as a conceptual background and source of inspiration when the designing process is started up.

Finally, the output of historical research might serve as an input for (further) exploration and for the design of novel concepts. This concerns stakeholders in the three domains.

3.3 Conceptual Research

Conceptual research is exploratory and experimental. This is what De Jong characterizes as research into undetermined objects. It aims to generate innovative, revolutionary concepts, manifestos and visions on the built environment. This can be visions on new ways of living or working, the 'cultural side' of architecture and urbanism.

Conceptual research starts from a specific problem. Input can be the results of evaluation research as well as results from historical research. In contrast to the practice of designing that has to deal with numerous conditions, conceptual research does not aim to seek the optimal compromise between a multitude of conditions. Conceptual research aims to deliver innovative visions, not necessarily realistic or feasible. It can sketch new scenarios and the connected social-spatial implications. Within conceptual research, intuition and creativity play an important role. The result is an innovative, revolutionary concept, manifesto or vision.

Conceptual research can in theory be found throughout the Faculty of Architecture. Examples are new approaches to ring roads around major cities (van der Hoeven, 2001, 2002) or the research into the possibilities of constructing buildings with double-curved aluminum façades with opening windows (Vollers, 2001).

3.3.1 Output

Conceptual research generally produces designs not thicker than paper (Kaan, 2008). These concepts can be expressed through different visual media like drawings, computer animations and scale models. The visualizations in turn can be exposed and discussed in exhibitions, lectures, debates, colloquia, seminars and conferences. Some of these events result in publica-tions such as exhibition catalogues or conference proceedings. Therefore, visual media, exhibitions, lectures, debates, colloquia, seminars and conferences are also part of the output products of conceptual research.

Conceptual research can also result into prototype buildings or constructions. These either contain innovative details or are the result of a new, revolutionary, overall concept of building or construction.

3.3.2 Stakeholders

Conceptual research aims to deliver inspiring, innovative output products which give input to professionals who are concerned with designing, spatial planning, building constructing or building management.

The policy domain is important, since public authorities have the possibilities, the desires or the need to use innovative concepts as a new way of interpreting and planning the built environment.

Finally, the scientific peers are potential stakeholders. The concepts developed in this type of research exceed the determined practice, which might be too local or too specific. The novel ideas might serve scientists as an object for study or an input for generating new ideas.

3.4 Practical Research

Practical research should be located entirely in the practice and educational domains. It is taught at the Faculty of Architecture and it is done in the practice which is being studied. It is in general not done as research within the faculty itself.

The architect conducts 'practical research' in his search for the right solution for a certain building assignment. An engineer concerned with the design of a construction for a building, practices 'practical research'. Students are trained to eventually function in the professional world and are therefore educated in 'practical research'. Students learn how to tackle a design assignment: how to deal with a program of requirements, how to make an analysis of the context and how to come to the optimal design.

In contrast to conceptual research, practical research aims to produce the optimal compromise between the demands of different parties and the program of requirements. The results of evaluation research, of historical research and of conceptual research can be used (and are used) as an input, as inspiration, in practical research. The outcome of practical research is object of study in evaluation and historical research.

3.4.1 Output

The output of practical research are designs for actual buildings, designs for urban areas and landscapes; designs and prototypes of constructions, designs for the management of building processes. All based on a determined context.

3.4.2 Stakeholders

In most cases, the stakeholder is the client who has commissioned the work.

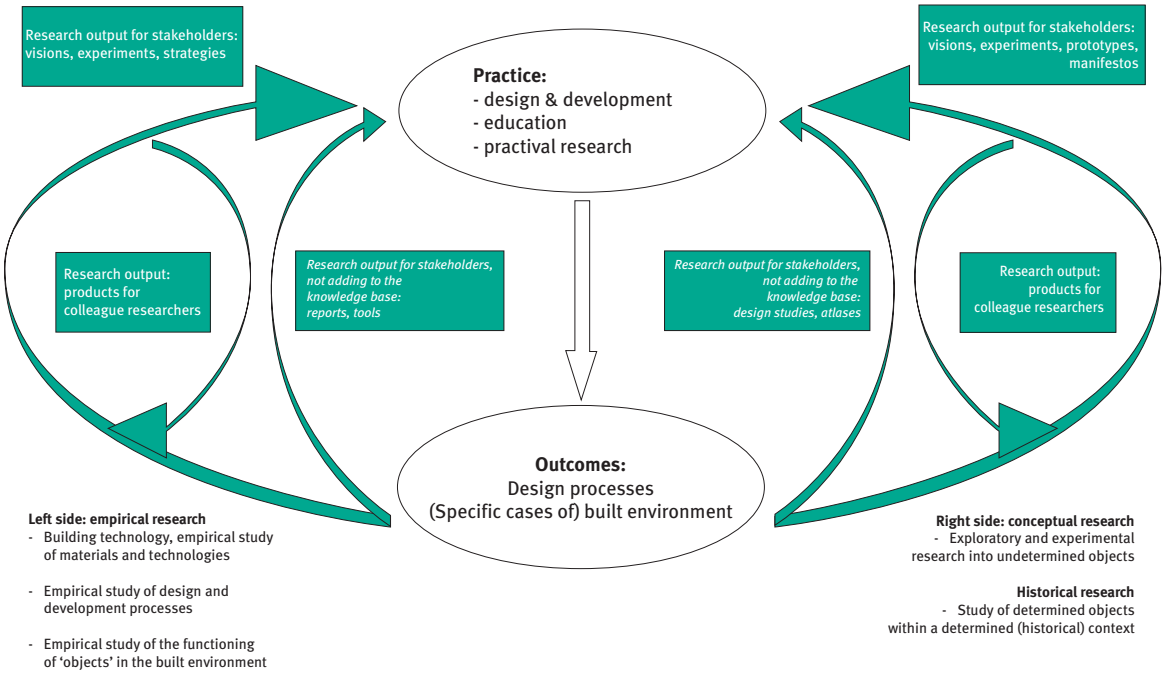
3.5 Proposal for a conceptual model of architecture research

In the above we have tried to elaborate the ambiguous concept of research by design. We have shown that there are various discussions in the literature and among researchers and practitioners how to define this concept. Some of these definitions aim at finding an epistemological ground to distinguish research by design from other types of research, other definitions go into the direction of a more instrumental approach, they are goal oriented. On the basis of interviews and documents we have made a subdivision into four types of research: evaluation research, historical research, conceptual research and practical research. Each of these subfields contributes from various angles to research by design and to the practice of architecture. The overall picture that emerges

from our analysis of the concept and the field of architecture research is a rather complex one in which the borders between research and practice and researchers and practitioners are often not very clear. For example, historical research studies existing or determined objects, leading to descriptions and typologies that influence the practice, but also can result in general concepts, visions, grand designs and theories about building patterns, the use of public space or constructing. Visions and theories can be 'tested' through realizing specific designs in practice. Such a process can be seen as a cycle which can lead again to the study of these specific designs, one way (evaluation research) or another (historical research), resulting again in concepts, theories or overviews.

This intricate process of knowledge circulation in which research and practice mutually influence each other is visualised in Figure 1. The four distinct sub categories of research circle in a way around the practice of architecture research. For each of the four types of research we have given examples of output categories and the arrows show how the research practice is influenced by the different kinds of research. Evaluation research and historical research both are firmly rooted in practice, and influence the practice directly via a variety of output that can be measured ex post (middle arrows), and indirectly via future oriented output that has to be measured ex ante (conceptual research, top arrows).

Figure 3.1 Knowledge flows



4 Evidence of research quality in architecture

Research by Design refers to a research practice in which communication about results is done through a range of outputs. The assessment of the quality of the results is not done by scientific peers only. Results aim to support professionals in the field to solve real world problems and thus professionals have a role in the assessment and validation of the results and the translation of such results in accepted knowledge. Is it possible to operationalise the concept Research by Design, its related understanding of research quality and its practices into a set of indicators for research quality to be used in an evaluation?

This chapter presents the results of the test study in phase 2. Based on the conceptual phase, seven dimensions of research quality of architectural research are distinguished, including usual dimensions as scientific quality, productivity and recognition, as well as four dimensions more related to realising contributions to society: agenda setting, collaboration with users, dissemination and actual impacts. For each of the dimensions a set of indicators is formulated, see Table 4.1. For two research groups of the Faculty, the indicators have been tested by creating information sheets that could be presented to an assessment committee. Data was retrieved from two sources; programme and budget proposals 2009-2012, which also contained past performance data for the period of 2005-2007, and stakeholder interviews. Main results are reported in this chapter. The information sheets and findings resulting from the interviews can be found in appendix A.

4.1 Dimensions and indicators

Here we present the indicators for a structured data collection facilitating both the scientific and societal quality assessment of research. We use 'indicators' as a broad concept, including qualitative evidence on specific aspects of research. These are based on the conceptual phase, the literature search and interviews. The indicators provide information about productivity and recognition in the scientific domain and about agenda setting, collaboration, knowledge dissemination and knowledge use & impact in the social domain. The information can be used to assess whether the research output and activities are in line with the mission of a research group and the type(s) of research it performs.

4.2 Results Test Programme 1: Housing

The mission of the program states 'the Housing research program aims to develop knowledge that can be used to support the transformation and management of the housing stock and related services'. The stakeholder interviews indicate the program is successful in terms of its mission. The program has also formulated a scientific ambition: 'the scientific ambition of the housing program is to adapt knowledge from policy and management studies to the processes and organization of sustainable housing transformation and management.' Based on the evidence we collected, we are unable draw conclusions concerning the success of the scientific ambition.

- Output and scientific recognition data was presented for two chairs in one document. We interviewed one of the chairs, who is program leader. The data we present has a bias towards this chair as not all information about this second chair was available.
- Scientific recognition is based on the program leader, since the group consists mainly of PhD students;
- Five valorization partners were reported for the two chairs, of which one was interviewed;
- Two additional stakeholders of the chair 'social entrepreneurship in housing management have been interviewed;
- Stakeholders of the program are unanimously positive about both the research topics and the research process. The group succeeds in serving housing corporations, tenants organizations and groups that critically monitor housing corporations;

Table 4.1 Dimensions and Indicators

Dimension	Indicator
Scientific Quality	As defined in SEP: Quality and scientific relevance of the research: Originality of the ideas and the research approach Significance of the contribution to the field Coherence of the programme Quality of the scientific publications
Scientific Production	Articles in refereed journals or journals with a clear editorial strategy to select on academic quality Book chapters presenting new work mostly are subjected to editorial scrutiny Books, monographs, catalogues Conference papers Edited volumes of conference proceedings Major reviews of literature or of exhibitions PhD Theses
Scientific Recognition	Visibility in the scientific community Editorships journals/international books or 'service to journals Election to academies or academic professional associations Prices and awards, honorary positions Invited lectures, international conferences
Responsiveness of agenda setting	Societal concerns and issues are explicitly addressed in the research design/programme Interaction with stakeholders to establish relevance, ranging from occasionally to full dialogue Relevant recent experience of researchers as a practitioner in societal domain/ practice/ government Positive evaluations or external funding related to societal/commercial issues
Collaboration with (potential) users	Commissioned research by societal actors Earmarked/structural funding related to societal theme Actual collaboration in research, testing, evaluation with stakeholders Establishment of consortia including non-academic organizations
Dissemination and knowledge transfer related to the mission	Production of texts/professional publications/non scientific publications/exhibitions Dissemination of technology/artefacts/standards Advisory and consultancy roles Popularization/education/contributions to societal debate Training of professionals/mobility/master theses
Actual results, impact and use of research	Convincing examples of use of outcomes of research Satisfaction/recognition of alumni and stakeholders Substantial returns or economic value of outputs of research Visibility in the public debate/media rankings

- Stakeholders all mention the excellent knowledge of the program leader on concerns and questions relevant to practice, which is less evident from the data in the research and program proposal;
- Projects with external parties are described shortly by the program, creating difficulties in determining the nature of the collaboration; commissioned research or structural funding related to social themes;
- Actual impact and use of knowledge has been mainly identified through the stakeholder interviews.

