

The background of the entire page is a photograph of a large, multi-story brick building with a complex roofline, surrounded by tall, thin trees. The image is reflected in a dark blue horizontal band at the bottom. Overlaid on this background are large, white, 3D-style characters for 'BK' at the top and '10-15' at the bottom. The 'BK' characters are positioned in the upper left quadrant, while the '10-15' characters are centered and span across the middle and lower portions of the page. The '10' is positioned above the '15', and they are separated by a small white diamond-shaped separator.

# BK

**Research portfolio TU Delft**  
Faculty of Architecture and  
the Built Environment 2010-15

# 10-15



BK

**Research portfolio TU Delft**  
Faculty of Architecture and  
the Built Environment 2010-15

10 -

15

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# TU DELFT

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# BK 10-15

Over the years 2010-2015 TU Delft's Faculty of Architecture and the Built Environment (in Dutch: Bouwkunde or BK) made good progress with its research by:

- merging the Architecture faculty and the Built Environment research institute;
- streamlining its PhD research by setting-up a graduate school for doctoral education;
- co-founding an institute for metropolitan solutions in Amsterdam together with MIT and Wageningen University (targeted yearly budget: 25 M€);
- implementing good research management;
- increasing the scientific output;
- managing a project portfolio with a yearly income of 1.5 M€ in research grants, 5 M€ in contract research and up to 2 M€ in other external funding;
- ranking 3<sup>rd</sup> in the QS World University Rankings by Subject 2015 - Architecture / Built Environment.

Presented in this book is an overview of research data and policies, together with a selection of our finest research results: activities, organisations, facilities/assets, output, including indications of their use and recognition.

Now it is not the time to become complacent. Instead we should look ahead to face new academic and societal challenges and opportunities, knowing we can always do better.



# TU DELFT

## Architecture and the Built Environment

Dean:

**Peter Russell**

Director of Research:

**Frank van der Hoeven**

Inaugural lecture by Winy Maas in the Oostserre at BK-City  
on the 15th of October 2009 as part of the official opening of  
the 'The Why Factory' think tank by Ronald Plasterk, the Dutch  
Minister of Education, Culture and Science



# 1 TU Delft: Architecture and the Built Environment

## 1.1 Scope

The research of TU Delft's Faculty of Architecture and the Built Environment covers the full spectrum of design, engineering, planning, and management as far as it concerns the built environment. The Faculty's research portfolio comprises nine research programmes:

- The Architectural Project and its Foundations (APF)
- Design and History (D&H)
- Computation and Performance (C&P)
- Green Building Innovation (GBI)
- Urbanism (U)
- Innovations in Management in the Built Environment (IMBE)
- Housing in a Changing Society (HCS)
- Urban and Regional Studies (U&RS)
- Geoinformation Technology and Governance (GEO-TG)

The Faculty's research focusses specifically at improving the design and performance of buildings, districts, cities and regions in order to better meet the requirements and expectations of their users and communities. From that perspective much of the knowledge that it generates could be understood as science with a high degree of societal relevance, appealing to the curiosity of other researchers, practitioners and the broader public alike.



Diagram Research programmes TU Delft's Faculty of Architecture and the Built Environment

TU DELFT BK	2010		2011		2012		2013		2014		2015	
	Nr.	FTE										
Scientific staff	181	53	176	52	170	51	170	50	166	48	168	51
Researchers	118	60	120	57	126	56	124	55	117	52	111	52
PhD candidates	146		148		153		153		150		155	
<b>Total research staff</b>	<b>445</b>	<b>113</b>	<b>444</b>	<b>109</b>	<b>449</b>	<b>107</b>	<b>447</b>	<b>106</b>	<b>433</b>	<b>100</b>	<b>434</b>	<b>102</b>
Visiting fellows	162		148		171		170		179		179	
<b>Total staff</b>	<b>607</b>	<b>113</b>	<b>592</b>	<b>109</b>	<b>620</b>	<b>107</b>	<b>617</b>	<b>106</b>	<b>612</b>	<b>100</b>	<b>613</b>	<b>102</b>

TABLE 1.1 Research staff (composition of the research unit)

TU DELFT BK	2010	2011	2012	2013	2014	2015
Refereed articles	112	107	129	146	160	170
Non-refereed articles	32	26	14	8	5	7
Book	94	71	62	43	40	33
Book chapters	271	233	267	215	216	156
PhD theses	23	23	23	28	34	19
Conference papers	346	289	255	215	253	181
Professional publications	295	264	235	251	214	189
Publications aimed at the general public	97	68	115	63	83	96
<b>Other Research Output:</b>						
Book reviews	21	10	21	18	11	16
Appearances on radio or television	65	56	128	115	72	102
Internal reports, lectures, posters, datasets	115	131	249	291	465	555
External reports	58	97	92	87	127	88
Editorships of books	65	33	41	39	62	66
Editorships of journals	39	41	50	54	62	75
<b>Total other Research Output</b>	<b>363</b>	<b>368</b>	<b>581</b>	<b>604</b>	<b>799</b>	<b>902</b>
<b>Total publications</b>	<b>1633</b>	<b>1449</b>	<b>1681</b>	<b>1573</b>	<b>1804</b>	<b>1753</b>

TABLE 1.2 Main categories of research output

TU DELFT BK	2010		2011		2012		2013		2014		2015	
	K€	%										
Direct funding	8.431	58%	8.903	56%	7.881	56%	8.003	54%	8.533	50%	8.493	54%
Research grants	182	1%	381	2%	833	6%	1.303	9%	1.844	11%	1.531	10%
Contract research	5.139	35%	5.235	33%	4.643	33%	4.365	30%	7.091	42%	5.401	34%
Own contribution	-996	-7%	-185	-1%	-608	-4%	-643	-4%	-2.149	-13%	-1.623	-10%
Other	1.826	13%	1.472	9%	1.248	9%	1.662	11%	1.738	10%	1.933	12%
<b>Total funding</b>	<b>14.583</b>	<b>100%</b>	<b>15.807</b>	<b>100%</b>	<b>13.998</b>	<b>100%</b>	<b>14.689</b>	<b>100%</b>	<b>17.057</b>	<b>100%</b>	<b>15.736</b>	<b>100%</b>
Personnel costs	-12.026	84%	-12.168	86%	-11.680	85%	-11.579	85%	-12.629	78%	-12.064	85%
Other costs	-2.312	16%	-2.054	14%	-2.111	15%	-2.022	15%	-3.495	22%	-2.191	15%
<b>Total expenditure</b>	<b>-14.338</b>	<b>100%</b>	<b>-14.221</b>	<b>100%</b>	<b>-13.792</b>	<b>100%</b>	<b>-13.601</b>	<b>100%</b>	<b>-16.124</b>	<b>100%</b>	<b>-14.255</b>	<b>100%</b>
<b>Result</b>	<b>245</b>		<b>1.585</b>		<b>206</b>		<b>1.089</b>		<b>933</b>		<b>1.481</b>	

TABLE 1.3 Funding (research unit's financing structure)

## DEFINITIONS STAFF

<i>Scientific Staff</i>	Full professors, associate professors and assistant professors: tenured and non-tenured
<i>Researcher</i>	Researcher: tenured and non-tenured
<i>PhD candidates</i>	Standard PhD's (employed) and Contract PhD's (externally or internally funded but not employed)
<i>Visiting Fellows</i>	All guests: full professors, associate professors, assistant professors and researchers, excluding PhD candidates
<i>Nr.</i>	Actual number of staff members
<i>FTE</i>	Calculation based on actual FTE and the number of months employed. In the case of scientific staff the research time is calculated as 40% of the overall employment and 80% in the case of researchers

## DEFINITIONS OUTPUT

<i>Refereed article</i>	Article published in a journal that is validated as 'refereed' in Ulrichsweb, and/or is indexed in the Web of Science and/or Scopus
<i>Non-refereed article</i>	Article in an academic journal, lacking external validation of being 'refereed'
<i>Book</i>	All books without making a distinction between academic, professional and popular.
<i>Book chapter</i>	All book parts without making a distinction between academic, professional and popular books chapters
<i>PhD-theses</i>	All PhD theses defended at TU Delft by PhD candidates who are registered in the Graduate School for Architecture and the Built Environment
<i>Conference papers</i>	All conference papers without making a distinction between academic and professional conferences.
<i>Professional publication</i>	Articles in non-academic journals
<i>Publications aimed at the general public</i>	Publications aimed at the general public: contributions to newspapers/weeklies.
<i>Other Research Output</i>	Datasets, external reports, lectures, internal reports, editorships

## DEFINITIONS FUNDING

<i>Direct funding</i>	Lump-sum budget received from TU Delft
<i>Research grants</i>	Funding obtained in national scientific competition (e.g. grants from NWO and the Royal Academy)
<i>Contract research</i>	Funding obtained for specific research projects from external organisations, such as industry, government ministries, European organisations and charitable organisations
<i>Other</i>	Funding that does not fit the other categories, such as chair positions directly funded by government or industry

TABLE 1.4 *Definitions, used in the tables*

Contribution of the various research programmes in selected output

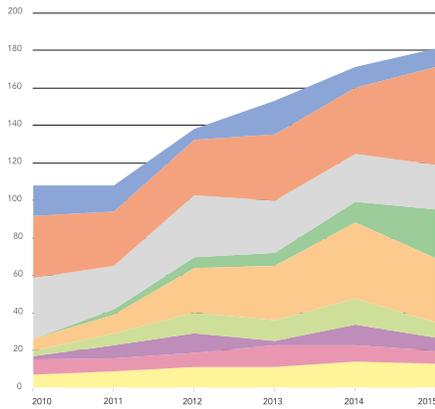


FIGURE 1.1 Refereed journal articles, in absolute numbers

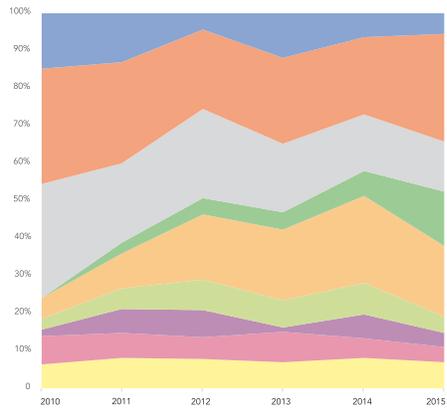


FIGURE 1.2 Refereed journal articles, in percentages

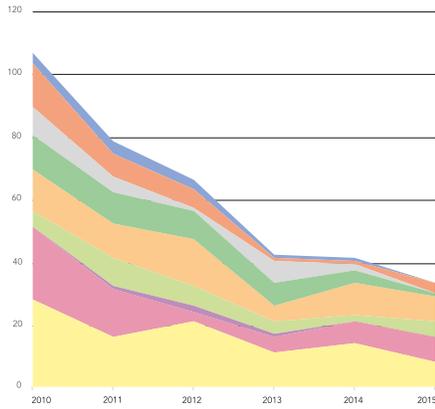


FIGURE 1.3 Books, in absolute numbers

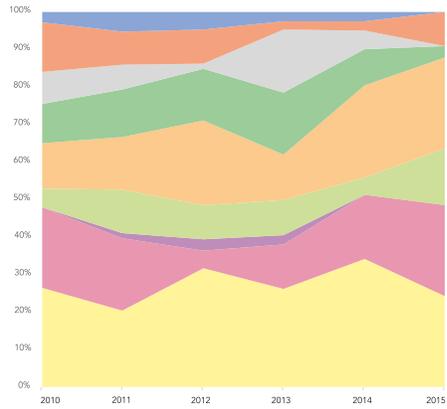


FIGURE 1.4 Books, in percentages

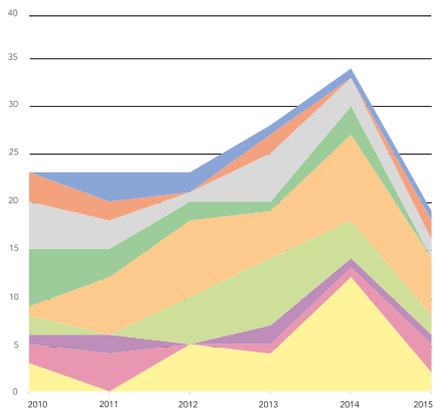


FIGURE 1.1 PhD theses, in absolute numbers

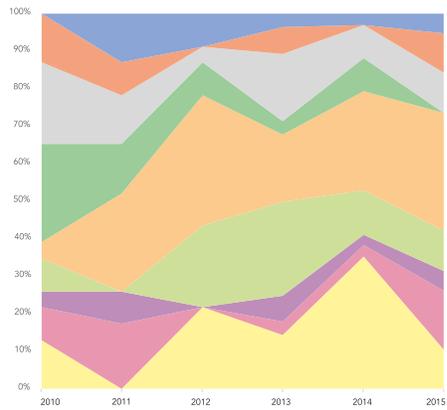


FIGURE 1.5 PhD theses, in percentages

APF
  D&H
  C&P
  GBI
  U
  IMBE
  HCS
  URS
  GEO-TG

Selected scientific outputs of each research programme

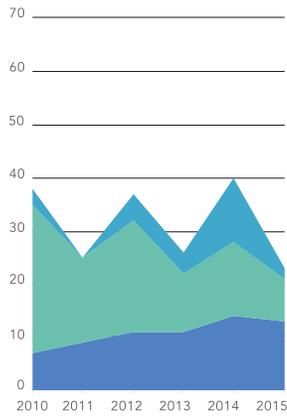


FIGURE 1.7 APF

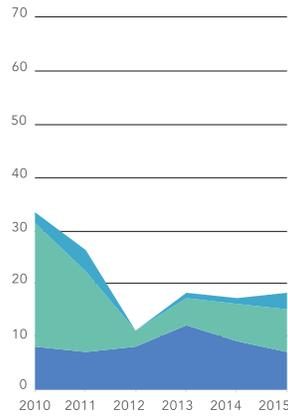


FIGURE 1.1 Design & History

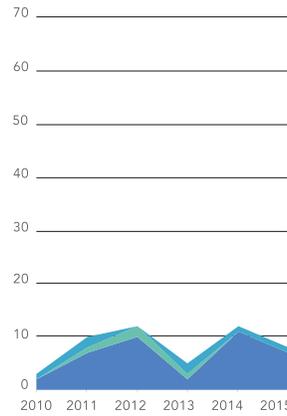


FIGURE 1.2 Computation & Performance

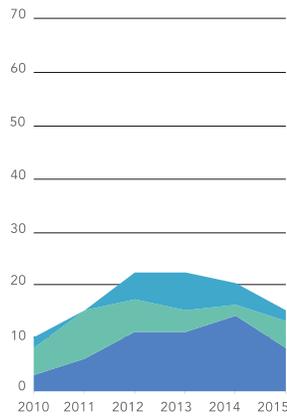


FIGURE 1.3 Green Building Innovation

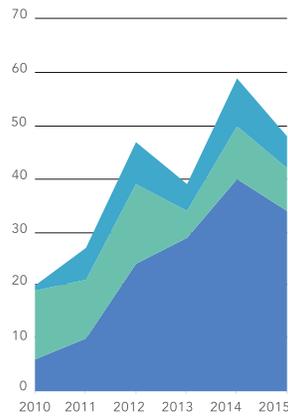


FIGURE 1.4 Urbanism

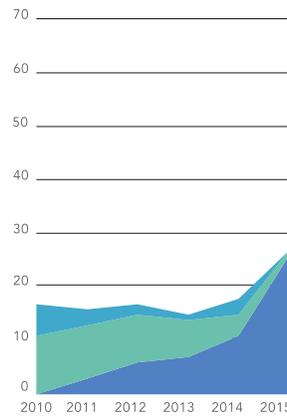


FIGURE 1.5 IMBE

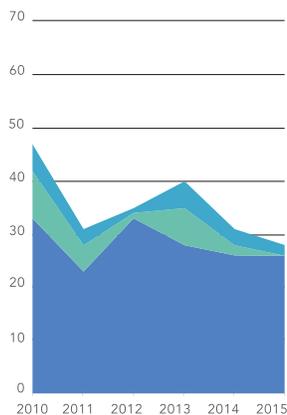


FIGURE 1.6 HCS

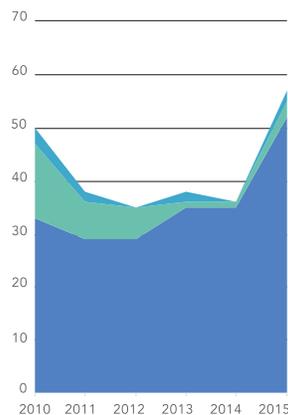


FIGURE 1.7 Urban and Regional Studies

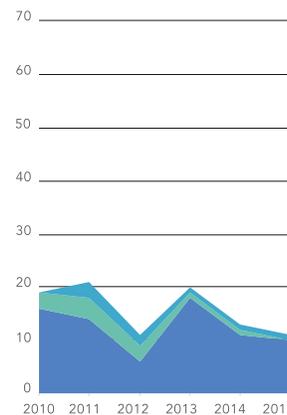


FIGURE 1.8 GEO-TG

■ Refereed articles   ■ Books   ■ PhD-Theses

Selected societal outputs of each research programme

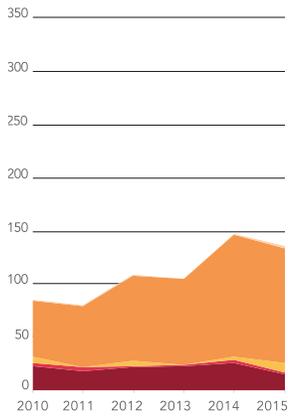


FIGURE 1.9 APF

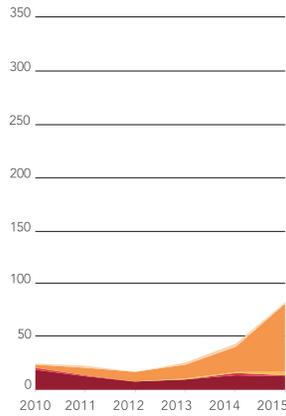


FIGURE 1.8 Design & History

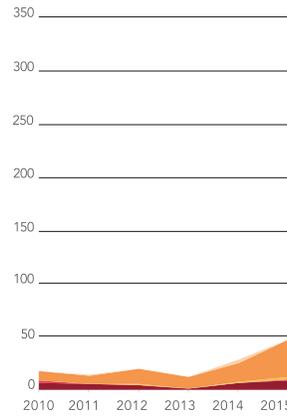


FIGURE 1.9 Computation & Performance

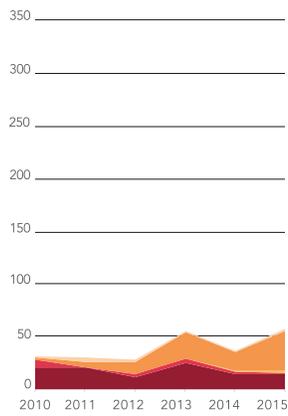


FIGURE 1.10 Green Building Innovation

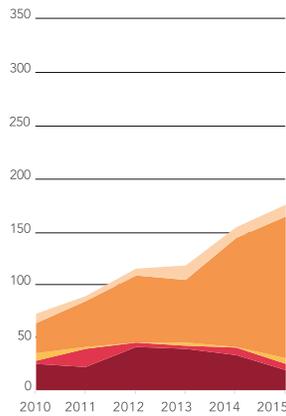


FIGURE 1.11 Urbanism

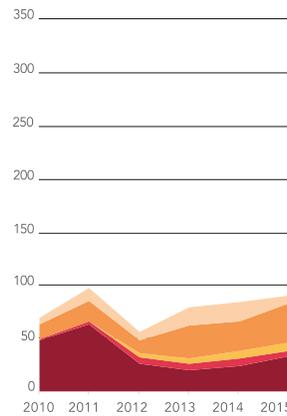


FIGURE 1.10 IMBE

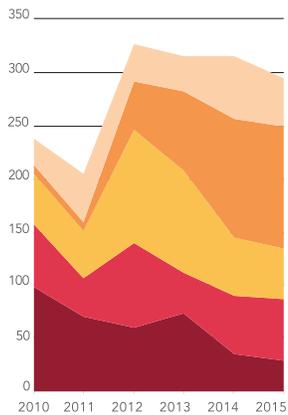


FIGURE 1.11 HCS

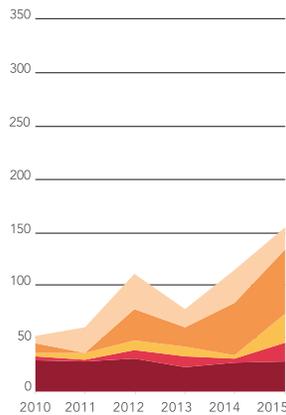


FIGURE 1.12 Urban and Regional Studies

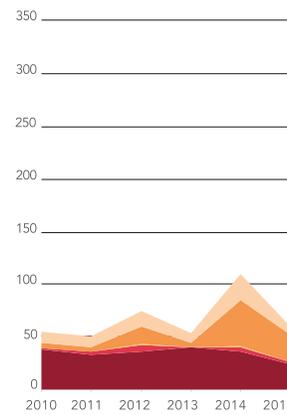


FIGURE 1.12 GEO-TG

■ External reports    
 ■ Internal reports, lectures, posters, datasets    
 ■ Appearances on radio or television  
■ Publications aimed at the general public    
 ■ Professional publications

### Sources of income per research programme

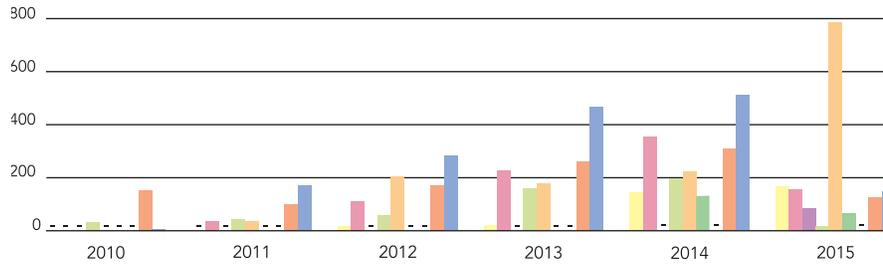


TABLE 1.5 Income from research grants per research programme in K€

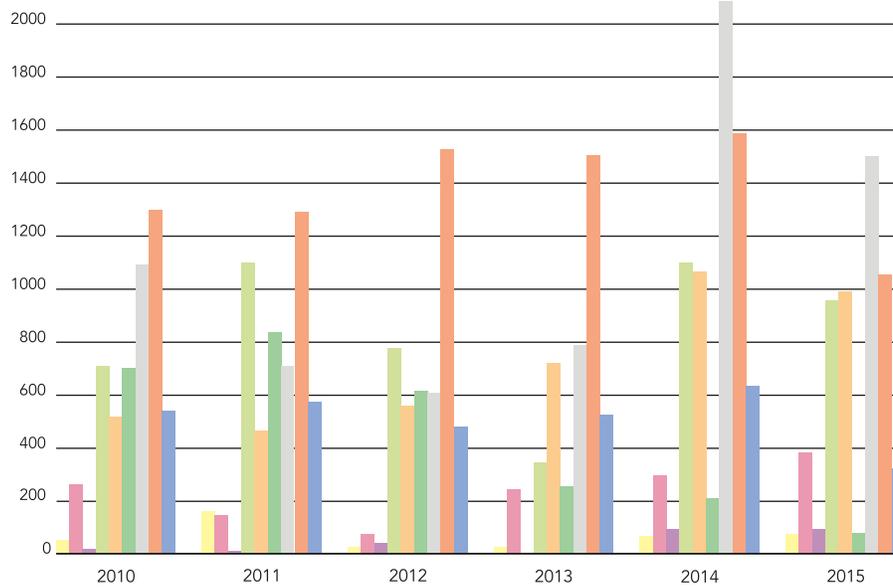


TABLE 1.6 Income from contract research per research programme in K€

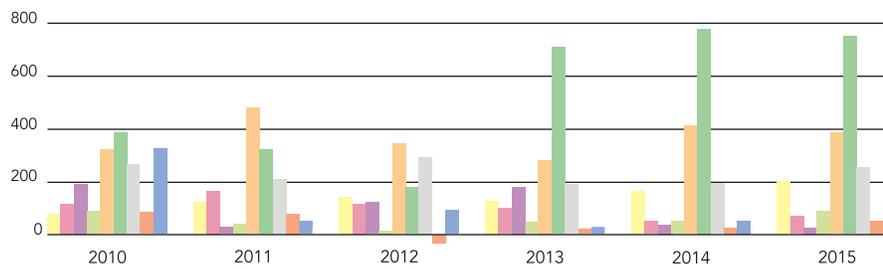


TABLE 1.7 Other income per research programme in K€

■ APF   
 ■ D&H   
 ■ C&P   
 ■ GBI   
 ■ U   
 ■ IMBE   
 ■ HCS   
 ■ URS   
 ■ GEO-TG

### Difference between income and expenditure per research programme

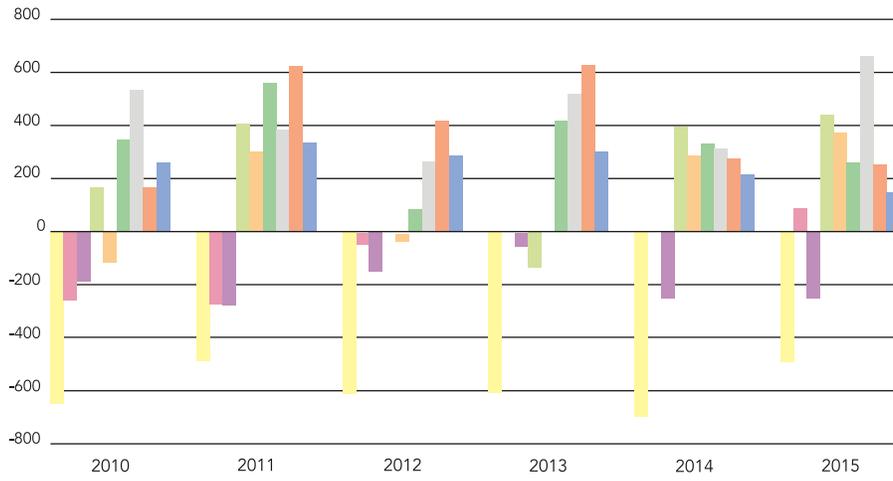


TABLE 1.8 Result: difference between income and expenditure per research programme in K€

■ APF   
 ■ D&H   
 ■ C&P   
 ■ GBI   
 ■ U   
 ■ IMBE   
 ■ HCS   
 ■ URS   
 ■ GEO-TG

## Strategy

In 2010–15, TU Delft consolidated its research in the field of architecture and the built environment by integrating the OTB Research Institute for the Built Environment into the Faculty of Architecture, adopting the Berlage Institute and co-founding the Amsterdam Institute for Advanced Metropolitan Solutions (AMS). In parallel, the Graduate School of Architecture and the Built Environment was established as the main environment for PhD research and doctoral education.

In this new configuration, the Faculty of Architecture and the Built Environment combines the Architecture faculty with the OTB institute. The Graduate School of Architecture and the Built Environment should be understood as the faculty's PhD and doctoral education programme. Berlage has become a centre for postgraduate studies in architecture and urban design. The centre is housed within the faculty building but no longer facilitates PhD research. AMS is a strategic institute in Amsterdam that valorises TU Delft's knowledge and expertise in the area of metropolitan solutions.

The management structure and the financial position of the faculty were improved in 2010–15 under the leadership of dean Karin Laglas. The faculty currently comprises five departments:

- Architecture;
- Architectural Engineering + Technology;
- Urbanism;
- Management in the Built Environment;
- OTB Research for the Built Environment.

The bonus system (BTA), which financially rewarded specific categories of research output, was abolished in 2010. The emphasis was put on publishing in peer-reviewed academic journals, obtaining externally funded projects in national and European research programmes, and becoming part of consortia with industry and government.

The faculty increased its collaboration with academic partners both nationally and internationally. It now participates in the 4TU.Federation – the federation of the Dutch universities of technology, namely Delft, Eindhoven, Twente and Wageningen – and in the Leiden–Delft–Erasmus strategic alliance. Internationally, the faculty is involved in BauHow5, an emerging alliance between TU Delft, UCL Bartlett, Chalmers, TU Munich and ETH Zürich.

The strategy in the period 2010–15 clearly reinforced the position of the faculty as a leading research and design oriented institute for architecture and the built environment that has a firm international ambition and strong roots in the Randstad Holland, one of Europe's key metropolitan regions. The strategy for the coming period will focus on:

- attracting a talented body of PhD candidates;
- improving the quality of researchers;
- strengthening the reputation-based research performance;
- fostering our national and international presence and forging strategic alliances;
- maintaining a broad portfolio of disciplines;
- technologically smart research infrastructures;
- good management, supporting staff and services.

## Targets

The faculty aimed at consolidating its research portfolio and its excellent international academic reputation as a leading design academy; becoming an international platform for innovation in architectural design, architectural engineering, urban planning, landscape architecture, real estate management, housing, urban studies and geoinformation; and providing a platform for debate on current societal themes in the fields of architecture and the built environment. As a key indicator of achieving all of this, the faculty set itself the target of becoming a top-10 institute in its field worldwide. In terms of scientific output, the faculty aimed at a shift from predominantly professional output to a more balanced portfolio that also includes peer-reviewed indexed academic publications. In this context, a quantitative target was set to motivate each staff member to publish or co-publish at least one indexed academic journal paper each year. This target is also known as 1–1–1. Specific efforts were invested in supporting the writing of individual grant proposals. These aims or targets still stand today.

## Environment

As a result of the global financial crisis and the subsequent slump in the Dutch housing market, the architectural services industry in the Netherlands experienced its severest downturn in recent memory. It affected the numbers of incoming bachelor's students as well as the job opportunities outside Delft's academic environment.

The Dutch government implemented austerity measures, which have had a measurable impact on the way science and education are financed. In response to this, TU Delft's Executive Board decided at the end of 2009 to conduct a review (herijking) of the university's teaching and research activities (and its support framework) with the objective that as of 2011, all management units would be financially viable. This effectively meant a 10% budget cut. Collaboration between three universities of technology was continued in the framework of the 3TU.Federation: 3TU.BOUW. A new regional alliance between Leiden University, TU Delft and Erasmus University emerged: Leiden–Delft–Erasmus (LDE).

The Ministry of Economic Affairs initiated its top sectors policy. The Netherlands Organisation for Scientific Research (NWO) was obliged to redirect a significant amount of its funding to support research in these sectors, which include the energy and creative industries. During the same period, we witnessed the transition from FP7 to H2020.

It now seems that the crisis in the housing sector and the architecture services industry is over. Students numbers are up. Wageningen University has joined the 3TU.Federation, effectively turning it into a 4TU.Federation. Wageningen's relevance for us lies in its programmes in the areas of landscape architecture and urban & spatial planning, and in the collaboration in AMS.

National science policy remains an uncertain factor, however. In 2015, the government initiated the Dutch National Research Agenda, a bottom-up process that enables citizens and organisations to suggest research questions. The agenda is communicated as a source of inspiration for those interested in research, without clear implications for existing policies and frameworks. Technology Foundation STW is currently integrated in the Netherlands Organisation for Scientific Research. Nevertheless, it seems that societal relevance is gaining importance across the board. From a perspective of architecture and the built environment, this is likely to increase funding opportunities.