4.3 Results Test Programme 2: Randstad Centre for Strategic Spatial Planning and Design

The mission states 'the aim is to develop theoretical insights and new data through the study of the Randstad and other complex regions and to communicate this effectively to policy makers and designers so as to inform practice'. The interview we had with a representative of the Ministry of Spatial Planning as a stakeholder of the program, suggests more effort is needed to achieve the mission.

- In general, the data of this group contained many statements about intentions to increase scientific productivity and visibility on the one hand and to include social relevance in the research programme on the other hand. This can be explained by recent rearrangements in research activities. However, research assessments are about past performance. Therefore, the collected evidence for the indicators remains rather limited;
- The existence of excellent international research networks is mentioned. Nevertheless, evidence of concrete networks lacks;
- Nine valorization partners were reported. Suggestions for stakeholder interviews resulted in two organizations, of which only one (Ministry of Spatial Planning VROM) was successfully reached for an interview;
- The Ministry acknowledged the social relevance of the research agenda of the group, but stressed the need for more interaction with the research group. Interaction in establishing the research agenda is reported by the research group. However, the exact way this happened is not described;
- Collaboration activities are mentioned by the research programme. The Ministry expressed a desire to collaborate, which is initiated by a recent increase in interaction;
- Dissemination and actual results of impact and use of research have not been found.

4.4 Results Test Overall

Collecting data for evaluation purposes is always a time consuming process. Especially if new kinds of data are required, organizations often are not able to collect the data. This was true for data on scientific performances in the early days of university research evaluation. Present day this is true for data on other kinds of performances, and we can only interpret the results of the tests with due caution.

Reflecting on the data quality we have see serious problems, which makes the evaluation of the quality of architecture research difficult.

First of all, due to continuous rearrangements of research programmes in the past it is difficult to relate past data to current research programs. Probably related to the rearrangements of research programmes, many of the statements about the programs, refer to intentions, rather than achievements. As the evaluations according to the Standard Evaluation Protocol aims to evaluate mainly the past performances, this provides a major obstacle to the any SEP evaluation; whether it takes into account all performances related to "research by design" or restricts itself to scientific performances in terms of ISI publications only.

Secondly, data about professional publications are available. Completeness of data about other outputs is uncertain, despite self reported importance of these outputs.

Third, we have tried to get financial information about the research themes, in order to test whether they can be used as indicators for collaborations. However, again the financial figures we could obtain were prognosed budgets for 2009-2012 instead of realized budgets. Furthermore we found that the way the budgets were ordered deviates from common practice.

- BTA income is presented as 2nd/3rd stream money, while this income results from internal allocation by the university. Presenting it as 2nd/3rd stream implies the income was generated by funding or contract research, which is not the case;
- 2nd and 3rd stream money are presented in the documents as one number, although the sources these streams originate from are different. 2nd Stream money originates from research foundations and 3rd stream money originates from social actors, such as governments, NGOs and companies.

Fourth, stakeholders, or valorization partners as they are called in some of the documents, could be easily listed. Nevertheless, additional information that can provide insights in the interactions and processes leading to valorization, are scattered throughout the documents. Systematic data on the interactions and processes with these valorization partners was lacking.

For both programs main stakeholders have been identified by the program leaders. We interviewed some of these stakeholders about their appreciation of the research program. These stakeholder interviews are a valuable source of information as evidence on the value of the research for the architectural practices. Stakeholders have clear opinions about research programmes and provide interesting information on the research process. But we also noticed stakeholders regularly perceive they are stakeholder of the programme leader only, not of the research programme. Some researchers have a similar perception: they sometimes perceive personal contacts as stakeholders of the whole program they are part of. In some cases, contacts with these stakeholders concern projects not directly related to the current research program. As a result, one should be cautious to use interviews with stakeholders to map the value of the research themes for architectural practices. It might be more useful to find other ways to include stakeholder perceptions into the evaluation process.

5 Publication and citation patterns

Current evaluation practices in the academic world tend to take for granted that scientific publications in ISI journals are the main publication outlet. Many research groups, and as a result whole disciplines, have changed publication behaviour likewise. Still, disciplines have an own publication culture and for some ISI journals do not function as the main platform for scientific communication.

The Faculty of Architecture considers the deviation of their scientific publication profile of what the mid term evaluation committee called scientific standards, not as characteristic for the faculty as such, but characteristic for their research field and the idea of Research by Design. Therefore we conducted a background study with the following questions:

- Does a disciplinary knowledge infrastructure exist, e.g. a core set of journals or other knowledge sources?
- Are there any important communication channels within the publication culture?
- Are there any trends in the production of publications?
- Do the references in the articles reflect the broader and heterogeneous research output?

We analyzed the publication culture in the ISI Web of Science databases (1988-2009): of nine faculties/departments of Architecture, of which most are mentioned in the interviews as a possible benchmark partner of Delft.
The departments selected from the UK are also among the best assessed departments in the last RAE 2008 (sub panel Architecture and the build environment).

- Delft University of Technology, Faculty of Architecture;
- The University of Sheffield, School of Architecture;
- University of Cambridge, Faculty of Architecture and Art History, Department of Architecture;
- University of Reading, Henley Business School, School of Real Estate and Planning;
- MIT, Department of Architecture;
- Eindhoven University of Technology, Faculty of Architecture, Building and Planning;
- Ghent University, Faculty Engineering Sciences, Department of Architecture and Urban Planning;
- Katholieke Universiteit Leuven/ Catholic University Louvain, Department of Architecture, Urban Design and Regional Planning;
- ETH Zürich, Faculty of Architecture (D-Arch).

We performed simple searches using the address field of the publications (see appendix 1 Search strategy).
An exception was made for ETH Zurich, because of inconsistent use of the name of the department. In this case all articles with the topic ‘architecture’ are included. This selection therefore cannot be compared with the other faculties. The aim was to include nearly all the articles published by the departments, and we checked for variations in spelling of the address and use of different names, e.g. department instead of faculty, etc. This rather simple search does however not guarantee that all the articles published by the departments in ISI-journals included in Web of Science are actually included in this analysis. Conclusions in terms of ranking of the departments have to be drawn with utmost care. The main purpose of this exercise is to analyze the publication and citation pattern in the Web of Science journals. More detailed information can be found in Appendix B.

5.1 Output of departments

Publications from the last two decades are included in this search (all years included in web of science). Considering that these departments start only to be visible in the ISI databases in the last decade, the h-index seems to be in line with the ‘publication career’ of the departments. This following the generally accepted ‘rule of the thumb’ in the harder scientific fields, that the h-index of an individual scientist should be as high as the years of

his scientific career. Sheffield, Cambridge, Eindhoven and MIT stand out among the rest in this respect, Delft being in the second league. (Sheffield was very high ranked in the RAE of 2008). The rest of the departments has a rather low visibility in the ISI Journals.

The search for the output of the nine departments included in this search resulted in 642 publications included in the ISI Web of Science database as a source-publication over the last two decades. Three-quarter of these publications are articles, one tenth is a proceeding paper and still five percent is a book review.

Table 5.1 Selected publications in ISI databases

Faculty	Number publ.	Average cited	h-index
MIT dept Architecture	113	5,97	12
TUD Fac Architecture	77	2,14	7
TUE dept Architecture	145	5,99	15
Univ Cambridge Dept Architect	92	5,01	12
Univ Ghent Dept Architecture	19	1,95	4
Univ Leuven Dept Architecture	21	6,14	5
Univ Reading Real Estate & Housing	23	2,17	2
Univ Sheffield Architecture	131	3,85	12
ETH (topic Architecture)	21	?	?
Total	**642**		

Table 5.2 Types of sources publications

Type of output	Total
Art Exhibit Review	5
Article	493
Bibliography	1
Book Review	24
Editorial Material	15
Meeting Abstract	3
Note	3
Proceedings Paper	82
Review	16
Grand Total	**642**

Twenty five journals contain 53% of the source publications (see Table 5.3). The rows in this table show that most of these core-journals are a source for several departments, but none is visible as an international broadly accepted resource. Most journals are cited prominently by one department and sparsely by a few others. There are however some journals cited by more departments that could be perceived as an international forum for an international community of scientists.

Table 5.3 Journals cited by departments

Journal	ETH	Ghent	Leuven	MIT	Reading	Sheffield	TUD	TUE	Cambridge	Grand Total
ENERG BLDG		2		8		6	3	2	14	**35**
BLDG ENVIRON		5	1	4		10	1	10	2	**33**
ENVIRON PLAN B-PLAN DESIGN				8		3	3	5	6	**25**
BUILDING RES INFORM			1	1	1	2	1	1	13	**20**
J CONSTR STEEL RES						16		3		**19**
AUTOM CONSTR				5		1	2	10		**18**
RENEWABLE ENERGY						7			6	**13**
URBAN STUDIES			3		6	1	2			**12**
LIGHTING RES TECHNOL				3		9				**12**
J WIND ENG IND AERODYN				1				11		**12**
A U-ARCHIT URBAN	9	2		1						**12**
THIN WALL STRUCT								11		**11**
SOLAR ENERG		1		2		2	1		4	**10**
ENG STRUCT						8	1	1		**10**
DESIGN STUD			1	2	1	4	1	1		**10**
J ARCHIT PLAN RES			1	3			1	4		**9**
ENVIRON PLAN A			1		2			5	1	**9**
CONSTR BUILD MATER		2				1	6			**9**
APPL ACOUST						5	2	1	1	**9**
J SOC ARCHITECT HIST	7	1								**8**
FIRE SAFETY J						6		1		**7**
ARCHIT DESIGN	4					1			2	**7**
TRANSP RES PT B-METHOD								6		**6**
J SOL ENERGY ENG				6						**6**
EUR PLAN STUD			5		1					**6**
DIGIT CREAT									6	**6**
STRUCT DES TALL SPEC BUILD				1				4		**5**
STRUCT DES TALL BUILDINGS								5		**5**
LEUKOS				3		2				**5**
LECT NOTE COMPUT SCI				1		1		1	2	**5**
J STRUCT ENG-ASCE						3	1	1		**5**
J ACOUST SOC AMER						4	1			**5**
INT J MIDDLE EAST STUD				5						**5**
HOUSING STUD					2		3			**5**
	20	13	13	54	13	92	29	83	56	

The journal titles indicate the presence of both construction and engineering and architecture journals. Analysis of the topic labels attached to the publications by ISI confirms this. (Table 5.4) The topics show that it is an inter-disciplinary set of publication covering an array of topics. Construction and building technology is best covered in the ISI journals, but architecture is also well visible.