## Performance indicators

ASSESSMENT DIMENSIONS	QUALITY DOMAINS	
	RESEARCH QUALITY	RELEVANCE TO SOCIETY
ACTIVITIES, ORGANISATION, FACILITIES/ASSETS, OUTPUT	<p><b>Activities</b></p> <ul style="list-style-type: none"> <li>• Internationally funded research projects FP7, H2020, ERC and JPI</li> <li>• Nationally funded research projects NWO and STW</li> <li>• Organisation of academic conferences, seminars, colloquia</li> <li>• Editorships</li> <li>• Curatorships</li> </ul> <p><b>Organisation</b></p> <ul style="list-style-type: none"> <li>• Participation in international academic centres</li> <li>• Collaboration with research institutes</li> <li>• Participation in international academic networks</li> <li>• Participation in academic consortia</li> </ul> <p><b>Facilities/assets</b></p> <ul style="list-style-type: none"> <li>• Collections</li> <li>• Digital archives and websites</li> <li>• Accommodation</li> <li>• Library</li> <li>• ICT network</li> <li>• Data storage</li> <li>• Databases</li> <li>• Labs</li> </ul> <p><b>Output</b></p> <ul style="list-style-type: none"> <li>• Refereed journal articles</li> <li>• Academic books</li> <li>• Academic book chapters</li> <li>• Academic book series</li> <li>• PhD theses</li> <li>• Conference papers</li> <li>• Academic journals</li> </ul>	<p><b>Activities</b></p> <ul style="list-style-type: none"> <li>• Internationally funded research projects INTERREG, IEE and ESPON</li> <li>• Nationally funded research projects for government and industry</li> <li>• Organisation of conferences, seminars, colloquia, exhibitions</li> <li>• Editorships</li> <li>• Curatorships</li> <li>• Role in practice and policymaking</li> <li>• Advisor/election to professional associations</li> <li>• Debates</li> </ul> <p><b>Organisation</b></p> <ul style="list-style-type: none"> <li>• Participation in co-funded centres</li> <li>• Collaboration with professional institutes</li> <li>• Participation in knowledge networks including professionals and end-users</li> <li>• Research staff with position in practice</li> <li>• Role in practice and policymaking</li> </ul> <p><b>Facilities/assets</b></p> <ul style="list-style-type: none"> <li>• Collections</li> <li>• Digital archives and websites</li> <li>• Accommodation</li> <li>• Labs</li> </ul> <p><b>Output</b></p> <ul style="list-style-type: none"> <li>• Professional journal articles</li> <li>• Professional books</li> <li>• Professional book chapters</li> <li>• Professional book series</li> <li>• Media presence</li> <li>• Applied research reports</li> <li>• Professional journals</li> <li>• Lectures at architecture institutes and other cultural venues</li> <li>• Exhibitions</li> <li>• Patents</li> </ul>

ASSESSMENT DIMENSIONS		QUALITY DOMAINS	
		RESEARCH QUALITY	RELEVANCE TO SOCIETY
USE		<ul style="list-style-type: none"> <li>• Number of citations in Web of Science, Scopus and Google Scholar</li> <li>• H-index entire group</li> <li>• Participation in consortia of European (FP7, H2020, JPI) and national (NWO, STW) projects</li> <li>• Citations</li> <li>• Downloads</li> <li>• Books in libraries</li> <li>• Visitors to website</li> <li>• Participation in academic conferences</li> <li>• Number of downloads of books/ book chapters</li> </ul>	<ul style="list-style-type: none"> <li>• Books in libraries (WorldCat)</li> <li>• Downloads</li> <li>• Visitors to website</li> <li>• Attendance at meetings/ conferences/ seminars organised</li> <li>• Media coverage of academic work, events, debates, exhibitions</li> <li>• Impact on public or private policies, regulations, organisations, procedures</li> <li>• Publications of architectural work of practicing professors and staff in professional journals (such as de Architect) and websites (Archined)</li> <li>• Use of scientific and professional publications in practice</li> </ul>
	MARKS OF RECOGNITION	<ul style="list-style-type: none"> <li>• Academic prizes and awards</li> <li>• Rankings</li> <li>• Personal grants (ERC, VENI, VIDI, VICI)</li> <li>• Acquisition of research grants based on peer review (FP7, H2020, JPI) and NWO, STW)</li> <li>• H-index of researchers defined by Web of Science, Scopus or Google Scholar</li> <li>• Total number of citations in Web of Science, Scopus or Google Scholar</li> <li>• Editorship of academic journals</li> <li>• Member of research review panels</li> <li>• Honorary positions</li> <li>• Invitations to give keynote speeches</li> <li>• Election to academic or academic professional associations</li> </ul>	<ul style="list-style-type: none"> <li>• Prizes and awards</li> <li>• Prestigious design assignments</li> <li>• Advisor/election to professional associations</li> <li>• Long-term cooperation with government and industry</li> <li>• Partner in design, planning or engineering office</li> <li>• Marks of recognition of scientific publications by societal groups and governance organisations</li> <li>• Income contract research</li> <li>• Honorary positions</li> <li>• Invited public lectures and debates</li> </ul>

TABLE 1.9 Selected output indicators



*Climate Proof Cities: urban heat island: surface energy balance*

## 1.1

### Results

In this paragraph we outline selected results of our research, their use and recognition. We have subdivided those 'results' in four categories: activities, organisation, facilities/assets and output. Presented here are the results at a faculty level or even beyond.

### 1.1.1

#### Activities

##### Climate Proof Cities

Europe faces a number of so-called grand challenges. Climate change and the need to adapt the urban environment to its impact is one of them. It is essential for the faculty to be engaged in research projects in such areas, especially when they enable us to cooperate in diverse consortia that include both academic and societal partners. The case of Climate Proof Cities is in this respect a great example that highlights this aspect.

In 2010, TU Delft joined a successful bid led by TNO for the Climate Proof Cities research programme. Climate Proof Cities became part of the national Knowledge for Climate research programme, financed in part by the Ministry of Infrastructure and the Environment. The Climate Proof Cities consortium comprised 10 universities and research institutes: TNO, Deltares, TU Eindhoven, TU Delft, Wageningen University and Alterra, Utrecht University, Radboud University, UNESCO-IHE, KWR and the University of Amsterdam.

Climate Proof Cities has yielded insights into how to make Dutch cities climate proof, with a focus on urban heat and increased precipitation in built-up areas. The consortium worked for four years together with municipalities, water boards and the national government to provide answers to questions from practice. At the beginning of the programme, municipalities and water boards outlined their five most important questions. These formed the point of departure for five work packages in the research programme:

- How does the local climate work in Dutch cities?
- How vulnerable are Dutch cities to the effects of climate change?
- What measures can be taken to better adapt cities to a future climate?
- How can these measures be implemented in urban areas?
- What is the final cost-benefit balance of the adaptation measures?

To answer these questions, the group worked closely with Rotterdam, The Hague, Amsterdam, Utrecht, Arnhem, Rijswijk, Tilburg, the province of North Brabant, STOWA (Stichting Toegepast Onderzoek Waterbeheer; Foundation for Applied Water Research), Delfland High Water Board, Waternet, Waterschap Hollandse Delta, Schieland District Water Control Board, and the Krimpenerwaard, as well as the New Construction and Restructuring Delta Programme. Three of the faculty's departments were involved in the programme: Architectural Engineering + Technology, Urbanism, and OTB. Three PhD studies were funded, together with two smaller research projects.

**Team:** Andy van den Dobbelen, Henk Visscher, Frank van der Hoeven, Ab Straub, Laura Kleerekoper, Martin Roders, Leyre Echevarria Icaza, Alexander Wandl.

**Grant:** €710,000

#### 4TU.BOUW Lighthouse projects

Knowledge will increasingly be produced in networks rather than institutes. Academic cooperation requires us to develop specific formulas to enable staff members to work together. The 4TU.BOUW Lighthouse projects is a good model of a successful collaboration formula.

TU Delft is part of a federation of Dutch universities of technology: the 4TU.Federation (it was the 3TU until May 2016, when Wageningen University joined the federation). The overall goal of the federation is to promote close collaboration in order to increase competitiveness in international research and education, and to concentrate research and education efforts to improve efficiency and scientific excellence. One of these areas of collaboration is the built environment. The 4TU.BOUW Center of Excellence for the Built Environment was setup to face its grand challenges using an effective and multidisciplinary approach. The 4TU.BOUW Center of Excellence consists of:

- University of Twente;
- TU Delft;
- TU Eindhoven;
- Wageningen University.

In 2013, Ulrich Knaack from TU Delft's Faculty of Architecture and the Built Environment was appointed scientific director of 4TU.BOUW. Under his leadership the 4TU.BOUW developed two lines of action: facilitating innovation in the built environment and providing dedicated professional doctoral engineering programmes (PDEng).

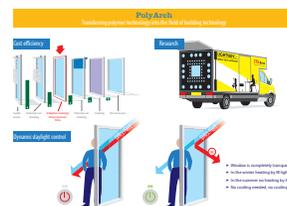
The 4TU.BOUW focus on innovation in the built environment is materialised through its Lighthouse Projects programme, which aims at promoting and starting up imaginative research projects that are related to a specific research agenda.



*Architectures of the Black Gold*



*PD Lab*



*Polyarch*

A Lighthouse Project is based on a €50,000 grant that is awarded in an open competition on the basis of two-page proposals. Projects are expected to deliver results within one year. The imaginative nature of the research as well as the delivery of tangible results (prototypes, test environments, etc.) distinguishes Lighthouse Projects from other funding schemes.

The relatively short project term of Lighthouse Projects appeals to fast-track and high-risk proposals. The Projects aim at achieving various levels of integration with industry and societal parties. It should be noted that the success of a project does not mean that all initial project goals have been met: a good failure can be a huge success and may generate, in the long run, more impact than a successful project with a more limited scope. A selection of Lighthouse Projects in which the faculty participated in 2014–15 are presented below.

Projects led by the Faculty of Architecture and the Built Environment:

- **Double Face:** Michela Turrin;
- **Robotically Driven Construction of Buildings:** Henriette Bier;
- **The LIGHTVAN:** Truus Hordijk;
- **Architectures of the Black Gold:** Carola Hein;
- **PD Lab:** Marcel Bilow;
- **Polyarch:** Eric van den Ham.

### 1.1.2

#### Organisation

##### Amsterdam Institute for Advanced Metropolitan Solutions

In 2013, an independent expert jury unanimously selected the Amsterdam Institute for Advanced Metropolitan Solutions (AMS) proposal by core academic partners TU Delft, Wageningen UR and MIT Boston as winner of a competition organised by the city of Amsterdam, aimed at setting up an Amsterdam-based, world-class institute for applied technology. Following contract negotiations, the city of Amsterdam awarded AMS €50 million over a 10-year period as a long-term investment in its economy, innovation, talent and knowledge infrastructure.

From the strategic decision to participate in the bidding process to its current operational phase, the Faculty of Architecture and the Built Environment has played a leading role in the design, roll out and growth of the AMS. The dean, Prof. Karin Laglas (2011–14), and faculty secretary, Kenneth Heijns, MSC, spearheaded the proposal phase. Currently, Prof. Arjan van Timmeren is the scientific director of AMS, Dr Maurice Harteveld co-leads the AMS education portfolio and the dean (Prof. Russell) is chairman of the AMS Board, which is supported by Kenneth Heijns, as executive secretary. In addition, many members of the scientific staff of the Faculty of Architecture and the Built Environment play important roles in research and education.

AMS is focused on metropolitan solutions and provides both education and research. It advocates an open model that lets academic, public and private partners participate in its research and valorisation activities, and has a projected turnover of €250 million over its first 10 years. The institute is governed by the AMS Board, steered by the scientific and managing directors, and supported by a crew of dedicated university support staff and a circle of principal investigators.

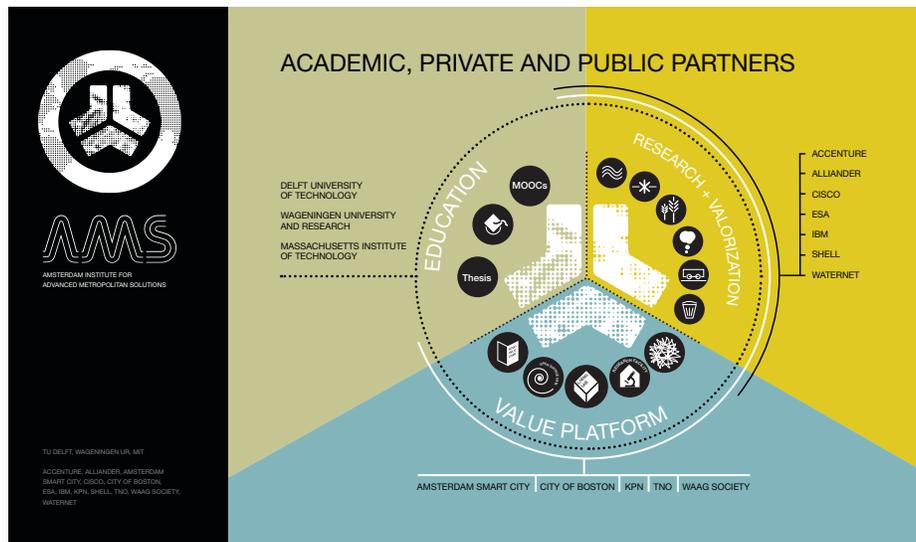
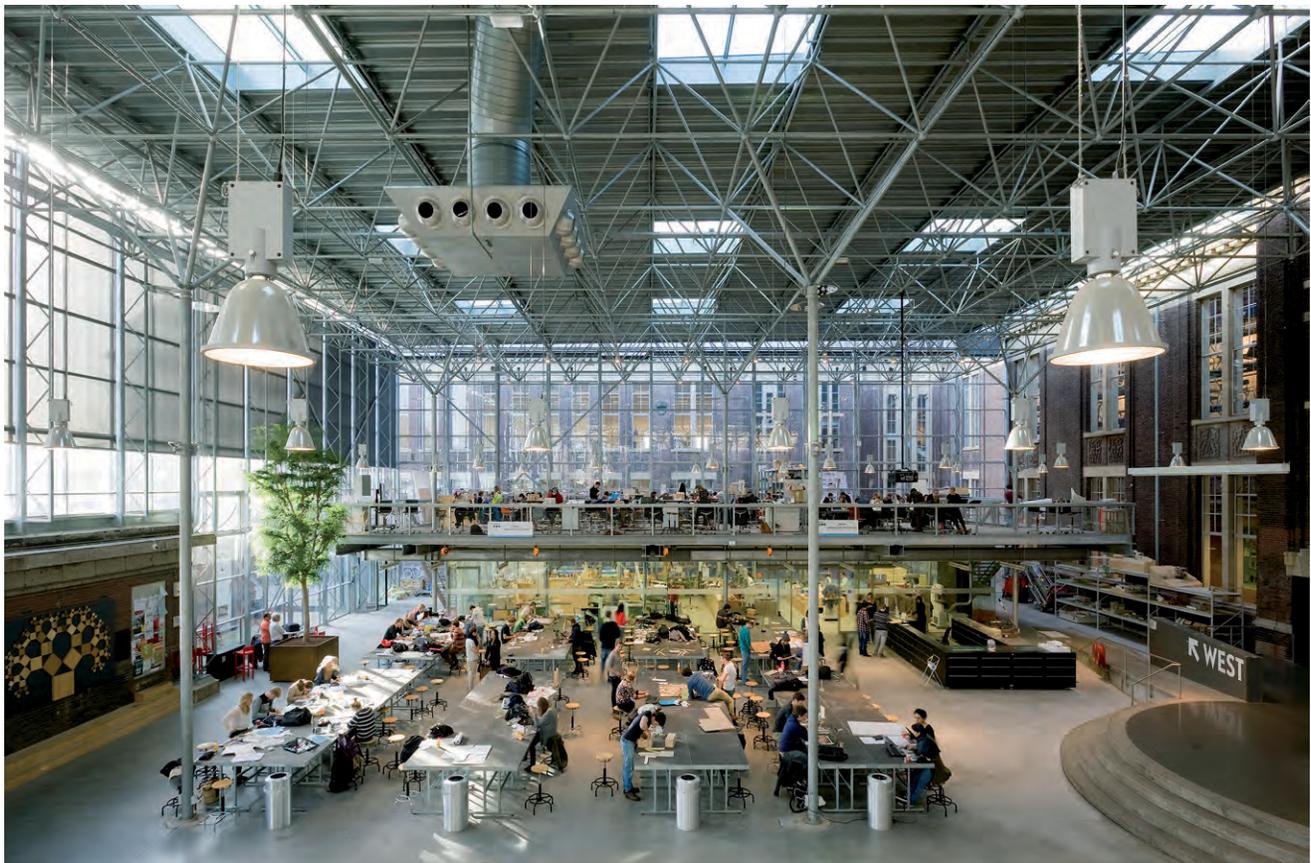


Diagram Academic, private and public partners in the Amsterdam Institute for Advanced Metropolitan Solutions

AMS is centred on applied research and design and focuses on three core concepts “circular city”, “vital city” and “connected city”. These concepts are depend on urban flows, such as water, energy, waste, food, data and mobility, and the integration of these flows. AMS will establish a specific course of study to enable talented students to do their master’s degree in metropolitan solutions. AMS has a driving ambition: to engineer talented students and create metropolitan solutions in a next-generation, world-leading institute for urban innovation.

By the end of 2015, AMS had developed a joint MSc programme “Metropolitan Analysis, Design and Engineering”, a MOOC (11,000 online students globally), €3.5 million turnover in research and innovation, a project portfolio of over €15 million, involving 27 projects and 43 project partners, and a first start-up company. Project partners include IBM, Cisco, WaterNet, Deltares, KPN, CGI, Goudappel Coffeng, Waag Society, AEB, Port of Amsterdam, and Alliander. Examples of key projects:

- **RainSense:** set out to make Amsterdam more resilient to flooding and damage caused by severe weather conditions;
- **Urban Mobility Lab:** aimed particularly at gaining new insights into the dynamics of multimodal traffic and travel patterns in order to develop better traffic and demand management in Amsterdam as well as better information services for travellers;
- **Urban Pulse:** to acquire a better insight into the resource usage of Amsterdam, mapping the urban metabolism of the city;
- **Amsterdam Crowd Management System SAIL:** real-time information on pedestrian flows in the SAIL 2015 area to promote smooth and safe visitor flows;
- **Roboat:** a five-year research program on world’s first autonomous fleet for moving people, moving goods, dynamic infrastructure and environmental sensing program with a budget of €25 million.



BK City: Zuidserre

### 1.1.3

#### Facilities/assets

##### BK City

Research requires facilities and assets. The biggest asset the faculty has is its own building: BK City – a living lab, a funky, inspiring, spacious environment that is home to young designers and passionate researchers. BK City is an international breeding ground for creative thinking, imagination, and both thoughtful and beautiful inventions. It is a place that is buzzing with life from early in the morning until late at night. With thousands of people studying, designing, conducting research and acquiring knowledge, it is the place where new ideas come to life.

The current building occupied by the Faculty of Architecture and the Built Environment was designed by its users to become a place where the dynamism and passion of the faculty is visible at a glance. In BK City, old classrooms became state-of-the-art studios, corridors became meeting places and the empty inner squares were redesigned to create two covered areas for lectures, presentations and an impressive models studio. The building has:

- a floor area about 36,000 m<sup>2</sup>;
- more than 50% of the area in use as studio or office space;
- many rooms for presentations;
- studios for bachelor's and master's students;
- workshop rooms;
- rooms for lectures and conferences (like the Berlage conference rooms);
- meeting places and lounges;
- a restaurant and an espresso bar.

The building is really something special that we can offer to the many collaborations we are part of. It is home to project kick-offs, final events, workshops, board meetings, hackathons, presentations, seminars, symposia and conferences. It gives us a competitive edge in terms of dissemination and communication among partners.

**Glasshouses:** The glasshouses were added to meet the need for more space and the desire to accommodate the modelling studio in the centre of the building (South), and to provide room for an exhibition with the 'Tribune' (East). They were designed by Octatube (overall structure), Fokkema & partners (interior) and MVRDV (Tribune), in collaboration with staff members (modelling studios) and Henk van der Geest (lighting).

**Chairs:** The chairs exhibited in the corridor are part of the famous Bouwkunde collection, with chairs made by designers like Rietveld, Maarten van Severen, Charles & Ray Eames, and Jasper Morrison.

**Library:** The library, with its famous 'counter of books' (made of redundant books), was designed by Fokkema & partners. It has more than:

- 35,000 books;
- 14,000 maps;
- 550 atlases;
- 260 magazine titles.

#### 1.1.4

### Output

#### [A+BE: open access PhD-thesis series](#)

The need to disseminate research results left the faculty at the mercy of architectural publishers that asked unrealistic sums to publish our work, while that same work was no longer ours to share. With the growing interest in open access, the faculty decided to go in a new direction with one of its key outputs: PhD theses. In 2011, the Faculty of Architecture initiated a new PhD series: A+BE | Architecture and the Built Environment. It became the testing ground for a new approach to academic publishing.

The A+BE series was conceived as a response to the 2010 budget cuts and the subsequent problems that especially PhD students experienced. Until 2010, PhD theses were often self-published. The departments covered the costs and the books were printed in a traditional way. The departments, however, had to reduce their spending, and material costs (including book publications) were among those areas where reductions were relatively easy to achieve. A+BE took a new approach by publishing theses in a series, using printing on demand, and focussing primarily on open access and an improved scientific distribution. Through innovative graphic design we were able to keep the costs of the book production low. The use of Open Journal Systems software ensured that the theses were indexed by Google Scholar right from the beginning.

We then decided to build upon this. The series obtained indexing in the Avery Index to Architectural Periodicals and the Directory of Open Access Journals. The series was recently evaluated for inclusion in Scopus by the Content Selection & Advisory Board (CSAB). The CSAB has advised that the title will be accepted for inclusion in Scopus.

The following are the reviewer's comments:

*"The theses that are published are very well cited, and this indicates the value of the publication as a whole. Going into the future, it might be worth establishing the operation with a policy of double blind peer review and an international board, in order to ensure that those who submit their work are clear about the review policy that is employed to determine what does and does not end up being published: this said, the editors are clearly doing exactly the right thing at present, because citation counts are so high."*

**Editorial team:** Frank van der Hoeven, Phoebus Panigyrakis, Vero Crickx



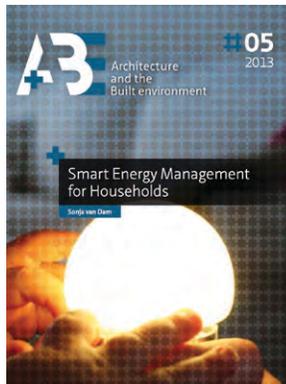
PhD-thesis Sake Zijlstra



PhD-thesis Marcel Bilow



PhD-thesis Jose Nuno Beirao



PhD-thesis Sonja van Dam



PhD-thesis Kees Gevers



PhD-thesis Thaleia Konstantiou



PhD-thesis Ana Luísa Martins da Conceição



PhD-thesis Martin Roders



PhD-thesis Charlotte van Emstede



Students constructing the Prêt-à-Loger house on-site at Versailles, France

### 1.1.6

#### Use

##### Prêt-a-Loger

Seeing is believing. TU Delft's entry to the Solar Decathlon Europe 2014 is a key example of how research findings in Delft are being used to develop innovative concepts. How can we make existing cities more sustainable on a large scale and increase the inhabitants' awareness of their energy consumption? The TU Delft student team showed how this can be achieved at the Solar Decathlon 2014, the two-week 'Olympic Games' of sustainable construction, which was held in Versailles. The TU Delft team's entry 'Prêt-à-Loger: Home with a skin' came first in Sustainability and in Communication & Social Awareness, and second in Energy Efficiency and in Construction Management & Safety. Overall, the team came third, only three points behind the winner, the Italian team.

The Solar Decathlon began as an initiative of the US Department of Energy in 2002 to demonstrate the applicability, feasibility and quality of solar technology for the housing industry by designing and building a zero-energy house. It is a competition between universities from around the world that can be described as a combination of a building fair and the Olympics. The competition proved so successful that, over the past decade, it has been extended to Europe and Asia. With over 300,000 visitors, this is an incredible opportunity for companies, students and universities to showcase their know-how and products on the world stage.

The TU Delft team chose to improve the sustainability of a terraced house built in the 1960s. It did so by applying a second skin, including a glass structure on the side facing the sun. This structure allows the house to run completely on solar energy. By choosing to modify an old terraced house, the team demonstrated how existing houses, of which there are 1.4 million in the Netherlands alone, can be transformed into sustainable housing. The students presented a very realistic concept, with the house distinguishing itself from the entries involving new builds or rooftop extensions that the other 19 universities presented.

Andy van den Dobbelen, professor of Climate Design and Sustainability at the Faculty of Architecture and the Built Environment and principal supervisor of the team:

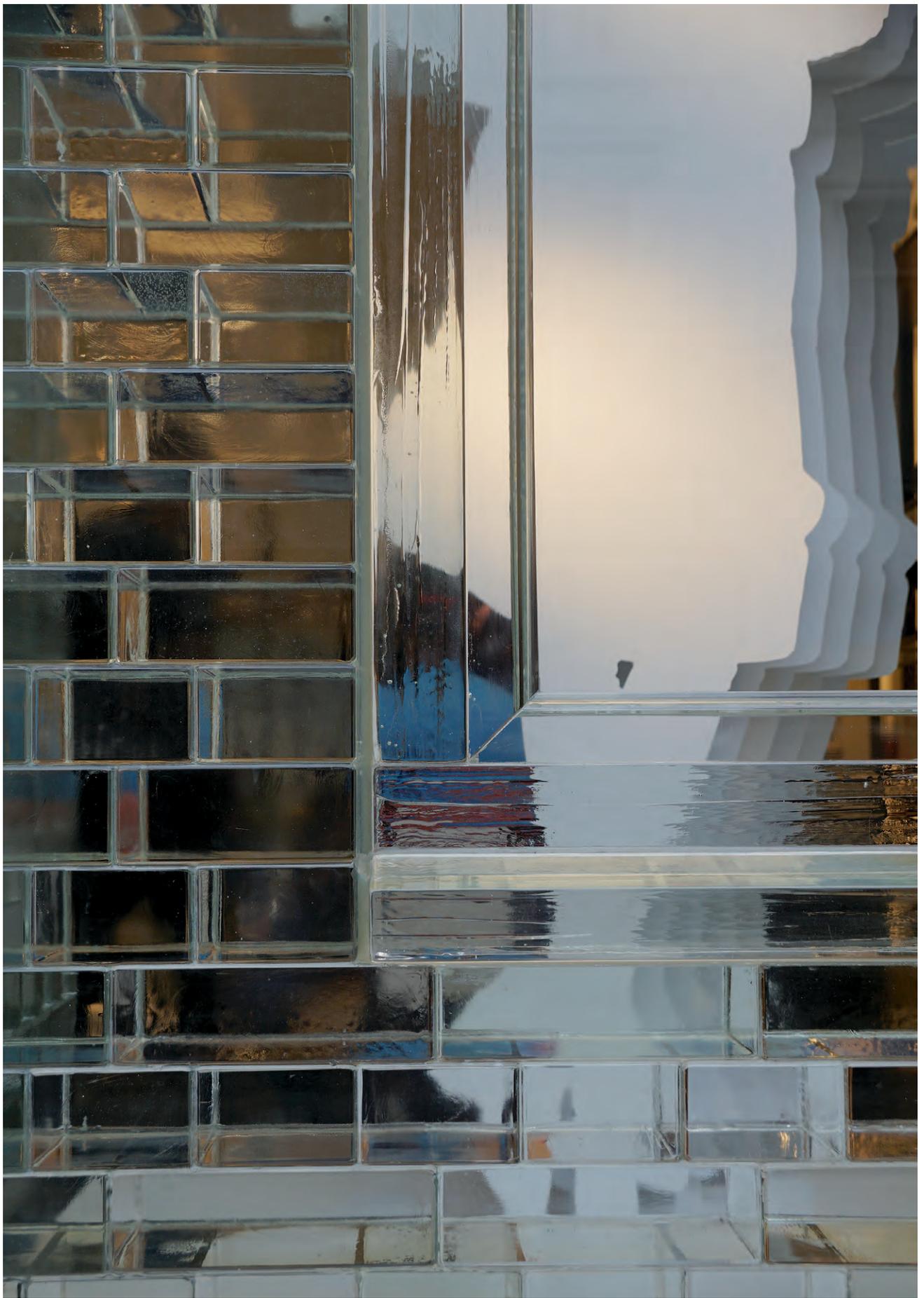
*"The sustainability challenge of the future lies in improving the existing buildings and changing everyone's personal behaviour, which will lead to an improvement in everyone's quality of life. With our house, we showed how a typical Dutch (northwest European) home can be made energy-neutral. We also want to show how we can improve people's lives with a more comfortable and spacious house, and with a beautiful, sustainable garden with local materials and plants."*

**Team advisors:** Andy van den Dobbelen, Hans Wamelink, Craig Lee Martin

### Glass bricks

A great way to demonstrate the use of TU Delft's research is applying it in award winning designs, like the glass bricks that were used in the Crystal Houses in Amsterdam. A wall of glued glass bricks that is ten times as strong as a regular brick facade. Experiments conducted by the Glass & Transparency research group proved this could be true. Their test results are being used to make Chanel's historic storefront at the P.C. Hooftstraat transparent. *"This wall could support a herd of elephants and it can withstand an attack with a sledgehammer."*

According to a design by the architecture firm MVRDV, the 'Crystal House' will consist of a facade of transparent 'bricks'. In terms of appearance this design is almost identical to the nineteenth century brick facade that is being replaced. The big question before the start of the project was how glass blocks would hold themselves up as elements of the facade. *"We put a number of test pieces together and subjected them to various tests,"* says Rob Nijssen, professor of Structural Design. *"The results were beyond our expectations."* Pressure testing, three-point bending testing and impact testing showed that the minimum compressive strength was as high as 10 N/mm<sup>2</sup>. This is about ten times stronger than the brick facade that is being replaced, and strong enough to build a robust, monolithic, self-supporting facade. In the Stevin Lab, researchers also looked at whether the structures are resistant to heat shock. The test pieces withstood this test too with flying colours. This is important, as it means that the glass won't crack during heavy rain after a hot summer day.



*Glass bricks*

To acquire maximum transparency, the researchers chose to work with stone of soda-lime-silica glass. These stones are made from sand with low iron content. The Italian specialist Poesia divisione di Vetreteria Resanese produced glass stones in five different sizes especially for the Dutch project. For the bonding of the construction, the research group Delo-Photobond chose UV-curing adhesive. At room temperature, this adhesive cures in a matter of seconds by irradiation with an UV-lamp. It is also colourfast and has a refractive index which is equal to that of the glass used. This ensures minimal visual distortion in the 210 millimeters thick glass wall. Furthermore, the glue contributes to the flexural strength of the brickwork. This requires strict tolerances, as the adhesive obtains maximum strength in a layer of 0.3 mm.

Repair of any possible damage to the exclusive glass facade is possible. *"In the laboratory, we succeeded at removing broken glass stone from the facade, cleaning it with a blowtorch and replacing it with a new one,"* says Nijse, who conducted research with Fred Veer (Glass & Transparency Research Group) and PhD students Faidra Oikonomopoulou and Telesilla Bristogianni. The implementation of the facade in the P.C. Hooftstraat was very labour-intensive. It made the facade pricey, also because of the price of the glass stones at fifty euros a piece. Still, there is great interest worldwide for the innovation that was devised in the Delft laboratory.

**Team:** Rob Nijse, Fred Veer, Faidra Oikonomopoulou, Telesilla Bristogianni

### 1.1.7

## Recognition

We consider our position in rankings, together with personal grants and prizes/awards obtained by our staff members as valuable indicators that provides a good sense of the recognition of the faculty.

### Rankings

**QS World University Ranking:** In 2015, QS World University Ranking issued for the first time a field-specific ranking for Architecture and the Built Environment. TU Delft was positioned 3<sup>rd</sup> worldwide.

**URAP Ranking:** In 2015, two new relevant rankings were provided by University Ranking based on Academic Performance (URAP): architecture and urban planning. In the field of architecture, TU Delft ranks 11<sup>th</sup>; in the field of urban planning, its position is 1<sup>st</sup>.

### Personal Grants

The Faculty of Architecture and the Built Environment is home to a number of successful personal grantees.

**ERC:** The ERC Consolidator Grants are designed to back up researchers who want to establish their research teams and continue developing a successful career in Europe. The scheme also strengthens independent and excellent new individual research teams that have been recently created. Sum: €2.000.000

- Deprivedhoods Maarten van Ham 2013

**VENI:** Veni is part of the Incentives Scheme of the Netherlands Organisation for Scientific Research. It enables researchers who have recently obtained their PhDs to conduct independent research and develop their ideas for a period of three years. Sum: €250.000

- Shopping in Post-war Europe Janina Gosseye 2012

**VIDI:** Vidi is also part of the Incentives Scheme of the Netherlands Organisation for Scientific Research. It enables researchers who have already spent several years doing postdoctoral research to develop their own innovative lines of research, and to appoint one or more researchers. Sum: €800.000

- Beyond Agglomerations: Evert Meijers 2014
- Modelling geographic information in 5D Jantien Stoter 2010

**Fellowship:** TU Delft is aiming to substantially increase the number of top female faculty members. To help accelerate this, Delft Technology Fellowship offers high-profile, tenure-track positions to top female scientists in research fields in which TU Delft is active.

- Professorship Philomena Bluysen 2013
- Associate Professorship Darinka Czischke 2014
- Assistant Professorship Queena Qian 2014



*Darinka Czischke and Queena Qian*

#### Award and prize winning designs

While assessing the strengths of the faculty's research, one should consider also the reputation of its professors as leading designers who contribute to the body of knowledge in architecture and urban planning through award-winning and prestigious designs.