Table 5.4 Topic labels attached to source publications

Topic label	# articles labelled with:
Engineering, Civil	199
Construction & Building Technology	191
Environmental Studies	85
Energy & Fuels	79
Urban Studies	44
Engineering, Environmental	42
Architecture	39
Materials Science, Multidisciplinary	34
Geography	28
Mechanics	28
Engineering, Mechanical	24
Art	23
Engineering, Multidisciplinary	21
Acoustics	20
Optics	20
Computer Science, Interdisciplinary Applications	17
Environmental Sciences	16
Transportation	16
Transportation Science & Technology	16
Engineering, Chemical	14
Engineering, Manufacturing	14
Planning & Development	13
Thermodynamics	12
Geosciences, Multidisciplinary	11
Operations Research & Management Science	10
Computer Science, Artificial Intelligence	9
Computer Science, Software Engineering	9
Economics	9
Computer Science, Theory & Methods	8
Water Resources	7

The number of publications of the nine departments included in the ISI databases is growing fast over the last years (figure 5.1). This might be the result of the inclusion of more relevant journals included in the databases of ISI, but also of changing publication patterns by the departments (mainly in the building technology areas of research). In the last decade the number of publication by the nine departments grew from 25 to 70 each year.

If one looks at the number of all publications having the topic label Architecture included in ISI databases, the number of publications is more constant compared to the growth in productivity of the nine departments (figure 5.2).

Figure 5.1 Number of publications by nine departments / year

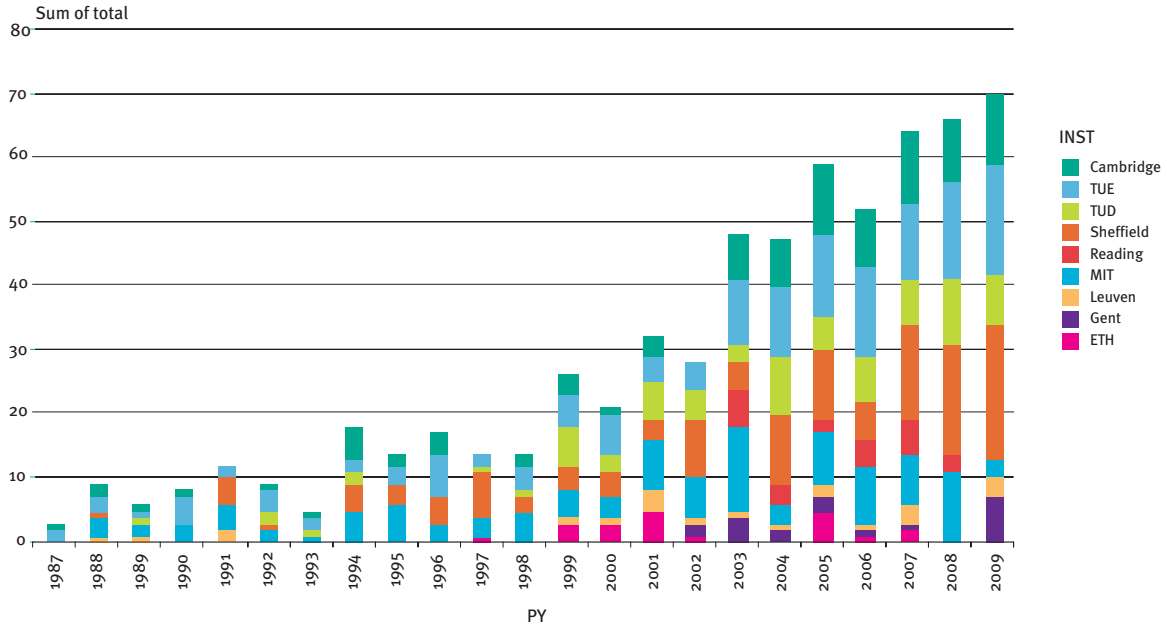
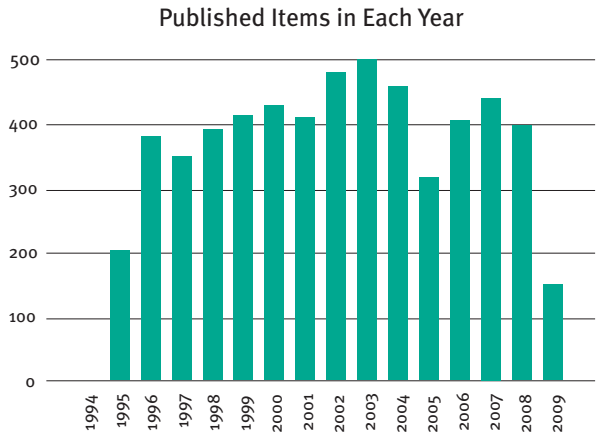


Figure 5.2 All publications with topic 'architecture'



5.2 Departments of architecture, cited sources

The references that are cited in these papers give some indication of the knowledge sources that authors draw from. The 642 publications contain 15.400 references to other publications. Of these references 15.228 could be included in this analysis. Of the other references to little information was available in the database for analysis and have been discarded.

These 15.228 citations refer to a set of 12.736 publications, including journal articles and books, etc (see appendix 2 cited sources). Only 3% of the cited publications are referred to in more than two publications. This indicates a rather scattered set of sources for research. In more established field one would expect some central review articles summarizing the state-of-the-art in the field, or articles on particular methods or technologies that are used broadly. The scattered sources indicate little shared concepts or theories.

Table 5.5 Citation frequency

Citation frequency	# Publications
Cited once or twice	12.259
Cited 3 times or more but less than 6 times	418
Cited 6 times or more but less than 11 times	56
Cited 11 times or more	3

If one looks for shared references by the nine departments, only 21 publications are cited by three departments or more (table 5.6). Most of these cited sources are books, 38% is a journal article. The more frequently cited sources include few philosophical books, a handful of methodological books and some several journal publications. This publication pattern indicates that Architecture is an eclectic field lacking a binding paradigm. The relevance of literature seems to be decided upon by individual authors.

Inspection suggests that there are few central books for architecture. For example the Reflective Practioner by Schön, referred to nine times, is found in publications involving Leuven, Reading, Delft, MIT and Sheffield. This also indicates lack of a shared knowledge base.

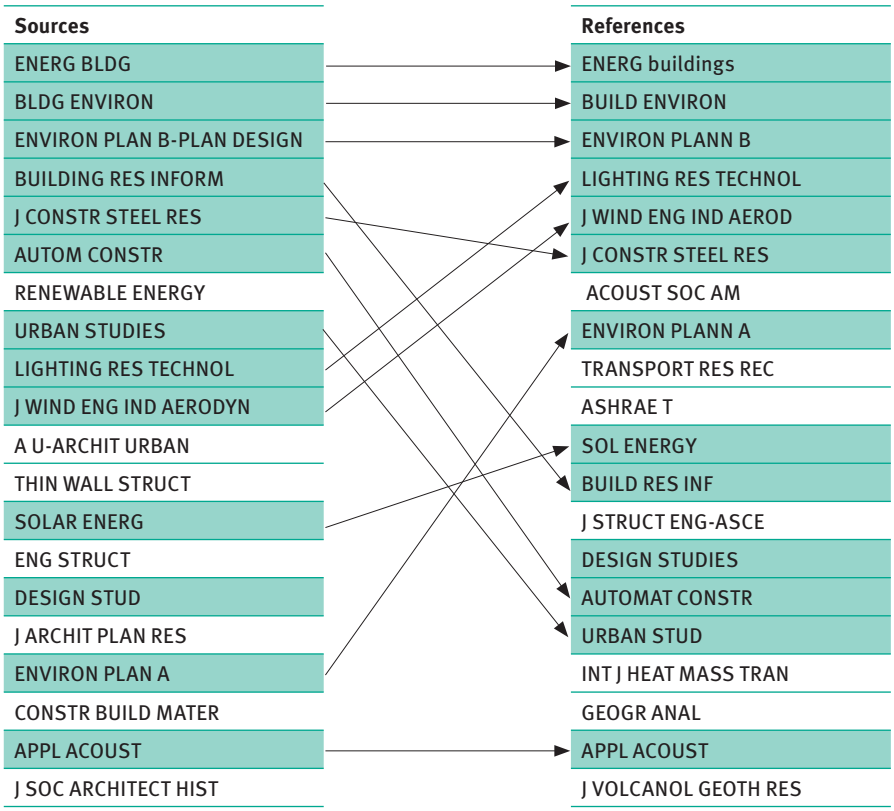
If knowledge circulation in architecture includes different sources including: monographs, reports, exhibitions, books, catalogues, web pages, and drawings, one expects to find some indications of that in the references cited. If we estimate the distribution of different publications types we indeed find that less than a half of the citations refer to journal publications. (46%) Other references are to proceedings (5%) and theses (3%) and a large category to other kinds of publications.

If one looks at the level of the journals cited one finds a core set of journals cited from. 153 journals are cited more than three times by more than three departments. Articles from these journals are cited 3084 times (25% of all citations). The list of most cited journals is very similar to the list of journals most published in (figure 5.3). Titles do suggest that the publications represent a limited number of sub disciplines.

Table 5.6 All references cited by more than two departments in this analysis

Cited publication	Cambridge	ETH	Ghent	Leuven	MIT	Reading	Sheffield	TUD	TUE	Grand Total
LAUNDER BE, 1974, COMPUTER METHODS APP, V3, P269	1				6				6	**13**
FANGER PO, 1970, THERMAL COMFORT ANAL	2						3	1	4	**10**
SCHON DA, 1983, REFLECTIVE PRACTITIONER				2	1	2	3	1		**9**
LAWSON, 1994, DESIGN MIND				2		1	4			**7**
BUSCH JF, 1992, ENERG BUILDINGS, V18, P235				1	3		2		1	**7**
LYNCH K, 1960, IMAGE CITY	1						2	1	1	**5**
DEDEAR R, 1998, ASHRAE T, V104, P112	1			1					3	**5**
ALEXANDER C, 1977, PATTERN LANGUAGE TOW	1			2			1	1		**5**
NICOL JF, 2002, ENERG BUILDINGS, V34, P563	1			1			1		1	**4**
NIELSEN PV, 1979, NUMERICAL HEAT TRANS, V2, P115	1				2				1	**4**
LACY RE, 1977, CLIMATE BUILDING BRI	1						1		2	**4**
FANGER PO, 2002, ENERG BUILDINGS, V34, P533				1				1	2	**4**
BRAGER GS, 1998, ENERG BUILDINGS, V27, P83				1			1		2	**4**
CASTELLS M, 1996, RISE NETWORK SOC, P32		1		2				1		**4**
COLEY DA, 2002, BUILD ENVIRON, V37, P1241			1		2		1			**4**
RAPOPORT A, 1982, MEANING BUILT ENV							1	1	1	**3**
OLGYAY V, 1963, DESIGN CLIMATE	1				1		1			**3**
LECHNER N, 2001, HEATING COOLING LIGH			1		1		1			**3**
LAWSON B, 2004, WHAT DESIGNERS KNOW				1		1	1			**3**
GIVONI B, 1998, CLIMATE CONSIDERATIO	1			1	1					**3**
ALLARD F, 1998, NATURAL VENTILATION	1			1			1			**3**
	12	**1**	**2**	**16**	**17**	**4**	**24**	**7**	**24**	**107**

Figure 5.3 Similarity in ranking of journals published in and cited from



If one looks at the dissertations being cited one finds that a visible dissertation culture did emerge and is a source for publications in most of the larger departments involved (Table 5.7). The main conclusion is that theses are predominantly cited by the own faculty.