- Dick van Gameren Villa 4.0, Hilversum
- Michiel Riedijk Museum aan de Stroom, Antwerpen
- Riens Dijkstra Skolkovo Gardens, Moscow
- Daniel Rosbottom Bodø Concert Hall, Bodø
- Job Roos BK City, Delft
- Kees Kaan Supreme Court of the Netherlands, The Hague
- Wessel de Jonge Sanatorium Zonnestraal, Hilversum
- Rob Nijssse & Winy Maas Crystal Houses, Amsterdam



## Dick van Gameren

*Office* Dick Van Gameren Architecten  
*Design* Villa 4.0  
*Function* Residential  
*Where* Hilversum, Netherlands  
*When* 2011  
*Prize* BNA Project of 2012





## Michiel Riedijk

<i>Office</i>	Neutelings Riedijk Architects
<i>Design</i>	Museum Aan de Stroom
<i>Function</i>	Museum
<i>Where</i>	Antwerpen, Belgium
<i>When</i>	2010
<i>Prize</i>	Belgium Steel Construction Award, 2012 AIT Global Award for the very best of Interior and Architecture, 2012 British Guild of Travel Writers European Tourism Award, second prize, 2012 USA Travel and Leisure Design Awards top 10 world's most beautiful museums, 2012 BBC World Travel Awards top 5, 2012 Nomination Best Public Building of the Year - Wallpaper Magazine Design Awards, 2011 Nomination & Shortlist Mies van der Rohe Award, 2010

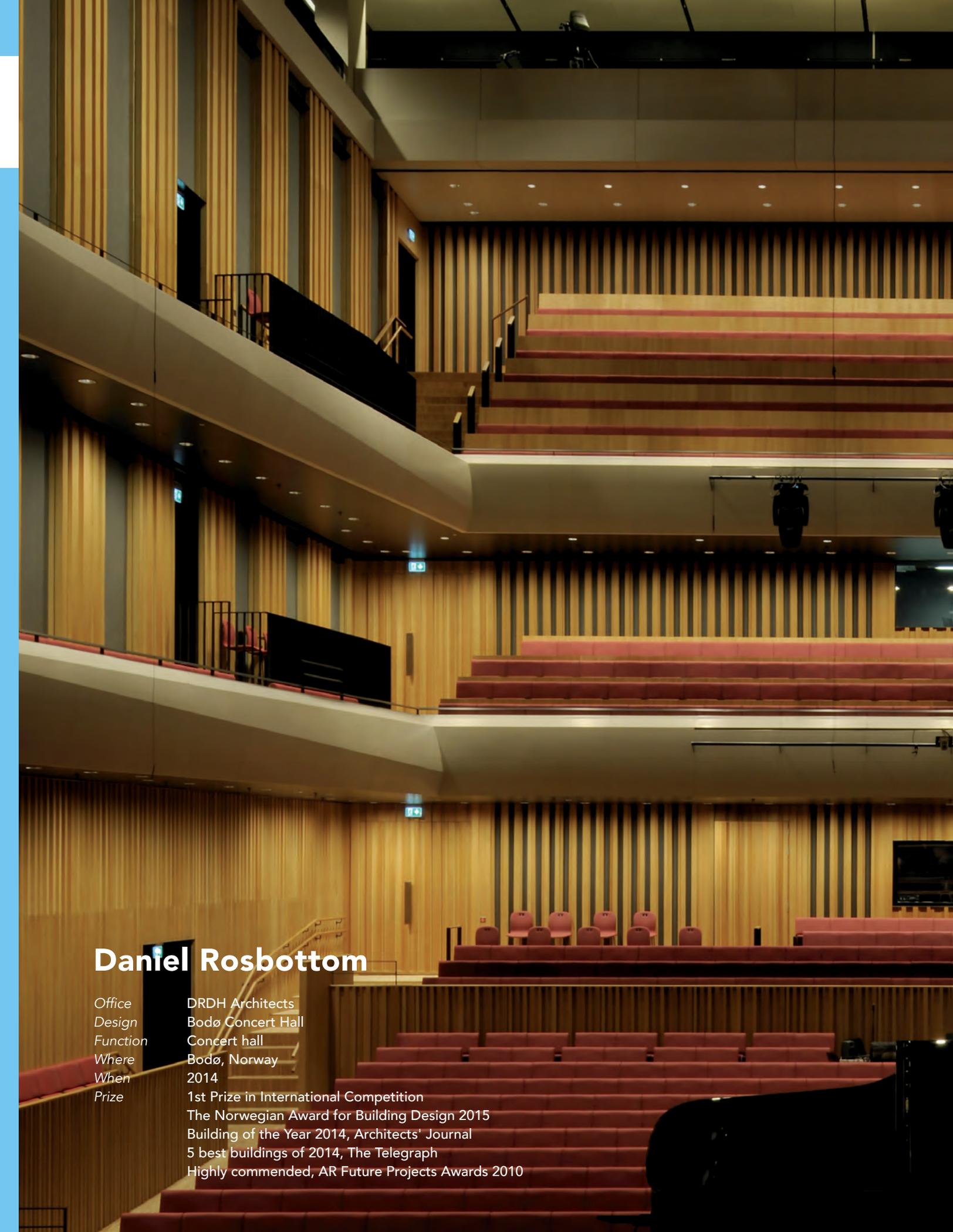




## Rients Dijkstra

Office	Maxwan
Design	Skolkovo GARDENS
Function	Park
Where	Moscow, Russian Federation
When	2015
Prize	Competition for the 50ha park for the Skolkovo Innovation Center





## Daniel Rosbottom

*Office*

DRDH Architects

*Design*

Bodø Concert Hall

*Function*

Concert hall

*Where*

Bodø, Norway

*When*

2014

*Prize*

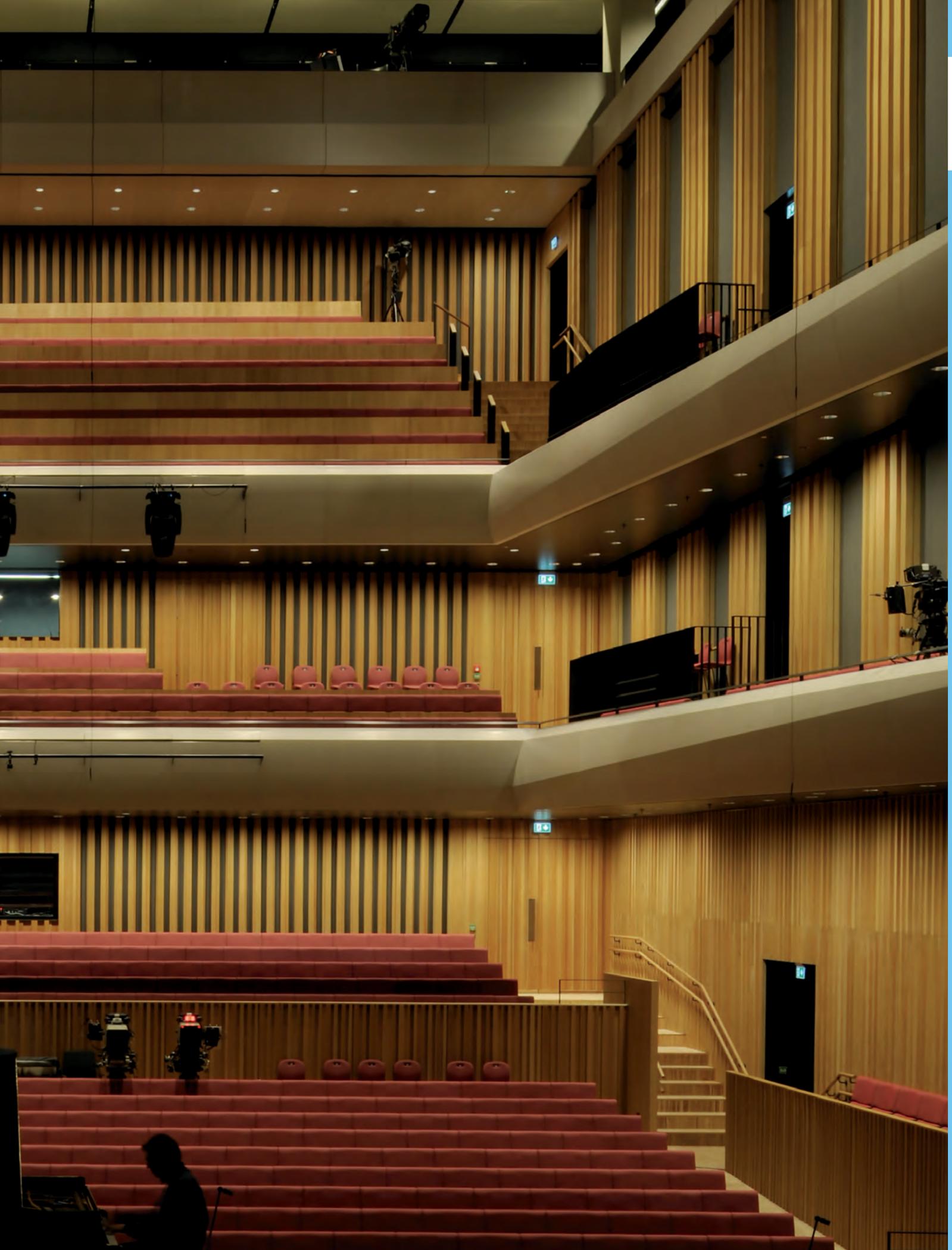
1st Prize in International Competition

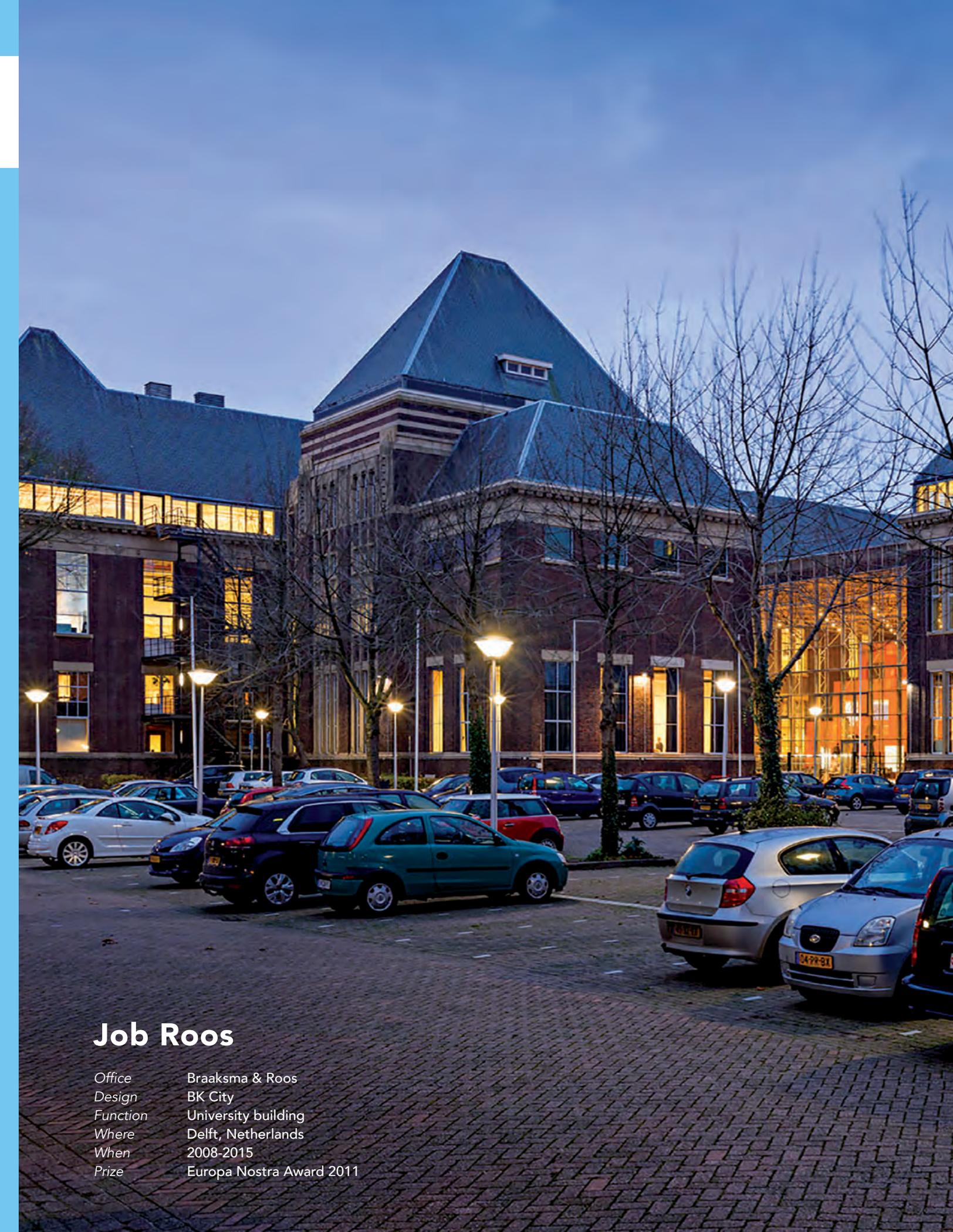
The Norwegian Award for Building Design 2015

Building of the Year 2014, Architects' Journal

5 best buildings of 2014, The Telegraph

Highly commended, AR Future Projects Awards 2010





## Job Roos

*Office* Braaksma & Roos  
*Design* BK City  
*Function* University building  
*Where* Delft, Netherlands  
*When* 2008-2015  
*Prize* Europa Nostra Award 2011



ENTRANCE  
BKCITY

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## Kees Kaan

*Office* Kaan Architecten  
*Design* Supreme Court of the Netherlands  
*Function* Court  
*Where* The Hague, Netherlands  
*When* 2012-2016  
*Prize* Living Daylight Award 2016

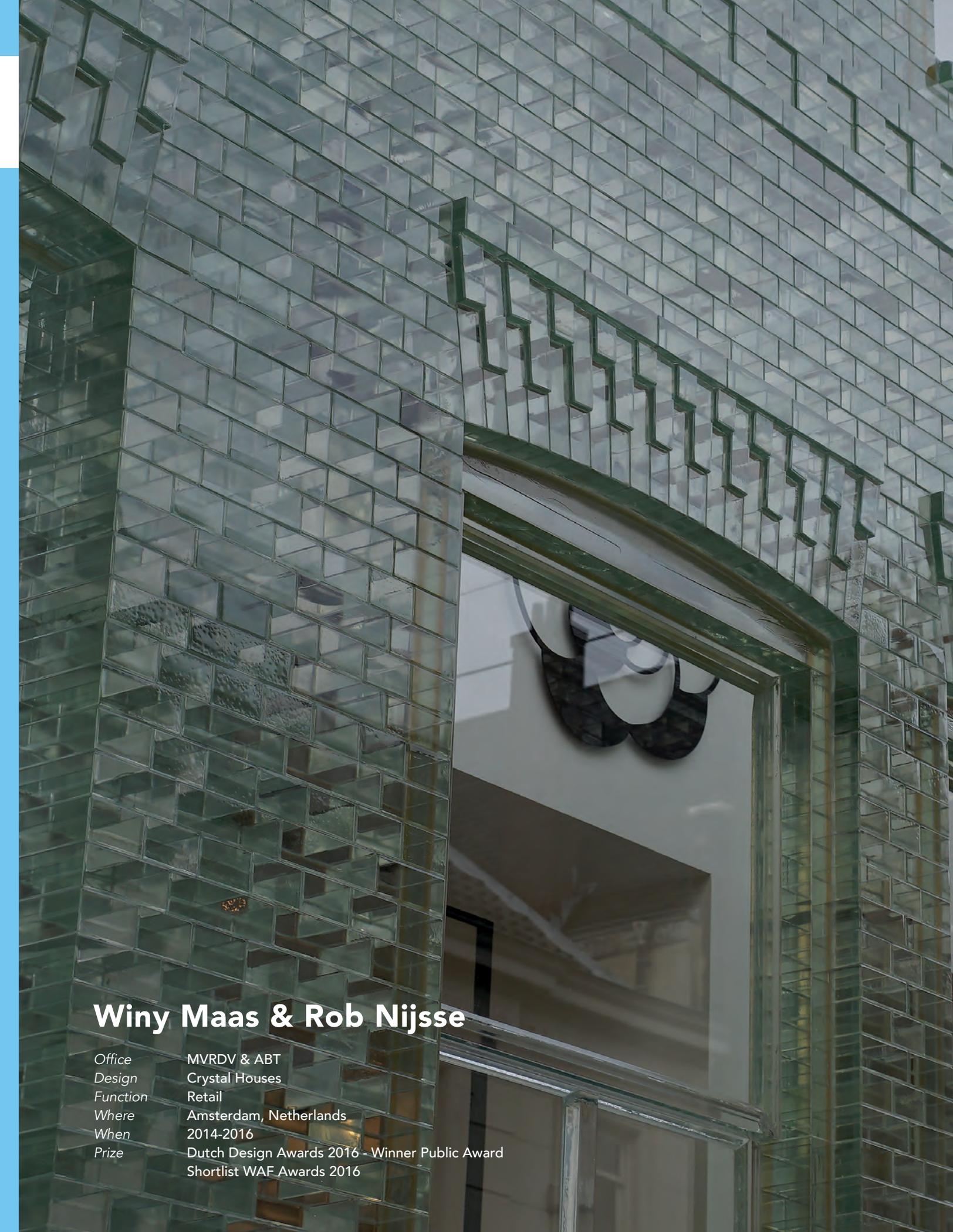




## Wessel de Jonge

<i>Office</i>	Wessel de Jonge
<i>Design</i>	Zonnestraal
<i>Function</i>	Sanatorium
<i>Where</i>	Hilversum, Netherlands
<i>When</i>	2003-2008
<i>Prize</i>	World Monuments Fund/Knoll Modernism Prize 2010





## Winy Maas & Rob Nijse

Office	MVRDV & ABT
Design	Crystal Houses
Function	Retail
Where	Amsterdam, Netherlands
When	2014-2016
Prize	Dutch Design Awards 2016 - Winner Public Award Shortlist WAF Awards 2016

CHANEL



### Context

The Graduate School for Architecture and the Built Environment (GS A+BE) is TU Delft's framework for all PhD studies at the faculty of the same name. It was launched in September 2011 in the framework of the TU Delft Graduate School (GS). The GS ensures that doctoral candidates receive excellent skills training, supervision and mentoring and deliver high-quality dissertations. Furthermore, the GS distinguishes itself by supporting a structured, transparent PhD process. This is facilitated by a monitoring system that keeps track of candidates' progress. All efforts are geared towards producing doctorates who have developed valuable skills for their future careers in academia or elsewhere.

All doctoral candidates are required to follow a tailored Doctoral Education (DE) programme so that they will acquire skills and knowledge related to their discipline, to scientific research in general and to their overall personal development (transferable skills). The faculty's Graduate School is responsible for training related to research (in general and domain specific) and for the advancement of discipline-related knowledge, competences and skills. The overall TU Delft GS offers transferable skills training courses and support to further improve doctoral candidates' professional development. The GS strives to provide its doctoral candidates with excellent supervision and support. A Code of Good Practice has been developed for both supervisors and candidates. The Code is a practical guide that helps to optimise the sometimes delicate relationship between supervisor and candidate. Candidates discuss certain aspects of the Code during the PhD Start Up workshops with which their doctoral training starts. The Code's guidelines are discussed with supervisors during small-scale workshops with the rector.

The University GS Board, with the help of support staff, develops the main features of the programme and its regulations and facilities. This is further detailed within the faculty graduate schools, where there is also a local GS board, a director and dedicated staff. TU Delft believes it is important to keep a user-centred perspective. Therefore, the GS regularly holds inquiries to improve the TU Delft Graduate School and its services (surveys 2011, 2014 and a 4-yearly survey as from 2015). The rector, the director of the GS and other staff members also regularly meet with doctoral candidates and supervisors at formal and informal gatherings. In the faculty we have set up a PhD council run by and for the PhD candidates. The Council supports the social network of the candidates and they give reactive and proactive feedback on the programme of the GS A+BE.

### Participation in research schools

In the academic fields of the GS A+BE, only two national research schools are relevant: NETHUR (Netherlands Graduate School of Urban and Regional Research) and OSK (*Onderzoeksschool Kunstgeschiedenis* – Research School for Art History). Some PhD candidates – mainly from the research programmes Housing in a Changing Society, Urban and Regional Planning, Geo Information Technology and Governance, Urbanism and Innovations in Management in the Built Environment, and Design and History – are members of these schools or take part in some of their courses. However, for the majority of the candidates there is no relevant national research school. GS A+BE therefore develops its own discipline-related courses.

### Selection and admission procedures

GS A+BE has developed a central procedure for applications from PhD candidates with a scholarship. The GS A+BE website provides insight into and access to the application process. Applicants are asked to provide information about their master's diploma, their scholarship, research plan and level of English. The A+BE Graduate Office screens the

documentation and forwards it to the relevant professors and selection committees. Selection is based on the quality of the proposal, the candidate's CV and his or her performance in one or more online interviews. Standard PhD candidates are appointed to positions within the faculty; candidates financed by externally funded projects are recruited via internationally advertised calls.

#### Supervision of PhD candidates internally

The supervisory team typically consists of a daily supervisor (assistant or associate professor) and at least one main supervisor (a professor). The team may include additional supervisors. Furthermore, a mentor is appointed to support the doctoral candidate during the doctoral process. There are standards concerning the amount of time supervisors should reserve for supervising candidates (daily supervisor 70 hours a year, supervisor 35 hours a year). The faculty ensures (through annual R&D reviews) that professors and daily supervisors are not responsible for more PhDs than they can handle. The availability of suitable supervisors is a critical factor in decisions about appointing new PhD candidates. The quality and progress of the candidates are monitored at each stage of the development cycle.

A formal progress meeting with the supervisors is held after six months to check that the candidate is on track for a successful 'go/no-go' meeting after the first year. In this meeting, the candidate presents his or her detailed research plan, first research results and Doctoral Education plan, and a decision is made whether the candidate may continue for the full period of four years. The purpose is to stop inadequate projects and candidates at an early stage and to give candidates useful recommendations to help them finish their PhD successfully in time. At least one independent professor sits on the go/no-go committee. The 'go/no-go' session is followed up each year by formal progress meetings.

#### Exit numbers

The exit numbers concern full-time PhD candidates, that is, the standard candidates (appointed with a salary) and the contract candidates (guests with external funding). The nominal full-time process is four years in the Netherlands. It is considered to be a successful process if the thesis is finished within four years. Due to procedures, however, the defence often takes place in year 5. Therefore, a thesis finished  $\leq 5Y$  is still considered to be successful. Table 1.10 shows the enrolment and the success rates. Only some of the candidates who started in 2011 started within the framework of the GS. The success rates have been low, but we expect a great improvement in the years to come. The aim of the faculty is a success rate of 60% in 2020.

In addition to the abovementioned PhD categories, the faculty also has a considerable number of part-time PhD candidates, that is, internal candidates (staff who can spend less than 0.5 FTE on their PhD) and external candidates (guests who have less than 0.5 FTE to work on the PhD). These internal and external parttime PhD's are not included in the tables of this research evaluation.

Due to force majeure, namely the fire at our faculty in May 2008, several PhD candidates lost an important part of their research material and had to overcome temporary drawbacks regarding housing and resources. In order to let them complete their research under appropriate conditions, they received a tailored extension, resulting in a longer period than the initial estimated four years.

Our graduates do very well in the labour market. We traced all PhD candidates who graduated between 2010 and 2015: 75% continued in academia, mainly as postdoc researchers. A large share of them remained in the faculty.

ENROLMENT				SUCCESS RATE													
Starting year	Gender			Finished								Total graduated		Not yet finished		Discontinued	
	Male	Female	Total	≤ 4Y		≤ 5Y		≤ 6Y		≤ 7Y							
2006	2	12	14	0	0%	2	14%	4	29%	8	57%	8	57%	3	21%	3	21%
2007	13	11	24	4	17%	9	38%	14	58%	17	71%	17	71%	5	21%	2	8%
2008	11	11	22	2	9%	4	18%	9	41%	11	50%	11	50%	9	41%	2	9%
2009	11	16	27	4	15%	7	26%	8	30%	9	33%	9	33%	13	48%	5	19%
2010	17	8	25	4	16%	9	36%	10	40%	10	40%	10	40%	13	52%	2	8%
2011	14	9	23	3	13%	6	26%	6	26%	6	26%	6	26%	10	43%	7	30%
<b>Total</b>	<b>68</b>	<b>67</b>	<b>135</b>	<b>17</b>	<b>13%</b>	<b>37</b>	<b>27%</b>	<b>51</b>	<b>38%</b>	<b>61</b>	<b>45%</b>	<b>61</b>	<b>45%</b>	<b>53</b>	<b>39%</b>	<b>21</b>	<b>16%</b>

TABLE 1.10 Length of PhD candidacies and success rate of the PhD programme

Sector	2010	2011	2012	2013	2014	2015	Total
Government	0%	2%	1%	0%	0%	0%	3%
Industry	3%	1%	2%	5%	1%	2%	15%
Non-profit	0%	1%	0%	2%	1%	1%	6%
Retired	1%	0%	0%	0%	0%	0%	1%
Research	14%	11%	10%	13%	15%	13%	75%
<b>Total</b>	<b>18%</b>	<b>16%</b>	<b>14%</b>	<b>19%</b>	<b>17%</b>	<b>16%</b>	<b>100%</b>

TABLE 1.11 First employment after finishing PhD: sector

Position	2010		2011		2012		2013		2014		2015		Total	
Assistant Professor	7	8%	4	5%	4	5%	5	6%	5	6%		0%	25	28%
Associate Professor	1	1%		0%		0%	1	1%		0%		0%	2	2%
Co-founder/ partner arch/urb firm		0%	1	1%	1	1%	1	1%	1	1%		0%	4	5%
Employee non-profit		0%	1	1%		0%	2	2%		0%	1	1%	4	5%
Lecturer	2	2%	3	3%		0%	2	2%		0%	1	1%	8	9%
Postdoc researcher		0%	2	2%	3	3%	1	1%	5	6%	3	3%	14	16%
Professional in industry		0%		0%		0%	1	1%	1	1%		0%	2	2%
Researcher	2	2%		0%	2	2%	1	1%	2	2%	5	6%	12	14%
Researcher / Lecturer		0%	1	1%		0%		0%		0%	2	2%	3	3%
Researcher/ professional in government		0%	2	2%	1	1%		0%		0%		0%	3	3%
Researcher/ professional in industry	3	3%		0%	1	1%	3	3%	1	1%	2	2%	10	11%
Retiree	1	1%		0%		0%		0%		0%		0%	1	1%
<b>Grand Total</b>	<b>16</b>	<b>18%</b>	<b>14</b>	<b>16%</b>	<b>12</b>	<b>14%</b>	<b>17</b>	<b>19%</b>	<b>15</b>	<b>17%</b>	<b>14</b>	<b>16%</b>	<b>88</b>	<b>100%</b>

TABLE 1.12 First employment after finishing PhD: position

## Integrity

TU Delft strives to be articulate and explicit with respect to its ideals, values, principles and responsibilities and the means it utilises to implement its vision in day-to-day practices, procedures and operations. The University assumes that all staff involved in research and education take personal responsibility in matters concerning academic and scientific integrity within the organisation. Here, two policy frameworks offer binding guidance: The Netherlands Code of Conduct for Academic Practice (version 2014), which is laid down by the Association of Universities in the Netherlands (VSNU), and TU Delft's own Code of Ethics, which formulates ideals, responsibilities and rights that should be taken as guidelines for everyone who is part of TU Delft. The University's Scientific and Academic Integrity Complaints Regulations include a complaints procedure for situations involving breaches of scientific or academic integrity that may occur within the organisation. In addition, TU Delft's Executive Board set up a committee to monitor the quality and independence of our policy on integrity. The 2010–15 period saw a number of developments that support conducting research in a way that is characterised by transparency and integrity.

### Peer-review

The dissemination of research outcomes increasingly takes place in peer-reviewed scientific journals, where it is subjected to the checks and balances of a larger community of likeminded researchers.

### Data stewardship

TU Delft actively works on data stewardship, supported by the 4TU Centre on Research Data (previously known as the 3TU.Datacentrum). The 4TU Centre on Research Data offers the knowledge, experience and the tools required to archive research data in a standardised, secure and well-documented manner. It provides the research community with:

- A long-term archive for storing scientific research data.
- Permanent access to and tools for the reuse of research data.
- Advice on and support with data management.

### Professors' ancillary activities

The registration of professors' ancillary activities is assigned a high priority. These ancillary activities of all professors are explicitly and transparently listed online as part of their personal pages.

### Graduate School

As part of the procedures of the new graduate school, all PhD theses are scanned for plagiarism before they are defended before the committee.

With the introduction of doctoral education, 'scientific integrity' became a mandatory course as part of the PhD Start UP (C9.M1). The course focuses on moral questions that are important for researchers to consider at the start of their academic careers. It helps them to gain insight into the societal, moral and public aspects of their work (e.g. duty to society, intellectual property, co-authorship, etc.).

### HR Excellence in Research

Delft University of Technology endorses the principles of the European Charter for researchers and European Code of Conduct for the recruitment of researchers. In 2013 the European Commission awarded the Delft University of Technology the HR Excellence in Research logo.

Provided below are three overview tables on the diversity of our scientific staff, researchers and PhD candidates with regards to gender, nationality and age.

GENDER		2010		2011		2012		2013		2014		2015	
Scientific staff	Male	136	75%	131	74%	126	74%	119	74%	121	73%	119	71%
	Female	45	25%	45	26%	44	26%	41	26%	45	27%	48	29%
	<b>Subtotal</b>	<b>181</b>	<b>100%</b>	<b>176</b>	<b>100%</b>	<b>170</b>	<b>100%</b>	<b>160</b>	<b>100%</b>	<b>166</b>	<b>100%</b>	<b>167</b>	<b>100%</b>
Researchers	Male	75	64%	76	63%	69	63%	62	61%	61	59%	64	66%
	Female	43	36%	44	37%	41	37%	40	39%	42	41%	33	34%
	<b>Subtotal</b>	<b>118</b>	<b>100%</b>	<b>120</b>	<b>100%</b>	<b>110</b>	<b>100%</b>	<b>102</b>	<b>100%</b>	<b>103</b>	<b>100%</b>	<b>97</b>	<b>100%</b>
PhD candidates	Male	81	53%	79	53%	80	52%	74	48%	79	53%	85	55%
	Female	72	47%	70	47%	74	48%	79	52%	71	47%	70	45%
	<b>Subtotal</b>	<b>153</b>	<b>100%</b>	<b>149</b>	<b>100%</b>	<b>154</b>	<b>100%</b>	<b>153</b>	<b>100%</b>	<b>150</b>	<b>100%</b>	<b>155</b>	<b>100%</b>
Staff overall	Male	292	65%	286	64%	275	63%	255	61%	261	62%	268	64%
	Female	160	35%	159	36%	159	37%	160	39%	158	38%	151	36%
	<b>Total</b>	<b>452</b>	<b>100%</b>	<b>445</b>	<b>100%</b>	<b>434</b>	<b>100%</b>	<b>415</b>	<b>100%</b>	<b>419</b>	<b>100%</b>	<b>419</b>	<b>100%</b>

TABLE 1.13 Gender diversity

NATIONALITY		2010		2011		2012		2013		2014		2015	
Scientific staff	NL	147	81%	141	80%	133	78%	123	77%	125	75%	127	76%
	EU	23	13%	23	13%	24	14%	25	16%	27	16%	28	17%
	Non-EU	11	6%	12	7%	13	8%	12	8%	14	8%	12	7%
	<b>Subtotal</b>	<b>181</b>	<b>100%</b>	<b>176</b>	<b>100%</b>	<b>170</b>	<b>100%</b>	<b>160</b>	<b>100%</b>	<b>166</b>	<b>100%</b>	<b>167</b>	<b>100%</b>
Researchers	NL	88	75%	93	78%	76	69%	67	66%	69	67%	65	67%
	EU	22	19%	20	17%	21	19%	23	23%	22	21%	18	19%
	Non-EU	8	7%	7	6%	13	12%	12	12%	12	12%	14	14%
	<b>Subtotal</b>	<b>118</b>	<b>100%</b>	<b>120</b>	<b>100%</b>	<b>110</b>	<b>100%</b>	<b>102</b>	<b>100%</b>	<b>103</b>	<b>100%</b>	<b>97</b>	<b>100%</b>
PhD candidates	NL	60	39%	54	36%	46	30%	45	29%	42	28%	40	26%
	EU	39	25%	37	25%	45	29%	40	26%	41	27%	40	26%
	Non-EU	54	35%	58	39%	63	41%	68	44%	67	45%	75	48%
	<b>Subtotal</b>	<b>153</b>	<b>100%</b>	<b>149</b>	<b>100%</b>	<b>154</b>	<b>100%</b>	<b>153</b>	<b>100%</b>	<b>150</b>	<b>100%</b>	<b>155</b>	<b>100%</b>
Staff overall	NL	295	65%	288	65%	255	59%	235	57%	236	56%	232	55%
	EU	84	19%	80	18%	90	21%	88	21%	90	21%	86	21%
	Non-EU	73	16%	77	17%	89	21%	92	22%	93	22%	101	24%
	<b>Total</b>	<b>452</b>	<b>100%</b>	<b>445</b>	<b>100%</b>	<b>434</b>	<b>100%</b>	<b>415</b>	<b>100%</b>	<b>419</b>	<b>100%</b>	<b>419</b>	<b>100%</b>