Table 5.7 Thesis of department cited by department

Department	Cambridge	ETH	Ghent	Leuven	MIT	Reading	Sheffield	TUD	TUE	Grand Total
THESIS U SHEFFIELD				1			86		2	89
THESIS TU EINDHOVEN	2		2	1				6	47	58
THESIS TU DELFT				2	1		2	43	3	51
THESIS MIT			1		42				3	46
THESIS KU LEUVEN				9					9	18
THESIS U CAMBRIDGE	7						9			16
THESIS EPFL LAUSANNE					11				1	12
THESIS U CALIFORNIA					3		2		7	12
THESIS CORNELL U					3				3	6
THESIS OHIO STATE U	1			1					4	6
THESIS TU DENMARK					1		1	1	3	6

5.3 All journal articles published by Leuven, Ghent and Delft

To find evidence on the delineation of the scientific forum addressed by the publications we analyzed also the total set of journal articles published by Delft, Ghent and Leuven in 2004 -2008 including international, national and professional articles. It is remarkable how few journals are shared by these departments. Only three journals are published in by three departments: De Architect, Docomomo Journal and Footprint. In total only 14% of the publications by these departments are included in these journals.

Table 5.8 Journals shared by Delft, Ghent, Leuven (2004-2008)

Journal	Delft	Ghent	Leuven	Total
A+ BELGISCH TIJDSCHRIFT VOOR ARCHITECTUUR		54	1	**55**
De Architect	49	4	1	**54**
OASE	37	15		**52**
Cement	18	1		**19**
ARCHITECTURE D AUJOURD HUI	8	5		**13**
Docomomo Journal	10	1	1	**12**
Bauwelt	7	2		**9**
CONSTRUCTION AND BUILDING MATERIALS	6	2		**8**
Footprint	6	1	1	**8**
Bouwfysica	5	2		**7**
ARCHIS	4	2		**6**
Arquitectura viva	4	1		**5**
ENERGY AND BUILDINGS	4	1		**5**
Agora	3		1	**4**
Journal of design history	2	2		**4**
ROM	3	1		**4**
The Journal of Architecture	0	2	2	**4**
International journal of architectural computing	1		2	**3**
Rehva journal	2	1		**3**
Architectural Engineering and Design Management	1		1	**2**
Design studies	1		1	**2**
Environment and planning b-planning & design	1		1	**2**
Home Cultures	1		1	**2**
JOURNAL OF BUILDING PHYSICS	1	1		**2**
Werk, Bauen + Wohnen	1	1		**2**
	175	**99**	**13**	**287**

5.4 Conclusions on publication patterns

In this chapter we analysed publication and citation patterns in ISI journals of nine architecture departments in order to assess whether publications in ISI journals are good indicators of the quality of architecture research. The ISI database includes a set of relevant international scientific journals on architecture and construction and building technology and engineering. Construction and building technology, engineering, energy and environment are the topics best represented in the ISI-articles of the nine departments. Architecture is next in line.

Like for many fields and organizations in the academic world, the nine departments of architecture in general become more visible in the ISI databases over the last decade. The number articles published in ISI journals by these departments is growing fast. We found 642 publications in the ISI databases published by the nine departments over the last two decades. Of these, three-quarter is an article, just above ten percent is a publication in conference proceedings and five percent is a book review.

However, the publications of the departments of architecture and citations within these publications reflect a rather scattered pattern covering many topics and disciplines and little structure. This suggests that there is no common publication culture among the departments and that the ISI journals do not act as the main scientific communication platform.

The 15.400 references in these publications show a small core of journals cited more frequently and indicate that dissertations are part of the publication culture. Only very few publications and other sources are cited by more departments. In general cited sources are very scattered, being cited only once or twice (96% of all citations). This suggests that architecture is an eclectic field of scientific activities lacking a clear delineated set of relevant publications or journals or a disciplinary publication pattern.

In addition to the analysis of publications in the ISI databases an analysis is made of the total set of journal publications by Delft Leuven and Ghent 2004-2008. This confirms the lack of a disciplinary publication pattern.

The publications and citation patterns of Eindhoven shows relative high visibility in the ISI web of knowledge. The patterns of Delft do not indicate a separate or minor position regarding productivity and visibility.

6 Evaluating architectural research at TUD: overview and conclusions

Evaluation of research is always a combination of data and assessment. Appropriateness of data and their level of abstraction is dependent on the evaluation context. In some contexts it is sufficient to present performance indicators only, while other evaluations include site visits and require detailed insight in processes. Evaluation contexts also differ in the kind of expertise needed for the assessment.

At the Faculty of Architecture of TU Delft the Standard Evaluation Protocol used by Dutch universities is perceived to result in an 'evaluation gap', because it fails to judge research output and dissemination activities of the faculty on its merits. First, the scientific output and communication channels common in architecture are different from the natural sciences, on which criteria and indicators in the protocol are based. Generally used criteria and indicators for scientific quality based on scientific publications and citations only provide a very limited picture of scientific quality in architecture. Secondly, important contributions of academic research to the profession, industry, policy and society are only to a limited extent part of the evaluation process. Although relevance is a criterion in the current SEP, it hardly addresses how to evaluate societal relevance.

The faculty has a Research Portfolio Architecture and the Built Environment, which aims at playing a key role in the architectural development of the western part of The Netherlands and to develop a strong international presence, exploiting the reputation of Dutch architecture and spatial planning and the significance of the Randstad as a predominant European region.

According to the Faculty, strengths in this portfolio can be found in:

- healthy, energy efficient, comfortable buildings in social inclusive neighbourhoods
- modelling and performance in architecture, building technology and urban development
- design and strategies for the urban society
- research by design and mapping in architecture, landscape architecture and urban design
- managing complexities of the built environment
- historical, cultural and theoretical underpinning.

Research activities of the individual groups are expected to fit within the vision and mission of the Faculty of Architecture (Box 6. 1). As the Faculty states: *'the mission should be executed in the full spectrum of the field of activities of the Faculty, in a combination of technique, context and creativity.' Examples are 'excellent international academic reputation', and on the other hand 'the transfer to bidders, (sub) contractors and suppliers in governments, institutes and companies.'* The Faculty aims to serve a broader audience than just the scientific audience.

The Faculty states that its mission should be executed *'in a combination of technique, context and creativity'.* These contexts need not to be the same for all research activities. The results can be of interest to different types of stakeholders, originating from different domains. Different stakeholders may also use or require different ways to disseminate knowledge. This involvement in relevant social domains is central to the method we have developed. The evaluation method enables the faculty to be accountable on the extent in which the mission is realized and enables the faculty to improve it research strategy, to make it more effective.

Box 6.1 Vision and Mission of Faculty

Vision:

- To consolidate and make use of her excellent international academic reputation as a leading design academy;
- To be a national platform for innovation of design, technique and process;
- To be platform for the debate on current and social themes in architecture.

Mission:

- To educate international leading bachelors, masters and PhD students primarily on architectural design and secondary on constructing and managing;
- To perform excellent and innovative research of design, technique and process;
- To transfer [the outcomes of] it to bidders, (sub) contractors and suppliers in governments, institutes and companies.

6.1 Research by Design

We observed that respondents experience a severe tension between the demands and criteria imposed by funding agencies and external research assessments and the aim of architecture, planning and building construction to be relevant for the professional world. This tension is reflected in the various ways the respondents define the concept of 'Research by Design', which is used within the faculty to conceptualise the specific characteristics of architecture and building research and practice. We have used this concept as a starting-point for the project.

Central to the discussion on 'Research by Design' is the level of scientific rigor of the design activities. These activities entail building theory, appropriate research methods, communication patterns, scientific critique, etc. This scientific rigor however has to be balanced with specific contextual demands of this field such as reflection and creativity in the design process. The concept thus encompasses a broad typology of research activities situated on an imaginary axis ranging from intuitive design on the 'art' side of this axis towards optimising scientific research on the 'science' side of the axis.

The Research by Design concept includes four categories of research:

- evaluation research, which is characterized as the empirical study of existing objects and processes. It analyses effects and consequences which become manifest once architectural objects or processes have been realized.
- historical research, which interprets, understands and explains designs, while paying attention to site characteristics.
- conceptual research is exploratory and experimental and aims at innovative, revolutionary concepts, manifestos and visions on the built environment.
- practical research is research done for educational purposes and in professional practices. It refers to the research architects, spatial planners and building technologists do to find optimum solutions for a certain building assignment.

These different categories of research have different goals and they relate in various ways to each other and to domains of application, they produce different types of output, and have interactions with different stakeholders. A short description of the research types and their specific output and stakeholders can be found in table 6.1.

Table 6.1 Four types of research

	Evaluation Research	Historical Research	Conceptual Research	Practical Research
Output in the form of Texts	ISI Publications Professional Publications Policy Reports	Books	Conference Proceedings	
Output in the form of Non-Texts	Tools	Exhibitions (and catalogues)	Exhibitions (and catalogues) Designs (Drawings/ Computer Animations/ Scale Models/ (Prototype) buildings or constructions)	Exhibitions (and catalogues) Designs (Drawings/ Computer Animations/ Scale Models/ (Prototype) buildings or constructions)
Scientific Stakeholders	Peers	Peers	Peers	
Potential Societal Stakeholders	Architects Urban Designers Spatial Planners Building Contractors Governments (Municipalities/ Provinces/National Government)		Architects Spatial Planners Building Contractors Building Managers Governments (Municipalities/ Provinces/National Government)	Client who commissioned the work

The conceptual phase indicated that the output of research in architecture and building sciences is much broader than in traditional disciplines. To illustrate, exhibitions, designs, and visual displays are an important result from research and contribute to the body of knowledge of the field.

This finding is in accordance with Strand (1998) and Donovan (2005), who explore possibilities to identify a comprehensive range of research outputs from the creative arts that is in line with generally accepted criteria for scientific rigor. They argue that in the creative arts there are mechanisms of public scrutiny, judgement by independent experts that reflects a reasonable standard of intellectual rigor. The concept of research used by the Research Assessment Exercise in the UK provides an established definition which may include such research outputs as well:

''Research' for the purpose of the RAE is to be understood as original investigation undertaken in order to gain knowledge and understanding. It includes work of direct relevance to the needs of commerce, industry, and to the public and voluntary sectors; scholarship; the invention and generation of ideas, images, performances, artifacts including design, where these lead to new or substantially improved insights; and the use of existing knowledge in experimental development to produce new or substantially improved materials, devices, products and processes, including design and construction. It excludes routine testing and routine analysis of materials, components and processes such as for the maintenance of national standards, as distinct from the development of new analytical techniques. It also excludes the development of teaching materials that does not embody original research.' (RAE 2008)

The British Research Assessment Exercise (RAE 2008), the sub-panel H30 on architecture and the built environment received 2653 outputs for assessment of which 64% were journal articles, 9% chapters in books, 8% conference contributions, 7% designs, 6% monographs and further edited books, reports, internet publications and patents. The sub-panel judged every output on its merits and found excellence in the full range of these outputs.

6.2 Exploring bibliometric data

Current evaluation practices in the academic world tend to take for granted that scientific publications in ISI journals are the main publication outlet. Many research groups, and as a result whole disciplines, have changed publication behaviour likewise. Still, disciplines have an own publication culture and for some ISI journals do not function as the main platform for scientific communication.

We analyzed the publication pattern of nine departments of architecture (mentioned as benchmark partners of Delft) analyzed using the ISI Web of Science Databases (1988-2009):

- Delft University of Technology, Faculty of Architecture;
- The University of Sheffield, School of Architecture;
- University of Cambridge, Faculty of Architecture and Art History, Department of Architecture;
- University of Reading, Henley Business School, School of Real Estate and Planning;
- MIT, Department of Architecture;
- Eindhoven University of Technology, Faculty of Architecture, Building and Planning;
- Ghent University, Faculty Engineering Sciences, Department of Architecture and Urban Planning;
- Katholieke Universiteit Leuven/ Catholic University Louvain, Department of Architecture, Urban Design and Regional Planning;
- ETH Zürich, Faculty of Architecture (D-Arch).

All publications of the last two decades (1988-2009) included in the ISI Databases by the nine departments selected on address are included in this analysis.

The nine departments of architecture in general become more visible in the ISI databases over the last decade. The number articles published in ISI journals by these departments is growing fast. Construction and building technology, engineering, energy and environment are the topics best represented in the ISI-articles of the nine departments. From the dataset we conclude that there relevant international scientific journals on architecture and construction and building technology and engineering are included in the ISI databases. Architecture is next in line.

Of the 642 publications by the nine departments over the last two decades, three-quarter is an article, just above ten percent is a publication in conference proceedings and five percent is a book review. The 15.400 references in these publications show a small core of journals cited more frequently and indicate that dissertations are part of the publication culture. Only very few publications and other sources are cited by more departments. In general cited sources are very scattered, being cited only once or twice (96% of all citations). This suggests that architecture is an eclectic field of scientific activities lacking a clear delineated set of relevant publications or journals or a disciplinary publication pattern.
In addition to the analysis of publications in the ISI databases an analysis is made of the total set of journal publications by Delft Leuven and Ghent in the period 2004-2008. This analysis confirms the lack of a disciplinary publication pattern.

A benchmarking study of scientific performances of nine architecture faculties/departments shows that a small sample of scientific journals is covered by ISI databases. The publication presence of Delft in these journals is lower than those of Eindhoven, Cambridge and MIT, comparable to that of Sheffield and higher than the other four. Results have not been controlled for the size of the respective departments.

Data on scientific publications in ISI journals have to be included in an evaluation report, as part of the full performances in the evaluation period. The results of publication and citation patterns in architecture show that these publications are insufficient as a sole indicator of scientific quality of architecture research. For an assessment of the research quality of the programs, information about program, other scientific outputs and good peer assessment will be required and probably of more value.

6.3 Evidence of research quality

Research by Design refers to a research practice in which communication about results is done through a range of outputs. The assessment of the quality of the results is not done by scientific peers only. Results aim to support professionals in the field to solve real world problems and thus professionals have a role in the assessment and validation of the results and the translation of such results in accepted knowledge. Is it possible to operationalize the concept of Research by Design, its related understanding of research quality and its practices into a set of indicators for research quality to be used in an evaluation?

A draft set of indicators was discussed with administrative staff of the Faculty and researchers. To fine tune indicators and to explore other suggestions by the feedback group, we held eight interviews with research programme leaders. Results of the interviews have led to seven dimensions of architectural research quality and related indicators and other forms of evidence. Table 6.2 gives the full overview.

To test the usefulness of these indicators, we have taken two of the faculties research programs, ‘Housing’ and ‘Randstad Centre for Strategic Spatial Planning and Design’ and used data from the program proposals from late 2009, as agreed with the Faculty. The results of this test are found in the appendices and are disappointing. It is unlikely that the data represent all performances and represent the actual quality of TUD architecture research. The proposals provide more information about the future than the past, while the indicators - and the SEP protocol - concern past performances. In the project, a wide range of possible outputs has been presented and discussed in addition to scientific publications. The perceived importance of these outputs for the dissemination of results from ‘Research by Design’ is in contrast with the data we could gather. We could list professional publications, but did not found much evidence of professional training activities, consultancy, artefacts or, standards, despite their claimed importance.

Collaborations with stakeholders increase the likelihood that research is of relevance for society and will have an impact upon architecture related policies and practices. We have distinguished four types of collaborations.

- Commissioned research by societal actors;
- Earmarked/structural funding related to societal theme;
- Actual collaboration in research, testing, evaluation with stakeholders;
- Establishment of consortia including non-academic organizations.

These can be used to present evidence about contract research and collaborations with stakeholders and allow an assessment of the intensity of the collaboration.

If societal stakeholders are expected to give input beyond their own direct experiences (as we expect also from scientific peers) and assess as it were on behalf of architectural practices and policies, interviews are not sufficient. For both programs, we interviewed stakeholders suggested by the program leaders. These stakeholder interviews are a valuable source of information as evidence on different aspects of research quality. But more needs to be done to improve stakeholder input. Stakeholders have clear opinions about research programmes that provide interesting information about the interactions with researchers and the use of results in architecture practices. We noticed stakeholders regularly perceive they are stakeholder of the programme leader instead of the research programme. Some researchers have a similar perception; they sometimes perceive personal contacts as stakeholders. In some cases, contacts with these stakeholders concern projects from previous appointments. Instead it might be useful to organise focus groups with a set of experienced stakeholders, include meetings between the peer committee and some of the stakeholders and/or include stakeholders in the peer committee.

6.4 Elaborating the SEP protocol

Evaluation of university research is structured by the SEP protocol, which tells that research groups have to write a self evaluation report on their performances as an input for the evaluation by the peer committee. Table 6.2 could be used to structure the evidence that has to be presented in the self evaluation report, but it deviates from the structure suggested by the SEP protocol 209-2015. If one wants to use the protocol as rule set for the evaluation process, the items need to be structured differently. This section describes how societal contributions can be included in a standardized self evaluation report, as well as lists some issues for the peer committee to be addressed.

The current SEP protocol lists societal contributions of research as one of the four aspects on which the peer committee is asked to score the research group. Compared to most of the SEP evaluations conducted so far, there is a double evaluation gap:

(1) it is unclear which evidence should be collected of societal contributions as part of the self evaluation;
(2) it is unclear who is able to assess the contributions. In the past committees have refused to assess the contribution to society, seeing themselves as peers from the scientific community, not peers from society at large.

The results of the ERiC pilot can be used in combination with the SEP protocol in two different ways. The first is to use the results to structure criterion 3 of the SEP protocol 'Societal Relevance'. This approach is useful to disciplines in which societal relevance is regarded less important. In architectural research though in many of its subfields scientific and societal knowledge production, and hence performance, reputation and notions of quality are strongly connected.

The second way to use ERiC results, is more appropriate for fields like architecture which are embedded strongly in professional or other societal contexts, and for research groups and organisations which explicitly aim at societal contributions. For those cases, it is more appropriate to integrate evidence on societal relevance of the research with other evidence required in a self-evaluation according to the SEP protocol. Table 6.3 specifies how the self evaluation items required by the Standard Evaluation Protocol can be improved for architectural research using the results of this pilot study. In this table, the item on societal relevance is filled in by focusing on those research contributions which had or are likely to have specific impacts on architectural practices and policies. In addition other sections in the self evaluation can also be improved by including mission, strategy and performances that acknowledge the professional contexts of architectural research.

Table 6.2 Dimensions and Indicators

Dimension	Indicator / evidence
Scientific Quality	As defined in SEP: Quality and scientific relevance of the research: Originality of the ideas and the research approach Significance of the contribution to the field Coherence of the programme Quality of the scientific publications
Scientific Production	Articles in refereed journals or journals with a clear editorial strategy to select on academic quality Book chapters presenting new work (mostly subjected to editorial scrutiny) Books, monographs, catalogues Conference papers Edited volumes of conference proceedings Major reviews of literature or of exhibitions. PhD Theses
Scientific Recognition	Visibility in the scientific community Editorships journals/international books or 'service to journals' Election to academies or academic professional associations Prices and awards, honorary positions Invited lectures, international conferences
Responsiveness of agenda setting	Societal concerns and issues are explicitly addressed in the research design/programme Interaction with stakeholders to establish relevance, ranging from occasionally to full dialogue Relevant recent experience of researchers as a practitioner in societal domain/ practice/ government Positive evaluations or external funding related to societal/commercial issues
Collaboration with (potential) users	Commissioned research by societal actors Earmarked/structural funding related to societal theme Actual collaboration in research, testing, evaluation with stakeholders Establishment of consortia including non-academic organizations
Dissemination and knowledge transfer related to the mission	Production of texts/professional publications/non scientific publications/exhibitions Dissemination of technology/artefacts/standards Advisory and consultancy roles Popularization/education/contributions to societal debate Training of professionals/mobility/master theses
Actual results, impact and use of research	Convincing examples of use of outcomes of research Satisfaction/recognition of alumni and stakeholders Substantial returns or economic value of outputs of research Visibility in the public debate/media rankings

Table 6.3 Structure of SEP self evaluation report with results EriC pilot

SEP item	SEP explanation	Results of ERiC pilot
Objectives and research area	Vision, mission and objective(s) of the institute Research area and programmes	Responsive of agenda towards societal concerns and issues
Composition	Composition of the research unit to be evaluated, based on two indications • total number of employees in each job category (including contract-PhD candidates) and • overview of the various sources of financing (internal and external)	Add • Staff with part time position in external organisations (architecture bureaus, policy bodies, consultancy) Specify: • Commissioned research by societal actors • Earmarked/structural funding related to societal • concerns/issues
Research environment and embedding	• National and international positioning ('soft' benchmarking based on SWOT-analysis), • number and affiliation of guest researchers (internally and externally funded)	Add • Actual collaborations with stakeholders • Participation in consortia
Quality and scientific relevance	• 3-5 most significant results/highlights relevant to the discipline, per group/subgroup • 3-5 key publications per group/subgroup (references; full text may be published on secluded website) • Number of articles in top 10% of publications relevant to the discipline; ditto for top 25% • 3-5 most important books or chapters of books, insofar as applicable	Add: • 3-5 most important dissertations (criterium: citations in journals or published as book = handelseditie) • 3-5 most important events • 3-5 most important exhibitions
Societal relevance: quality, valorisation and impact	Socio-cultural and/or technical or economic quality, impact, valorisation	This section can be based on four issues: • Describe the most significant knowledge contributions made in the review period to architectural practices and policies. • Evidence of the appreciation of stakeholders of these contributions. • Strategies of how these contributions have been disseminated (outputs, media) • Evidence of impacts of these contributions
Output	• Number of publications • Number of PhDs (completed and in progress) • Use (number of users) of research facilities (if part of institute's mission)	• Number of conference papers • Edited volumes of conference papers • Number of major reviews of literature and exhibitions
Earning capacity	Acquiring projects and programmes through competitive funds, public and private, national and international	

SEP item	SEP explanation	Results of ERiC pilot
Academic reputation	Most important signs of recognition for research staff (prizes, awards, invitations to address major conferences, conference organisation activities, editor-ships, membership of academies)	Include professional reputation, based on roles in professional contexts, policy making etc. If available include stakeholder feed back on quality of the group.
Viability	Viability of the unit to be evaluated, in terms of resource management, avail-able infra-structure and innovative capacity	
Next generation	Information about PhD training	
SWOT Analysis	Procedure and outcomes of the SWOT-analysis (SWOT analysis proper may be published on the secluded website) Conclusions regarding strategy and activities based on the SWOT-analysis	
Strategy	Based on the SWOT analysis	

As said, evaluation is a combination of evidence and assessment. The self evaluation report presents the evidence. The actual assessment (apart from the SWOT analysis) has to be done by the peer committee. Peer committees have had difficulties to assess societal relevance of the group's research. The results in this pilot give some suggestions which may facilitate the assessment of societal contributions.