TABLE 1.14 Nationality diversity

AGE		2010		2011		2012		2013		2014		2015	
Scientific staff	>20 y	0	0%	0	0%	1	1%	1	1%	1	1%	0	0%
	>30 y	35	19%	36	20%	27	16%	29	18%	34	20%	21	13%
	>40 y	62	35%	64	36%	65	38%	64	40%	67	40%	60	36%
	>50 y	50	27%	45	26%	42	25%	39	24%	39	23%	56	34%
	>60 y	34	19%	31	18%	35	21%	27	17%	25	15%	30	18%
	<b>Subtotal</b>	<b>181</b>	<b>100%</b>	<b>176</b>	<b>100%</b>	<b>170</b>	<b>100%</b>	<b>160</b>	<b>100%</b>	<b>166</b>	<b>100%</b>	<b>167</b>	<b>100%</b>
Researchers	>20 y	19	16%	17	14%	14	13%	17	17%	18	17%	20	21%
	>30 y	60	50%	58	48%	55	50%	50	49%	47	46%	36	37%
	>40 y	18	16%	21	18%	17	15%	16	16%	15	15%	18	19%
	>50 y	13	11%	16	13%	16	15%	14	14%	15	15%	14	14%
	>60 y	8	7%	8	7%	8	7%	5	5%	8	8%	9	9%
	<b>Subtotal</b>	<b>118</b>	<b>100%</b>	<b>120</b>	<b>100%</b>	<b>110</b>	<b>100%</b>	<b>102</b>	<b>100%</b>	<b>103</b>	<b>100%</b>	<b>97</b>	<b>100%</b>
PhD candidates	>20 y	2	1%	4	3%	8	5%	18	12%	20	13%	32	21%
	>30 y	93	61%	91	61%	95	62%	90	59%	88	59%	87	56%
	>40 y	43	28%	41	28%	38	25%	34	22%	31	21%	25	16%
	>50 y	10	7%	9	6%	10	6%	8	5%	9	6%	9	6%
	>60 y	5	3%	4	3%	3	2%	3	2%	2	1%	2	1%
	<b>Subtotal</b>	<b>153</b>	<b>100%</b>	<b>149</b>	<b>100%</b>	<b>154</b>	<b>100%</b>	<b>153</b>	<b>100%</b>	<b>150</b>	<b>100%</b>	<b>155</b>	<b>100%</b>
Staff overall	>20 y	21	5%	21	5%	23	5%	36	9%	39	9%	52	12%
	>30 y	188	42%	185	42%	177	41%	169	41%	169	40%	144	34%
	>40 y	123	27%	126	28%	120	28%	114	27%	113	27%	103	25%
	>50 y	73	16%	70	16%	68	16%	61	15%	63	15%	79	19%
	>60 y	47	10%	43	10%	46	11%	35	8%	35	8%	41	10%
	<b>Total</b>	<b>452</b>	<b>100%</b>	<b>445</b>	<b>100%</b>	<b>434</b>	<b>100%</b>	<b>415</b>	<b>100%</b>	<b>419</b>	<b>100%</b>	<b>419</b>	<b>100%</b>

TABLE 1.15 Age diversity

## Benchmarking

The Faculty of Architecture and the Built Environment is part of a university of technology where the predominant publication culture is based on indexed peer-reviewed journal articles. In a world that uses the large databases of such journals (Web of Science, Scopus) to benchmark academic performance, the output of a 'design' faculty had always appeared modest compared to that of 'science' faculties. However, the emergence of field-specific rankings has shed new light on the Faculty of Architecture and the Built Environment: compared to our peers, we are performing pretty well.

### QS World University Ranking

In 2015, QS World University Ranking issued for the first time a field-specific ranking for Architecture and the Built Environment – and TU Delft was positioned 3<sup>rd</sup> worldwide. The QS World University Ranking uses four criteria: academic reputation, employer reputation, research citations per paper and the h-index. It uses Elsevier's Scopus as database. TU Delft scores best compared to all other institutes when it comes to the h-index.

### URAP University Ranking by Academic Performance

URAP University Ranking by Academic Performance provided for 2014–15 a field-specific ranking on Design and Built Environment. Here, TU Delft was positioned 1<sup>st</sup> worldwide. URAP University Ranking by Academic Performance uses six criteria: article, total document, citation, article impact total, citation impact total and international collaboration. URAP uses Thomson Reuters' Web of Science as database.

In 2015–16, two new relevant rankings were provided: architecture and urban planning. In the field of architecture, TU Delft ranks 11<sup>th</sup>; in the field of urban planning, its position is 1<sup>st</sup>.

Rank	UNIVERSITY	COUNTRY	OVERALL SCORE	ACADEMIC REPUTATION	EMPLOYER REPUTATION	CITATIONS PER PAPER	H-INDEX	OVERALL SCORE
1	MIT	USA	97.3	100.0	94.9	90.3	88.2	94.20
2	University College London	ENGLAND	95.9	98.8	80.6	94.4	92.2	90.89
3	TU Delft	NETHERLANDS	91.2	91.1	84.2	91.4	99.0	84.29
4	University of California Berkeley	USA	91.7	90.1	88.3	100.0	97.9	81.92
5	Harvard	USA	89.8	90.9	100.0	87.3	74.8	80.38
6	NUS	SINGAPORE	87.0	85.4	90.2	92.8	89.6	79.08
7	ETHZ	SWITZERLAND	87.7	91.4	74.2	88.0	74.8	75.94
8	Tsinghua University	CHINA	87.1	86.3	94.5	87.0	85.3	67.28
9	University of Cambridge	ENGLAND	87.9	87.6	98.4	90.7	76.8	65.86
10	The University of Tokyo	JAPAN	83.0	84.3	89.5	77.5	72.7	64.60

TABLE 1.16 QS field specific ranking Architecture and the Built Environment 2015

Rank	UNIVERSITY	COUNTRY	ARTICLE	CITATION	INT. COLLABORATION	ARTICLE IMPACT	CITATION IMPACT	TOTAL
1	TU Eindhoven	NETHERLANDS	63.11	100.00	86.76	100.00	100.00	89.45
2	University of California Berkeley	USA	80.44	91.82	100.00	91.79	71.47	84.70
3	KU Leuven	BELGIUM	70.22	84.28	97.06	84.29	70.14	78.51
4	Hong Kong Polytechnic University	HONG KONG	72.89	81.80	63.24	81.80	66.22	73.82
5	Tsinghua University	CHINA	76.44	77.02	77.94	77.05	60.88	72.94
6	University College London	ENGLAND	100	62.22	69.12	62.24	50.50	69.43
7	University of Sheffield	ENGLAND	72.44	70.31	73.53	70.32	57.40	67.94
8	ETHZ	SWITZERLAND	68	70.68	75.00	70.65	59.03	67.52
9	Technical University of Denmark	DENMARK	60.00	70.59	80.88	70.59	62.73	67.01
10	Concordia University - Canada	CANADA	54.67	69.85	58.82	69.86	66.06	64.01
11	TU Delft	NETHERLANDS	69.78	62.59	77.94	62.62	53.38	63.63

TABLE 1.17 URAP field specific ranking Architecture 2015

Rank	UNIVERSITY	COUNTRY	ARTICLE	CITATION	INT. COLLABORATION	ARTICLE IMPACT	CITATION IMPACT	TOTAL
1	TU Delft	NETHERLANDS	100.00	99.43	100.00	99.43	77.70	94.20
2	University College London	ENGLAND	82.47	100.00	75.85	100.00	90.76	90.89
3	University of Utrecht	NETHERLANDS	63.71	91.53	67.37	91.59	100.00	84.29
4	University of California Berkeley	USA	72.58	90.10	62.29	90.14	85.98	81.92
5	University of Leeds	ENGLAND	62.47	87.12	64.83	87.14	93.70	80.38
6	University of Oxford	ENGLAND	57.73	85.00	62.29	84.99	97.66	79.08
7	University of Toronto	CANADA	70.31	82.20	63.14	82.17	76.69	75.94
8	Arizona State University	USA	67.22	71.67	54.66	71.61	65.42	67.28
9	University of Cambridge	ENGLAND	54.02	69.15	61.86	69.17	74.02	65.86
10	University of Sydney	AUSTRALIA	56.29	68.00	59.32	68.03	69.57	64.60

TABLE 1.18 URAP field specific ranking Urban planning 2015

## Self-reflection

Looking back at our initial goals and targets and what we accomplished in 2010–15, it seems that we achieved most of what we set out to achieve.

### Research quality

In terms of research quality, the faculty has made measurable progress across the board:

- the number of peer-reviewed publications is up significantly, not just in a few groups, but in most research programmes;
- the emergence of field-specific rankings seems to indicate that TU Delft's research in Architecture and the Built Environment is a forerunner in its field world-wide;
- although obtaining personal grants from science foundations once seemed out of reach, we now have a broad group of researchers who have obtained such funding.

### Relevance to society

Architecture and all disciplines involved in the built environment attract considerable interest from both practitioners and the public. We have been able to materialise the societal relevance in a large number of initiatives. The founding of the Amsterdam Institute for Advanced Metropolitan Solutions (AMS) is probably the most exemplary achievement at this point. Many other consortia-based projects and collaborations underpin the societal relevance of the research.

### Viability

Having weathered TU Delft's austerity process and the global financial crisis, the future looks quite promising – although it does not mean that all fields are in equally good shape. We are very aware that work needs to be done in certain areas. Having come a long way with an approach that was developed locally in Delft, one could argue that this does not guarantee future performance. In order to keep our research viable, it is time to expose our research culture to international influences, hence the importance of new alliances such as BauHow5.

## SWOT analysis

### STRENGTHS

- A considerable and enviable resource base through the confederation of the Faculty of Architecture, the OTB Research Institute and the Berlage Institute.
- Staff are well integrated into the rich practice of Dutch architecture, urban design, spatial planning, housing, built environment and geomatics.
- An increasing number of staff are PhD graduates.
- A solid body of excellent PhD research, attracting PhD students from all over the world.
- A sense of a vibrant young community of researchers interested in each other's work.
- An excellent international reputation as evidenced by field specific rankings.
- Good research management.
- Multidisciplinarity.
- Broad portfolio.
- Cooperation with TU Eindhoven, University of Twente and Wageningen University in the 4TU Federation Centre for the Built Environment
- Partnership with MIT and Wageningen University: the Amsterdam Institute for Advanced Metropolitan Solutions.

### OPPORTUNITIES

- With its large contingent of PhD students, the faculty can become a centre for research, not just in the Netherlands but in Europe and beyond.
- Design and engineering are increasingly accepted as mature academic activities.
- H2020 is offering new funding and collaboration opportunities.
- 'Top sector' policies on Creative Industries and Urban Energy are leading to more national research funding in these key areas.
- Cooperation with Leiden University and Erasmus University in LDE.

### WEAKNESSES

- Success in obtaining research grants and contract research is not equally distributed over the research programmes or the departments.
- Architecture is still a field with a weak academic journal culture.
- Gender imbalance among especially professors and management.
- An older generation of professors who lack academic leadership.

### THREATS

- Becoming complacent about accomplishments.
- Uncertainty about Dutch governmental science policy and fit ('top sectors', NWA).
- Lack of tenure prospects for promising young researchers.
- Viability issues in specific topic areas due to retiring leading staff.
- Work pressure.

# APF

## The Architectural Project and its Foundations

Programme leaders:

Tom Avermaete  
Klaske Havik

Patient (Re)Search:

Max Risselada Farewell Exhibition and Colloquium

12 September - 10 October 10, 2014



Architectural Model  
Architectural Model

Architectural Model  
Architectural Model



# The Architectural Project and its Foundations

## Scope

The research programme The Architectural Project and its Foundations focuses explicitly on architecture as a field of expertise, a field in which making and thinking are inextricably linked. The programme regards the 'architectural project' as the cornerstone of architectural practice and reflection.

The research programme The Architectural Project and its Foundations regards the architectural project as the junction where a complex combination of cultural, social, functional, economic and ecological factors is articulated as a concrete spatial proposal. This articulation requires the specific expertise that characterises the discipline of architecture. Precisely this expertise is at the centre of the research programme of the Department of Architecture at TU Delft. The programme examines the development of architectural design – focusing on the changing definitions of architecture, the transforming approaches of analysis and design, and the position architects can take in this context – with the goal of providing new perspectives on how we think, design and build today. The programme takes a clear position, balancing scientific research with a strong link to societal issues and the field of architectural practice.

The programme is composed of two sub-programmes, each of which has multiple research groups. The Architectural Project sub-programme encompasses design-led investigations into how architectural projects can perform at the scale of the building, the city and the territory, while the Foundations sub-programme studies the theoretical, methodological and historical underpinnings of the architectural project, investigating architectural perspectives, approaches, instruments and disciplinary boundaries.

### The Architectural Project

- **AP1** Buildings and Interiors: Types, Models, Contexts and People
- **AP2** Architecture and the City: Public Realm/Public Building
- **AP3** Borders and Territories
- **AP4** Mapping the Territory and the Cities of the Randstad

### Foundations

- **F1** Revisions: Changing Ideals and Shifting Realities
- **F2** Positions: The Architectural Discipline and its Instruments

## Overview

APF	2010		2011		2012		2013		2014		2015	
	Nr.	FTE										
Scientific staff	36	10,1	35	10,2	31	9,4	31	8,8	29	8,1	29	8,0
Researchers	19	7,1	16	6,0	17	5,3	16	4,6	15	5,1	14	4,9
PhD candidates	13		13		15		13		13		13	
<b>Total research staff</b>	<b>68</b>	<b>17,3</b>	<b>64</b>	<b>16,2</b>	<b>63</b>	<b>14,6</b>	<b>60</b>	<b>13,4</b>	<b>57</b>	<b>13,2</b>	<b>56</b>	<b>12,9</b>
Visiting fellows	19		16		15		22		26		38	
<b>Total staff</b>	<b>87</b>	<b>17,3</b>	<b>80</b>	<b>16,2</b>	<b>78</b>	<b>14,6</b>	<b>82</b>	<b>13,4</b>	<b>83</b>	<b>13,2</b>	<b>94</b>	<b>12,9</b>

TABLE 2.1 Research staff (composition of the research unit)

APF	2010	2011	2012	2013	2014	2015
Refereed articles	7	9	11	11	14	13
Non-refereed articles	9	4	1	0	0	2
Book	28	16	21	11	14	8
Book chapters	68	60	66	81	94	61
PhD theses	3	0	5	4	12	2
Conference papers	20	20	13	19	30	15
Professional publications	23	18	22	23	26	15
Publications aimed at the general public	3	4	1	1	3	2
<b>Other Research Output:</b>						
Book reviews	5	0	3	2	1	2
Appearances on radio or television	6	0	5	0	3	9
Internal reports, lectures, posters, datasets	53	58	81	82	116	109
External reports	1	1	1	0	1	2
Editorships of books	11	8	8	12	38	25
Editorships of journals	10	7	5	8	15	12
<b>Total other Research Output</b>	<b>86</b>	<b>74</b>	<b>103</b>	<b>104</b>	<b>174</b>	<b>159</b>
<b>Total publications</b>	<b>247</b>	<b>205</b>	<b>243</b>	<b>254</b>	<b>367</b>	<b>277</b>

TABLE 2.2 Main categories of research output

APF	2010		2011		2012		2013		2014		2015	
	K€	%										
Direct funding	1.058	90%	1.247	82%	1.036	86%	1.050	87%	1.068	78%	1.110	76%
Research grants	-	0%	-	0%	15	1%	20	2%	141	10%	165	11%
Contract research	44	4%	151	10%	19	2%	18	1%	58	4%	65	4%
Own contribution	-	0%	-	0%	-	0%	-4	0%	-56	-4%	-79	-5%
Other	71	6%	118	8%	140	12%	124	10%	163	12%	198	14%
<b>Total funding</b>	<b>1.173</b>	<b>100%</b>	<b>1.515</b>	<b>100%</b>	<b>1.211</b>	<b>100%</b>	<b>1.207</b>	<b>100%</b>	<b>1.373</b>	<b>100%</b>	<b>1.459</b>	<b>100%</b>
Personnel costs	-1.707	94%	-1.868	93%	-1.698	93%	-1.635	90%	-1.831	88%	-1.831	94%
Other costs	-112	6%	-136	7%	-121	7%	-178	10%	-240	12%	-123	6%
<b>Total expenditure</b>	<b>-1.820</b>	<b>100%</b>	<b>-2.004</b>	<b>100%</b>	<b>-1.819</b>	<b>100%</b>	<b>-1.813</b>	<b>100%</b>	<b>-2.071</b>	<b>100%</b>	<b>-1.954</b>	<b>100%</b>
<b>Result</b>	<b>-647</b>		<b>-489</b>		<b>-608</b>		<b>-606</b>		<b>-698</b>		<b>-494</b>	

TABLE 2.3 Funding (research unit's financing structure)

## 2.3

**Strategy**

The research programme positions architecture as a field of expertise with its own specific logics, approaches and instruments. The investigations of all groups within the programme are geared towards a better understanding of the character of this expertise (Foundations sub-programme) and its capacity to engage with complex cultural, social, ecological and economic issues (Architectural Project sub-programme).

Each group is chaired by a senior researcher and includes both experienced staff and junior researchers or PhD candidates. PhD research on the themes is thus carried out alongside postdoc and long-term investigations. A threefold structure of guidance takes place to monitor the research progress and to ensure that there are in-depth discussions about the research topics within the department: on a daily basis, researchers work together with their immediate colleagues and their daily supervisors. At a secondary level, the groups organise small PhD seminars that are based on a close reading of texts and discussions on both method and content. The third level consists of peer-review colloquia, which the department organises two or three times a year.