The first set of suggestions regard the introduction of stakeholders from architecture practices policies into the evaluation procedure. One possibility, tested in this report is to interview stakeholders about their perception of the group's results. The advantage is that a range of stakeholder perceptions can be included. The drawback is that it is often unclear on which experiences and insights these perceptions are based, and when it is clear, they often reflect only a small part of the performances of the research group. Two other possibilities would be:

- to include highly reputed professionals from architecture and spatial planning into the peer committee, or
- to include in the site visit of the peer committee a meeting with some of the main stakeholders.

The other suggestion is that to improve the checklist in the Standard Evaluation Committee for the committee. While for the assessment categories: 'quality', 'productivity' and 'viability and feasibility' several items are listed to be checked, for societal relevance, none is specified. The committee could improve the score on societal relevance by distinguishing between:

- societal relevance of actual results
- strategy for dissemination of results
- impacts realised

Like for the other items in the protocol, these can also be scored on a 1-5 scale.

Pilot Study at Faculty of Architecture TU Delft

Appendices

Appendix A: Full test results

This appendix contains the information sheets of the two groups included in the test as described in Chapter 5. Since the dimension scientific quality is in line with SEP, this indicator has not been tested.

Asterisks indicate a reference to stakeholder interviews, where more information can be found concerning the indicator.

A.1 Research programme 1: Housing

Programme Leader: Dr. Vincent Gruis

Mission The Housing research programme aims to develop knowledge that can be used to support the transformation and management of the housing stock and related services. The scientific ambition of the housing programme is to adapt knowledge from policy and management studies to the processes and organisation of sustainable housing transformation and management. Thereby it aims to develop theories and approaches that are suited to cope with the specific challenges within housing as well as to contribute to general theories on policy, management and organisation. With this ambition, research is focussed on two themes: - Sustainable Housing Transformation, which studies the processes for stimulation and dissemination of innovations that contribute to the sustainability of the housing stock; - Social Entrepreneurship in Housing Management, which studies the way in which housing organisations (can) adapt themselves and their activities to changing demand for housing and related services.

Input

		Remarks
Annual Budget	€ 507,770 (€ 1,010,910 including BTA)	Prognosed Budget 2009-2012
1st stream	€ 309,320	
2nd/3rd stream	€ 198,450 (€ 503,140 including BTA)	2nd and 3rd stream is presented as one number, while the financial means originate from different types of sources; 2nd stream originates from research councils, 3rd stream originates from private parties. By presenting 2nd and 3rd stream as one number, it is not clear what share of funding is based on questions and issues important to stakeholders from society. Furthermore, BTA income is presented as 2nd/3rd stream money, while it originates from the university and is based on scientific productivity and activity.
FTE/Year (Tenured)	8,3	

Valorization Partners

Partner	Description of Valorization Proces/Value	Remarks
Central Housing Fund	-	Valorization partners and valorization processes are described apart from each other. Therefore, the value of the research for partners is difficult to determine. This could be improved by a short description on the valorization process/value for each partner.
AEDES (interviewed)	-	
SEV	-	
Housing Associations	-	
VROM	-	

Scientific Quality

Indicator	Evidence	Remarks
As defined in SEP: Quality and scientific relevance of the research: originality of the ideas and the research approach Significance of the contribution to the field Coherence of the programme Quality of the scientific publications	Not tested	

Scientific Production

Indicator	Evidence			Remarks
	2005	2006	2007	
Articles in refereed journals or journals with a clear editorial strategy to select on academic quality	7	9	3	Output productivity is presented in combination with another research programme. The programmes are part of the same research group on the administrative level, but seem to be distinct groups on the research level. Therefore, it would be clearer to present output productivity for individual groups, which will better represent the productivity of a programme.
Book chapters presenting new work mostly are subjected to editorial scrutiny	1	0	4	
Books, monographs, catalogs	0	1	0,5	
Conference papers	14	28	14	
Edited volumes of conference proceedings	-			
Major reviews of literature or of exhibitions	-			
PhD Theses	2			See other remarks about combined presenting of output with other research programmes.

Scientific Recognition

Indicator	Evidence	Remarks
Visibility in the scientific community	The programme leader is coordinator of the working group on Housing Research and has lead tow large international comparative research projects: Asset Management in the Social Rented Sector' and 'Management of Privatised Housing'. Furthermore, he is a senior researcher within NETHUR and has been a reviewer for among others Urban Studies, Housing Studies and Journal of Housing & the Built Environment.	
Editorships journals/international books or 'service to journals'	2005: 0 2006: 0 2007: 1	These types of activities are presented in combination with another research programme. The programmes are part of the same research group on the administrative level, but seem to be distinct groups on the research level. Therefore, it would be clearer to present these types of activities for individual groups, which will better represent the productivity of a programme.
Election to academies or academic professional associations	-	
Prices and awards, honorary positions;	-	
Invited lectures, international conferences	-	

Responsiveness of agenda setting

Indicator	Evidence	Remarks
Societal concerns and issues are explicitly addressed in the research design/programme	Key research questions: How do or can housing organizations adapt themselves and their activities to changing demand for housing (related) services?	
Interaction with stakeholders to establish relevance, ranging from occasionally to full dialogue	Expertmeeting Adviesraden - an expertmeeting with housing managers organised within MOVe Expertmeetings Bedrijfsconcepten in Beeld - Three expertmeetings with directors of housing associations (MOVe)*	
Relevant recent experience of researchers as a practitioner in societal domain/ practice/ government	A part of the group has experience in the practice of housing organizations.	
Positive evaluations or external funding related to societal/commercial issues	*	

Collaboration with (potential) users

Indicator	Evidence	Remarks
Commissioned research by societal actors	Clients are Central Housing Fund, AEDES (€ 8.320, SEV (€ 23.120) and several Housing Associations. Co-funding by Cartesius, PeGo, Meer met Minder and Seinen. Mixed funding has also taken place in the so-called Corpovenista programme. Additional external resources are received from TRESPA Intern BV (€ 11.515, National Renovation Contest), Far West (€ 15.000, Assessment Housing Stock), RMO (€ 4.201, book chapter), and ATRIVE (€ 2.862, presentations). Ministry of Housing (VROM) is another valorization partner.	It remains unclear in some cases whether the research is commissioned or research is structurally funded over longer periods of time
Earmarked/structural funding related to societal theme	Sponsorship of PhD research by Woonbron (€ 17.500).	
Actual collaboration in research, testing, evaluation with stakeholders	Together with AEDES, a symposium has been organized.	
Establishment of consortia including non-academic organizations	Together with ECN, TNO and DHV the research group is one of the leading participants in the RIGOREUS programme, which is partly funded by SenterNovem (€ 60.000).	

Dissemination and knowledge transfer related to the mission

Indicator	Evidence	Remarks
Production of texts/professional publications/non scientific publications/ exhibitions	Organization of Symposium Professionals in 't veld - a yearly symposium organised within the research theme social entrepreneurship in housing management (MOVe) Organization of Expertmeeting Klantenpanels - an expertmeeting with housing managers organized within MOVe) Symposium MOVe - a yearly symposium within MOVe Essay Vastgoedondernemer of wijkregisseur – nominated essay competition Vitale Stad (Gruis and Van Kerkhoven) Essay Verre vriend of goede buur - Winning Essay SEV competition (Van Bortel, Gruis, Nieboer and Mullins)	Like groups are requested to list the five main publications, it might be useful to list five main professional outputs and explanation of their importance for the SEP evaluation.
Dissemination of technology/artefacts/ standards	*	
Advisory and consultancy roles	The programme leader is member of the board of supervisors of two Dutch housing associations and the Commissie AedesCode.	
Popularization/education/contributions to societal debate	-	
Training of professionals/mobility/ master theses	Together with AEDES, master classes have been organized.	

Actual results, impact and use of research

Indicator	Evidence	Remarks
Convincing examples of use of outcomes of research	*	
Satisfaction/recognition of alumni and stakeholders	*	
Substantial returns or economic value of outputs of research	*	
Visibility in the public debate/media rankings	*	

Stakeholder Interviews

Stakeholders interviewed about the group Housing are AEDES, an association of housing associations; Maatschappelijk Forum Wonen (MFW) a public organisation involved in monitoring housing corporations; and de Woonbond, a tenant representatives organisation.

Concerning the research agenda, AEDES indicates it is interesting because of short term research on actual issues from practice. De Woonbond says the view of the programme leader and their view on housing show large similarities, which makes the research agenda interesting to them. MFW has sponsored the MOVe research program as its final attempt to get attention for social commitment of housing associations.

AEDES and de Woonbond say the group has no formal strategy for structural interaction with stakeholders. AEDES adds contact was most of the time initiated by them. At the moment, AEDES has informal meetings with the programme leader several times a year to discuss activities and opportunities for collaboration. MFW says there is a strategy, but is unable to define it.

Joint dissemination of results is difficult according to the Woonbond. It could harm the integrity of the group and thereby their message. Since the message often is of interest to De Woonbond, it would also harm their interests. MFW and the Woonbond expect that the message of a scientific research group will have more weight than their own message.

All interviewed stakeholders have a positive opinion about strengths of and opportunities for the Housing programme. According to AEDES, strengths are short term results on relevant research topics for housing associations and the programme leader himself who is knowledgeable in the field. Of all relevant research groups in the Netherlands, AEDES has best and most structural contacts with Housing. Experience of De Woonbond is in line with that. Strength of the group is researchers are well known with practice, instead of being desk researchers. An important difference with other universities active in the same field (Rotterdam, Maastricht and to a lesser extent Amsterdam) is Housing focuses on social aspects, while others focus more on financial aspects of housing.

MFW adds a strength of the group is its independency and its academic view on housing. AEDES and Woonbond say opportunities are even more focus on questions and issues from practice and investigating who stakeholders are and whether they value the research.

Evidence of actual use of research outcome is provided by AEDES and de Woonbond. The research on the position of commissioners of housing associations has been published in AEDES magazine and has been referred to in a letter from Minister Van der Laan of Living, Neighbourhoods & Integration to the Parliament. Furthermore, the association has used business models constructed by the group, to guide transition trajectories and it has used research on involvement of stakeholders of housing associations in policy making. De Woonbond indicates that their shared view with the programme leader can be directly recognized in an advice of the VROMraad. The VROMraad consulted the programme leader and de Woonbond among others.

The kick-off meeting of the joint project with MFW was scheduled after the interview, so concrete results could not be discussed. However, MFW has received many positive reactions after signing the contract with the group. It was broadly believed by third parties the research was the best way to reach the goals of this organisation. Even before initiation, third parties were interested in results. According to MFW, it appears the results are of interest to housing associations and consultancy offices among others. MFW believes the outcomes of the research will be shocking for the sector, but the organization will also be satisfied without this type of outcomes.

A.2 Research Programme 2: Randstad Centre for Strategic Spatial Planning and Design

Programme Leader: Prof. Vincent Nadin

Mission: The Randstad Centre investigates the changing spatial structure of complex urban regions and how intervention in that process through strategic spatial planning and design can be improved. The aim is to develop theoretical insights and new data through the study of the Randstad and other complex regions, and to communicate this effectively to policy makers and designers so as to inform practice.

Input

		Remarks
Annual Budget	€ 1,180,306 (€ 2,120,504 including BTA income)	Prognosed Budget 2009-2012
1st stream	€ 987,186	
2nd/3rd stream	€ 193,120 (€ 940,198 including BTA income)	2nd and 3rd stream is presented as one number, while the financial means originate from different types of sources; 2nd stream originates from research councils, 3rd stream originates from private parties. By presenting 2nd and 3rd stream as one number, it is not clear what share of funding is based on questions and issues important to stakeholders from society. Furthermore, BTA income is presented as 2nd/3rd stream money, while it originates from the university and is based on scientific productivity and activity.
FTE/Year (Tenured)	21,96 (2009)	

Valorization Partners

Partner	Description of Valorization Proces/Value	Remarks
EU 7th Framework Programme - Theme 8: Socio-economic sciences and humanities		Valorization partners and valorization processes are described apart from each other. Therefore, the value of the research for partners is difficult to determine. This could be improved by a short description on the valorization process/value for each partner.
Province Zuid Holland		
NWO		
City of Amsterdam		
City of Rotterdam		
City of The Hague		
City of Zoetermeer		
Port of Rotterdam		
City of Almere		

Scientific Quality

Indicator	Evidence	Remarks
As defined in SEP: Quality and scientific relevance of the research: originality of the ideas and the research approach Significance of the contribution to the field Coherence of the programme Quality of the scientific publications	Not tested	

Scientific Production

Indicator	Evidence			Remarks
	2005	2006	2007	
Articles in refereed journals or journals with a clear editorial strategy to select on academic quality	15	15	28	
Book chapters presenting new work mostly are subjected to editorial scrutiny	8	14	22	
Books, monographs, catalogs	4;	6	8	
Conference papers	45	45	45	
Edited volumes of conference proceedings	-			
Major reviews of literature or of exhibitions	-			
PhD Theses	7			

Scientific Recognition

Indicator	Evidence	Remarks
Visibility in the scientific community	The faculty has excellent international teaching and research networks. Members of the Randstad group are centrally involved in these links through organization of conferences, masterclasses, studios, joint publications and particulary through the International Federation on Urbanism.	Mentioning or describing these networks would improve the reliability of this statement.
Editorships journals/international books or 'service to journals'	2005: 5 2006: 5 2007: 5	
Election to academies or academic professional associations	-	
Prices and awards, honorary positions	-	
Invited lectures, international conferences	-	

Responsiveness of agenda setting

Indicator	Evidence	Remarks
Societal concerns and issues are explicitly addressed in the research design/programme	The Randstad is adressed in the NWO Programme Sustainable Accesability in the Randstad. The Netherlands Government has identified the future development of the Randstad as a critical issue in its Randstad 2040 Programme. Urbanisation is central to the critical issues of our time (see e.g. UN-Habitat 2007, UNECE 2000, South Afrika, 2001) The social and political significance of this field of work is illustrated by the intention of the European Union to make 'territorial cohension'one of its central goals alongside sustainable development and economic competi-tiveness. The PhD project of C. Sezer seeks ways to analyze public visibility quality of the streets to facilitate the comcept as a spatial tool to improve living quality of disadvantaged urban areas in Amsterdam.	
Interaction with stakeholders to establish relevance, ranging from occasionally to full dialogue	Aspects of the programme are dis-cussed with TRAIL, Vereniging Delta Metropool and Ministry of VROM.	Describing the way the programme is discussed would improve reliability. There is a difference in a discussion in the lunch break during a conference and discussions in a series of organized meetings about the programme.
Relevant recent experience of researchers as a practitioner in societal domain/ practice/ government	Prof. Schrijnen is a practice professor and a leading figure in spatial planning and design in The Netherlands. He has recently played a leading role in plan-ning in Rotterdam, regional plan ning in South Holland and master-planning the expansion of Almere. Prof. Meyer has professional experience in City Planning Department Rotterdam. Ir. Brandes has professional experience in urban planning and urban design.	
Positive evaluations or external funding related to societal/commercial issues	NWO PhD scholarship (€ 175,117)	

Collaboration with (potential) users

Indicator	Evidence	Remarks
Commissioned research by societal actors	Interreg (€ 131.917+103,918 (2 projects)), Proeftuin Rijnland (€ 60.000).	
Earmarked/structural funding related to societal theme	Thailand Government (€ 12,000 per annum for four years), China (€ 10,000 per annum for four years).	
Actual collaboration in research, testing, evaluation with stakeholders	The Randstad programme is organising the Randstad 2040 International Perspectives Event with VROM.	
Establishment of consortia including non-academic organizations	-	

Dissemination and knowledge transfer related to the mission

Indicator	Evidence	Remarks
Production of texts/professional publications/non scientific publications/ exhibitions	2005: 18 2006: 22 2007: 24	
Dissemination of technology/artefacts/ standards	-	
Advisory and consultancy roles;	-	
Popularization/education/contributions to societal debate	The questions of strategic spatial development and design are of great importance to the teaching programme as employers increasingly seek skills related to this type of work.	
Training of professionals/mobility/ master theses	-	

Actual results, impact and use of research

Indicator	Evidence	Remarks
Convincing examples of use of outcomes of research	-	
Satisfaction/recognition of alumni and stakeholders	-	
Substantial returns or economic value of outputs of research	-	
Visibility in the public debate/media rankings	-	

Stakeholder Interviews

For the Randstad Centre, the Ministry of VROM – section Planning has been interviewed and public research organization FORUM. Because of the very different relations of the stakeholders with the research group, results are discussed per stakeholder.

There is no structural relation between the Ministry and the Randstad Centre. The involved director and Prof. Nadin have recently begun to develop a structure for interacting. It is felt by the Ministry the two organizations are active on the same subjects and can make use of each other. Therefore, the respondent could mainly statements about expectations and opportunities.

The Ministry says there are ways reflect on the research agenda of the research group, although there is no formal structure to do so. The Ministry is also not aware of the current activities of the Randstad Centre.

In the other direction, there are opportunities for research groups to reflect on the agenda of the Ministry. However, the Randstad centre has given no input or reaction. Because of her independency, academic research should be able to raise social issues and to reflect on the social agenda. The Ministry expresses a great need of that and indicates opportunities for influencing the agenda and activities have been increasing in recent years. For example, representatives of the Faculty are member of the 'leerstoelencuratorium' of the Ministry which is involved in agenda setting of sponsored research chairs. Another example is the regular meetings with spatial planning professors on current topics. At the moment, the Ministry determines the topics, but professors are invited to bring up topics as well.

The Ministry would like to use knowledge of the research group –and is in need of that knowledge, to develop policy in the political domain. The Ministry also has an interest in scientific research because it is valuable in educating future policymakers.

According to the respondent, strengths are independency and reliability of academic research. Several opportunities have been mentioned. First is more interaction about current activities to facilitate cooperation and reflection. Second, in sharing knowledge, it should not only be about sharing research conclusions, but also about policy implications. Because of use of knowledge in policy making, the research group should investigate what problems policy makers face and what knowledge policy they need to solve them.

With FORUM there are formal contacts. Because of the recent start of collaborating, the two interview respondents could only provide statements about the process and not yet about obtained end results and impact. The reasons for FORUM to collaborate with universities in general are first the influx of new ideas and second an organizational shift that requires new analyses and concepts. The reason to collaborate with the research group in specific, is the international PhD programme of the TU Delft, which offers FORUM the opportunity to obtain knowledge from abroad. In the past, FORUM used to collaborate with commercial agents, but these are too expensive and the contacts lack sustainability and long term vision.

The collaboration up to present day is perceived as fruitful. FORUM has influenced the research agenda of the project by negotiating the project proposals and by regular meetings with the PhD student. Furthermore, FORUM took part in a four day international PhD conference. The participation is highly valued because of the international information that has been gathered during the conference. The collaboration in the PhD project of Ceren Sezer

resulted in a new view on users of spatial environments, by making a distinction between inhabitants and passers-by. In this project, research is jointly carried out in city districts; interesting contacts are exchanged and FORUM and the research group are actively bringing important actors together to discuss the issues that are related to the project. In the end, results could be used in EU proposals. However, because of the phase of the research, there are no final results yet.

According to FORUM, strengths are professor Nadin, who is very approachable. Next to that, the PhD project is very much about practice, making results directly applicable.

Appendix B: Bibliometric study

B.1 Search strategy

A straightforward search on address was performed using known addresses. The strategy started with a search as broad as possible to allow for variations in spelling. Based on visual inspection of the results this was narrowed down by adding additional search terms to a selection of publications only by the specific department/faculty/school, including as much variations in the spelling of the address as possible. This however does not guarantee that the complete set of ISI-publications by the specific department is included in the selections we found. Although we do expect to have selected a reasonable comprehensive and representative set of publications by the respective departments, no final conclusions may be drawn with regard to the ranking of the departments. The findings can only be indicative. The main purpose was to benchmark the publication patterns by the departments as it becomes visible from this specific set.

Search on address of department/faculty
Timespan=All Years. Databases=SCI-EXPANDED, SSCI, A&HCI.

The University of Sheffield, School of Architecture

- http://www.sheffield.ac.uk/architecture/
- Address=(Univ Sheffield SAME Dept Architect*) OR Address=(Univ Sheffield SAME Sch Architect*)

University of Cambridge, Faculty of Architecture and Art History, Department of Architecture

- http://www.arct.cam.ac.uk/Arct/Home.aspx
- Address=(UNIV Cambridge SAME Dept Architecture) OR Address=(UNIV Cambridge SAME Fac Architecture) OR Address=(UNIV Cambridge SAME Sch Architecture)

University of Reading, Henley Business School, School of Real Estate and Planning

- http://www.henley.reading.ac.uk/rep/
- Address=(Univ Reading SAME Dept Real Estate) OR Address=(Univ Reading SAME Fac Real Estate)

MIT, Department of Architecture

- http://architecture.mit.edu/
- Address=(MIT SAME Dept Architecture)

Delft University of Technology, Faculty of Architecture

- http://www.bk.tudelft.nl/
- Address=(Delft Univ Technol SAME Fac Architecture) OR Address=(Delft Univ Technol SAME Dept Architecture) OR Address=(Univ Delft SAME Fac Architecture)

Eindhoven University of Technology, Faculty of Architecture, Building and Planning.

- http://w3.bwk.tue.nl/nl/
- Address=(Eindhoven SAME Architecture SAME Bldg)

Ghent University, Faculty Engineering Sciences, Department of Architecture and Urban Planning

- http://www.architectuur.uGhent.be/
- Address=(Univ SAME Ghent SAME Dept Architect*) OR Address=(Univ SAME Ghent SAME Dept Architect*)

Katholieke Universiteit Leuven/ Catholic University Louvain, Department of Architecture, Urban Design and Regional Planning

- http://www.asro.kuleuven.be/new/asro.aspx?tabid=1&culture=nl-be&site=asro
- Address=(Univ Leuven SAME Inst Urba*) OR Address=(Univ Leuven SAME Dept Architect*)

ETH Zürich, Faculty of Architecture (D-Arch)

- http://www.arch.ethz.ch/darch/index.php
- Since use of department names seemed to be inconsistent the selection was made on topic.
- Address=(ETH Zurich)
- Refined by: Subject Areas=(ARCHITECTURE OR CONSTRUCTION & BUILDING TECHNOLOGY) AND Subject Areas=(ARCHITECTURE)

B.2 Most cited sources (journals, books, proceedings) >14 citations

SOURCE	Cambridge	ETH	Ghent	Leuven	MIT	Reading	Sheffield	TUD	TUE	Grand Total
ENERG BUILDINGS	36		22	10	45		20	9	47	**189**
BUILD ENVIRON	18		21		14		40		42	**135**
ENVIRON PLANN B	9			3	73	1	8	22	18	**134**
J WIND ENG IND AEROD				1	9		1		95	**106**
LIGHTING RES TECHNOL					25		78		3	**106**
J CONSTR STEEL RES							93		6	**99**
J ACOUST SOC AM							80	7	1	**88**
ENVIRON PLANN A				1	1	14	1	1	67	**85**
TRANSPORT RES REC									80	**80**
ASHRAE T	7		1	4	35		1	4	26	**78**
SOL ENERGY	9		8		33		15	1	1	**67**
BUILD RES INF	38			2	8		1	12	3	**64**
DESIGN STUDIES				12	7	4	30	1	8	**62**
J STRUCT ENG-ASCE							40	6	16	**62**
AUTOMAT CONSTR				4	22		1	2	32	**61**
URBAN STUD				5		36	6	13		**60**
INT J HEAT MASS TRAN			22		23			3	9	**57**
GEOGR ANAL									54	**54**
APPL ACOUST	1						43	5		**49**
J VOLCANOL GEOTH RES	45									**45**
ACUSTICA							40	4		**44**
ENVIRON BEHAV	1						20	1	22	**44**
TRANSPORT RES B-METH	1								41	**42**
ENG STRUCT							30	2	9	**41**

SOURCE	Cambridge	ETH	Ghent	Leuven	MIT	Reading	Sheffield	TUD	TUE	Grand Total
J ILLUM ENG SOC					20		20			**40**
J MARKETING RES									40	**40**
COMPUT GRAPH	4				26		5			**35**
REG STUD	1			5		8			20	**34**
TRANSPORTATION									32	**32**
TRANSPORT RES A-POL	2								27	**29**
ACI STRUCT J	2						22	2	2	**28**
FIRE SAFETY J	4						23			**27**
THIN WALL STRUCT									27	**27**
CHEM ENG SCI					19				7	**26**
J CONSUM RES							4		22	**26**
INDOOR AIR	3		6		1		2	3	10	**25**
J ENG MECH-ASCE	1			1				12	11	**25**
J SOUND VIB	3						20		2	**25**
STRUCT ENG	1						23			**24**
ECON GEOGR				3		1			19	**23**
J HYDROL									23	**23**
ANN ASSOC AM GEOGR				1				1	20	**22**
ENERGY	5		9				2	5	1	**22**
J FLUID MECH	3				15				3	**21**
NATURE	6				2		1	2	10	**21**
PROG HUM GEOG				1		3	1		16	**21**
B VOLCANOL	20									**20**
BUILD SERV ENG RES T	16			1			1	2		**20**
ECONOMETRICA	3					5			12	**20**
HOUSING STUD						3		17		**20**
MANAGE SCI									20	**20**
ASTRON ASTROPHYS	19									**19**
INDOOR BUILT ENVIRON	18		1							**19**
INT J NUMER METH ENG					3		5	11		**19**
J REAL ESTATE RES						19				**19**
J SOC ISSUES					3		13		3	**19**
INT J URBAN REGIONAL				5	1	9	2	1		**18**
LANCET	3				1		7	2	5	**18**
RENEW ENERG	5		1	1	4		6		1	**18**
SCIENCE	5				2	1	4		6	**18**
WATER RESOUR RES	2		1						15	**18**
COMPUT STRUCT							5	3	9	**17**
J ENVIRON PSYCHOL				1	1	1	4	1	9	**17**

SOURCE	Cambridge	ETH	Ghent	Leuven	MIT	Reading	Sheffield	TUD	TUE	Grand Total
J FINANC ECON						17				**17**
J OPT SOC AM A					6		10	1		**17**
J RETAILING									17	**17**
P 17 INT C AC ICA RO							17			**17**
POWDER TECHNOL					17					**17**
PSYCHOL REV							1	1	15	**17**
TRANSPORTATION RES B									17	**17**
ENERG POLICY	11						4	1		**16**
HERON							2	5	9	**16**
J PROPERTY RES						16				**16**
J REAL ESTATE FINANC						16				**16**
MARKET SCI									16	**16**
PROF GEOGR				2			1	1	12	**16**
PROG ORG COAT									16	**16**
STRUCTURAL ENG	1						13		2	**16**
AM PSYCHOL					2		10	1	2	**15**
ARTIF INTELL				8	1			3	3	**15**
ATMOS ENVIRON	2				3		1		9	**15**
COMPUTER METHODS APP	1				6			1	7	**15**
ENVIRON SCI TECHNOL			5				6		4	**15**
J STRUCT DIV ASCE							6	3	6	**15**

B.3 Delft dissertations cited

YR	THESIS	Leuven	MIT	Sheffield	TUD	TUE	Grand Total
1953	RIETEMA K, 1953					1	1
1965	SCHERPBIER G, 1965					1	1
1988	ROTS JG, 1988				6		6
1992	DEWAARD M, 1992	1					1
	SLUYS LJ, 1992				3		3
1993	FEENSTRA PH, 1993				3		3
	GROOT C, 1993					1	1
	SCHLANGEN E, 1993				2		2
	VEER FA, 1993				1		1
1994	NIU J, 1994		1				1
1995	BRODT K, 1995				3		3
1996	LOURENCO PB, 1996				3		3
1997	CHITCHIAN D, 1997				1		1
	MATOUSEK V, 1997				1		1
	VERSTIJNEN IM, 1997	1					1
	VERVUURT AHJ, 1997				1		1
	WANG W, 1997				1		1
1998	BOTH C, 1998			1			1
2000	VALVLIET MRA, 2000				1		1
	VANNEDERVEEN GA, 2000				1		1
	VANZIJL GPA, 2000				5		5
	VELDS M, 2000				1		1
2002	VANWENT K, 2002				2		2
	WENT K, 2002				1		1
2003	BUISMAN J, 2003				1		1
	KOOLWIJK JSJ, 2003				1		1
2004	DERUITER E, 2004			1			1
	DEWILDE P, 2004				1		1
2006	LUBELLI B, 2006				3		3
	YING Y, 2006				1		1
Grand Total		**2**	**1**	**2**	**43**	**3**	**51**

Appendix C: Interviews

The following people have been interviewed:

- Dr. P. (Patricia) Alkhoven en Dr.H. (Hetty) Berens
  Nederlands Architectuurinstuut, Department Collection
- Dr.ir. T.L.P. (Tom) Avermaete
  Full time associate professor (Architecture), section Architectural Composition
- Prof.dr.ir. A.C.J.M. (Mick) Eekhout
  Founder 'Octatube Spacestructures bv'
  Practice professor Structural Design (Building Technology), Chair of Product Development
  Initiator 3TU spearhead 'Building Innovation'
- Prof.dr. A.D. (Arie) Graafland
  Director Delft School of Design
  Full professor of Theory of Architecture (Architecture) on the Anthoni van Leeuwenhoek Chair
- Mr. F.A.M. (Fred) Hobma
  Full time assistant professor (Real Estate and Housing), section Building Law
- Dr. ir. F.D. (Frank) van der Hoeven
  Former associate professor (Urbanism)
  Currently Secretary Research, Faculty of Architecture Delft University of Technology
- Dr. E.D. (Edward) Hulsbergen
  Full time associate professor (Urbanism), section Spatial Planning
- Drs. H. (Hans) Ibelings
  Architecture critics
  Publisher/editor of architecture magazine 'A10'
- Prof. ir. C.H.C.F. (Kees) Kaan
  Founder and director 'Claus and Kaan Architects'
  Practice professor Architectural Design (Architecture), Chair of Relation to Practice
- Dr. V. (Vincent) Nadin
  Full time professor (Urbanism), section Spatial Planning
  Leader of the new research program 'Randstad'
- Prof.ir. M. (Michiel) Riedijk
  Founder and director Neutelings and Riedijk Architecten
  Practice professor architectural Design
- Dr.ir. L. (Lara) Schrijver
  Full time assistant professor (architecture), section Building Typology
  Leader of the new research program "Architectural Project as 'Craft'"
- Dr.ir. D.J.M. (Theo) van der Voordt
  Full time associate professor (Real Estate and Housing), section Real Estate Management
  Research coordinator of theme Real Estate and Housing

Appendix D: Workshops Participants

On Friday 10 October 2008, we organized a workshop to discuss the first results of the project in two workshops. Thus, we could come to a robust definition of quality of architecture and building sciences and consequently formulate meaningful quality criteria. Societal relevance of research, involvements of stakeholders, as well as the scientific merits of research were on the agenda of this workshop. Participants of the workshops were:

D.1 Morning Workshop

- Drs. N.S. (Nienke) Blaauw
  Project officer research, Faculty of Architecture
- Prof.dr.ir. A.C.J.M. (Mick) Eekhout
  Founder 'Octatube Spacestructures bv'
  Practice professor Structural Design (Building Technology), Chair of Product Development
  Initiator 3TU spearhead 'Building Innovation'
- Ir. R. (Reto) Geiser, ETH Zürich
  Architect
  Researcher with a focus on modern architecture and the contemporary architectural and urban discourse
  Founder of Basel-based 'STANDPUNKTE', a platform to promote emerging voices in architecture and its related field
- Ir. P. (Paul) Gerretsen
  Agent, 'Vereniging Delta Metropool'
- Prof.dr.ir. T.M.(Taeke) de Jong
  Full professor, Chair of Environmental Planning and Ecology
- Prof. ir. C.H.C.F. (Kees) Kaan
  Founder and director 'Claus and Kaan Architects'
  Practice professor Architectural Design (Architecture), Chair of Relation to Practice

D.2 Afternoon Workshop

- Prof. dr. ir. L. (Luca) Bertolini
  Professor of Urban and Regional Planning, Faculty of Social and Behavioural Science, University of Amsterdam
- Dr. L. (Lara) Schrijver
  Full time assistant professor (architecture), section Building Typology
  Leader of the new research program "Architectural Project as 'Craft'"
- Ir. D.F. (Dirk) Sijmons
  Director H+N+S Landscape Architects
  Professor on Environmental Design at Faculty of Arfchitecture, Delft University of Technology.
- Dr.ir. D.J.M. (Theo) van der Voordt
  Full time associate professor (Real Estate and Housing), section Real Estate Management

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The following organisations contribute to ERiC:
HBO-raad, KNAW, NWO, VSNU and the Science System Assessment department of the Rathenau Instituut
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