While each of the research groups within the programme focuses on distinct themes and approaches, the engagement of the department with both fundamental and applied research is reflected in the identification of long-term research foci – which represent long-term and collectively held research interests across the different groups of the programme – and short-term research issues, which respond to challenges in society and key topics of funding bodies. Together, the foci and the issues form a shared value frame for the research programme. The main collective research foci that the department defined at the beginning of the review period are:

- Architecture as Public Matter;
- The Architectural Project as Craft;
- The Role of the Architect.

The issues looked at in the past few years included healthcare architecture. The issues the department proposes for the near future include (but are not limited to):

- Transcultural approaches (including affordable housing worldwide);
- The future of the modern past (rediscovery, reuse, redevelopment and reinterpretation of modern discourse and practice).

## 2.4

**Targets**

In recent years, The Architectural Project and its Foundations research programme has worked towards the greater integration of research ventures across departmental chairs and an improved selection of incoming PhD candidates.

First, the formation of different research groups has resulted in the greater integration of research ventures across departmental chairs. Whereas the research used to be limited to a single chair, nowadays people from different chairs collaborate on common research fields and projects. PhD candidates can thus participate in these different groups and engage in dialogue with a broader range of researchers. In order to underscore these collaborations across chairs, we have initiated monthly meetings with the leaders of the research groups. This enables the research leaders to get acquainted with the ongoing work in other groups, and common research projects are discussed and joint funding

proposals are prepared. Further, an improved selection of incoming PhD candidates has been achieved by establishing a departmental research committee that performs in-depth evaluations of proposals and candidates. In addition, various research groups have developed a system of thematic calls for PhD research.

For the near future, we have identified the following targets:

- To acquire more indirect and contract research funding. Given that our field is positioned between the humanities, social sciences and natural sciences, acquiring funding remains a difficult task. By insisting on the specificity of architectural expertise as a field capable of precisely synthesising these different aspects, we encourage innovative research in the field itself and hope to achieve more success in acquiring funding;
- To strengthen the presence of the department in international networks, to further develop its international reputation as a centre of excellence and to initiate joint projects and applications;
- To strengthen cooperation with national stakeholders. An expert group with stakeholders from key organisations, institutes and municipalities has been formed to critically respond to research and to raise new issues;
- To further increase the amount of research published in highly rated peer-reviewed journals and books;
- To develop more opportunities to prepare excellent students in our own MSc programme to pursue PhD research and academic careers;
- To make more explicit how the results of the productive relationship between research and education can generate relevant research output and contribute to architectural knowledge.

## 2.5

### Environment

The research programme of the Department of Architecture examines the development of architectural design with the goal of providing new perspectives on how we think, design and build today. This requires active observation of the cultural, economic and societal environment in which architects operate. In order to scrutinise such developments, the department has developed a strong network, engaging both with stakeholders from practice and with international partners and networks in the academic world. The national and international outreach of the programme was evaluated positively during the midterm review and will remain an important point of attention in the coming years.

#### Responding to societal challenges

The department holds that architectural research has a role in responding to societal challenges. The long-term foci and short-term issues that the department has formulated combined with the thematic approaches of the research group allow for cross collaboration on societally relevant issues.

The recent economic crisis, for instance, has led to a change in the role of architects and a renewed interest in craftsmanship. These became two of the collective foci of the department during the past period. The short-term issues also respond to the themes and ambitions formulated in the research and innovation agendas of funding bodies.

### Collaboration with stakeholders

Because of the presence of a large number of high-profile practitioners in this group (professors Van Gameren, Kaan, Riedijk, Fretton, Maas and Rosbottom), relations with stakeholders in contemporary architectural practice are continually activated, both formally and informally. The results of the research groups are disseminated to broader groups of practitioners through lectures and debates. Members of this research programme engage with national and local governments to develop or apply their research.

## 2.6

### Performance indicators

As a result of its particular profile, which combines fundamental and applied research, theory and architectural practice, the department has a long tradition in valorising its research not only through standard academic channels, such as peer-reviewed journals and academic lectures, but also through public debates and seminars, as well as exhibitions for a broader public. All of these are understood as systematic research outcomes that contribute to scientific knowledge.

The research results of this programme are typically disseminated through edited or authored thematic books that are aimed not only at academics but also at a broader readership, specifically in the professional and cultural field. Therefore, in addition to publications by high-ranked academic publishers, also publications by professional publishers in the Netherlands, such as Nai010, SUN, Vantilt and Architectura & Natura are highly valued.

Researchers publish widely in peer-reviewed academic journals such as *The Journal of Architecture*, *The Journal of Architectural Education*, *Architectural Theory Review*, *Architecture and Culture* and *Journal of the Society of Architectural Historians* (see for a more extensive list the 'Environment' section). In addition, the department also encourages researchers to be active as editors of the themed academic journal and book series that the department actively supports (DASH, OverHolland, Footprint and OASE) and that have a high impact on the professional and academic debate in the field of architecture. Of these journals, Footprint and OASE are peer-reviewed and have academic status (Scopus). Our researchers also publish in professional journals such as *De Architect* (the primary Dutch professional magazine on architecture) and *S&RO* (*Stedenbouw en Ruimtelijke Ordening*) or on Archined (an important digital forum on architecture and urbanism), and they are active in interpreting the Dutch architectural production through, for instance, the Dutch Architecture Yearbook.

Another important performance indicator is the department's presence in the international architectural debate through its exhibitions and participation in conferences and debates. In the past few years, researchers of the programme have contributed to the highly prestigious Architecture Biennale in Venice, while collaborations with the Jaap Bakema Study Centre have also contributed to a stronger research culture regarding exhibitions.

Some of the research results of the programme evolve into design approaches and projects of practitioners who are directly involved in the programme. Part of the performance of the research programme can therefore be measured in the way that their work receives critical acclaim, wins competitions and is rewarded with prizes.

ASSESSMENT DIMENSIONS	QUALITY DOMAINS	
	RESEARCH QUALITY	RELEVANCE TO SOCIETY
ACTIVITIES, ORGANISATION, FACILITIES/ASSETS, OUTPUT	<p><b>Activities</b></p> <ul style="list-style-type: none"> <li>• Curated exhibitions</li> <li>• Participation in academic conferences</li> <li>• Organisation of and participation in colloquia</li> <li>• Academic lectures</li> </ul> <p><b>Organisation</b></p> <ul style="list-style-type: none"> <li>• Participation in research networks</li> <li>• Collaboration with research institutes</li> <li>• Hosting conferences</li> <li>• Editorships</li> </ul> <p><b>Facilities/assets</b></p> <ul style="list-style-type: none"> <li>• Journal series</li> <li>• Collections</li> <li>• Digital archives and websites</li> </ul> <p><b>Output</b></p> <ul style="list-style-type: none"> <li>• Articles in peer-reviewed academic journals</li> <li>• Edited or authored thematic books</li> <li>• Editorship of themed academic journals</li> </ul>	<p><b>Activities</b></p> <ul style="list-style-type: none"> <li>• Curated exhibitions</li> <li>• Participation in international architectural events</li> <li>• Participation in and organisation of debates</li> <li>• Lectures at architecture institutes and other cultural venues</li> </ul> <p><b>Organisation</b></p> <ul style="list-style-type: none"> <li>• Collaboration with professional institutes</li> <li>• Curating exhibitions</li> <li>• Organising debates</li> </ul> <p><b>Facilities/assets</b></p> <ul style="list-style-type: none"> <li>• Book series</li> <li>• Collections</li> <li>• Digital archives and websites</li> </ul> <p><b>Output</b></p> <ul style="list-style-type: none"> <li>• Articles in professional journals</li> <li>• Edited or authored thematic books</li> <li>• Editorship of themed academic journals</li> </ul>
USE	<ul style="list-style-type: none"> <li>• Reach of calls for papers for conferences and edited journal issues</li> <li>• Books in libraries</li> <li>• Media coverage of academic work in professional media</li> </ul>	<ul style="list-style-type: none"> <li>• Media coverage of events, debates, exhibitions</li> <li>• Publication of architectural work of practicing professors and staff in professional journals and websites</li> </ul>
MARKS OF RECOGNITION	<ul style="list-style-type: none"> <li>• Successful grant applications</li> <li>• Academic prizes</li> </ul>	<ul style="list-style-type: none"> <li>• National and international awards for contributions to the field of architecture and urbanism</li> <li>• Professional prizes</li> </ul>

TABLE 2.4 Selected output indicators

## Results

The following text describes how the department's central focus on architectural expertise, both at the level of the architectural project and at the level of tools, approaches and instruments, has generated a wide range of results that pair scientific quality with societal relevance.

### Activities

The department considers it crucial to have a dynamic research environment with opportunities for international knowledge exchange. In recent years, a number of conferences have been organised at Delft that have given the floor to international researchers who touched upon different aspects of 'the Architectural Project', and this has resulted in substantial publications.

The '*New Urban Configurations*' conference held at the Faculty of Architecture and the Built Environment in the autumn of 2012 was organised by members of the research group AP2 (Architecture and the City: Public Realm/Public Building). It was attended by a large number of international researchers connected to the European Association of Architectural Education (EAAE) and the International Seminar on Urban Form (ISUF), and resulted in a publication.

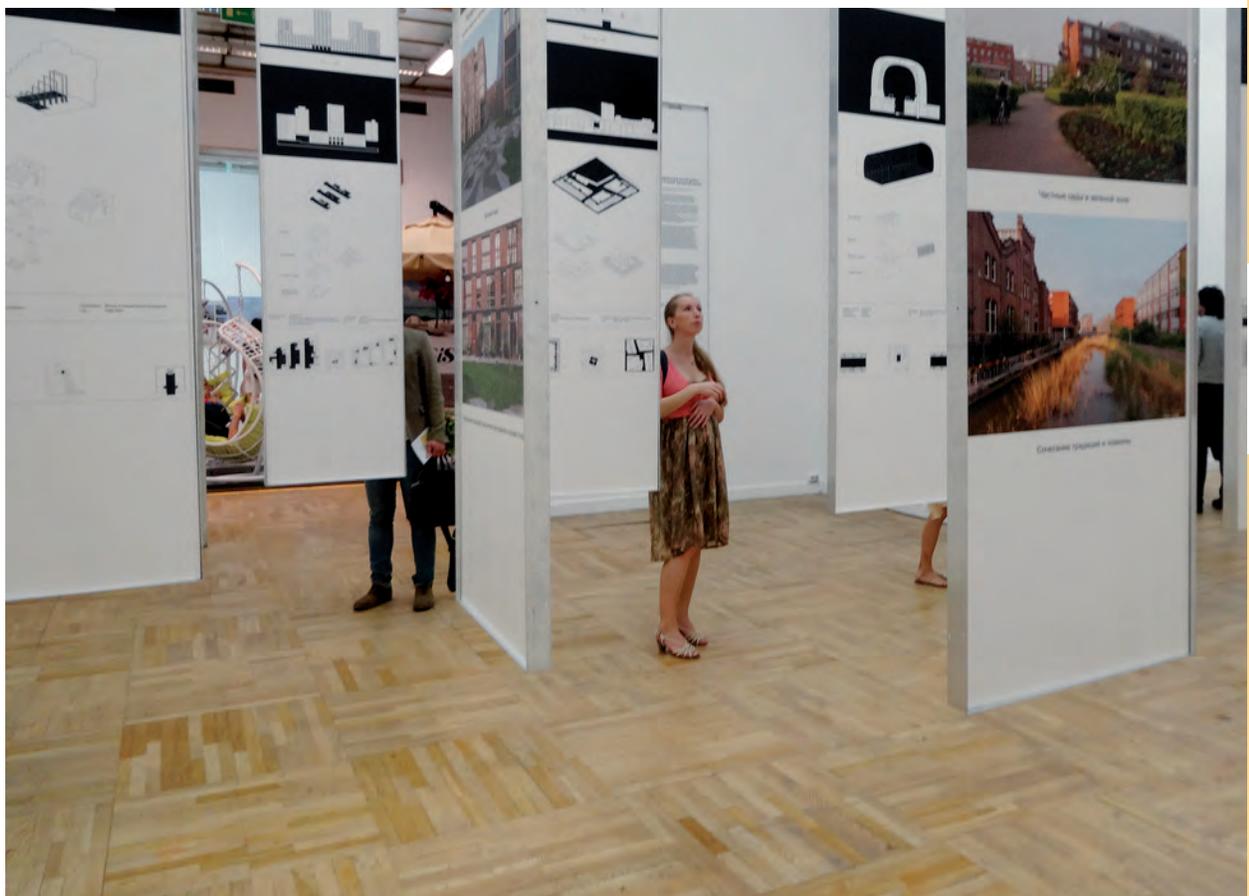
While the above conference took the urban context in which the architectural project is situated as a point of departure, the conference '*Writingplace. Literary Methods in Architectural Research and Education*', which was held at the faculty in November 2013, focused on the level of tools and instruments by means of which architects can understand and conceptualise their field.

Likewise, the '*Critical and Clinical Cartographies*' conference, which was held in November 2014, investigated how, through the practice of cartography, expertise from the fields of robotics, mechatronics, medical technologies, design and architecture can inform the study of the relation between the human body as a living organism and the machine technologies applied in medical care.

The conference '*The Shopping Centre, 1943-2013: The Rise and Demise of a Ubiquitous Collective Architecture*', which was held in June 2015, brought to the fore a particular type of architectural project and studied both its history and its potential.

The conference '*Research on Display*', which was held in Delft in the autumn of 2015, looked at the role of architectural exhibitions in the development and dissemination of architectural knowledge.

Exhibitions form a very important part of our research output, not only as a way of presenting the results of research but also as a mode of doing research, ordering material, reassessing archive material, and bringing knowledge about the architectural project and architecture as a field of expertise to a larger audience. Exhibitions in the past have often marked important moments in architectural discourse and, in a similar way, the department's exhibitions are intended not only to make knowledge available but also to spark discussion within the field.



Exhibition at the International Moscow Architecture Biennale, May 2014: "The almost perfect urban block: towards a new urbanity"

In recent years, our research programme has participated in highly recognised events such as the Venice Biennale. The exhibition *'The Balcony'*, as part of the main exhibition *Elements of Architecture*, and the simultaneously held exhibition *'Bakema: a Celebration'* in the Dutch pavilion featured at the 14<sup>th</sup> International Architecture Exhibition in 2014. The international Moscow Architecture Biennale in May 2014 featured our exhibition *'The almost perfect urban block: towards a new urbanity'*.

The research programme also collaborates with other parties for large international exhibitions, such as the collaboration with the Canadian Center of Architecture (CCA) in Montreal, with the exhibition *'How architects, experts, politicians, international agencies and citizens negotiate modern planning: Casablanca Chandigarh'*, Canadian Centre of Architecture (CCA) Montreal, Canada, November 2013–April 2014

The department has a long tradition of organising debates and seminars that bring together research and practice. These debates are often organised for a broad audience that includes practicing architects, while they are paired with research output in the form of book publications or journals. An example is the lecture series *'Architecture as a Craft'*, which was accompanied by a book (2010) featuring, amongst others, Sou Fujimoto, Christoph Gantenbein, Enrique Walker and Gregg Pasquarelli. Other examples include the symposium *'X Agendas for Architecture'* in 2011, and the debate *'Building Atmosphere'* with Peter Zumthor, Juhani Pallasmaa and Gernot Böhme in Amsterdam in 2014, presenting the OASE issue on the same topic.

In conclusion, these conferences, exhibitions and debates have in common that they bring together in-depth research about the architectural project and its foundations and a strong orientation towards the field of architectural practice, not only in the choice of topics but also in the way in which the research is presented to include a professional audience and to initiate discussions in architectural discourse and practice.



Exhibition "The Balcony", as part of the main exhibition Elements of Architecture, 14th International Architecture Exhibition, Venice Biennale 2014



## 1.2.2

## Organisation

At the level of organisation, the department again positions itself between the academic world and the world of practice. Collaborations take place with strong research networks as well as with national stakeholders and organisations in practice. The project *'Renewing City Renewal. A call for strong design'* was a design-led investigation in collaboration with municipalities, knowledge institutes, architecture firms and housing corporations. It was financed by external funding and resulted in a book publication in 2014.

The research programme has been leading in a number of externally funded research networks such as European Architecture beyond Europe (funded by EU COST action ISO904) and the network The Tacit Dimension: Architecture Knowledge and Scientific Research, funded by Netherlands Organisation for Scientific Research (NWO). Members of the research programme hold active positions in, for instance, The International Planning History Society (IPHS), The European Association for Architectural Education (EAAE) and The European Architectural History Network (EAHN). Members of the research programme have also been chairing panels at international research venues such as the *'Border Conditions'* panel at the Border Aesthetics conference, September 2012, Tromsø (NO), and *'Between Avant-Garde Discourse and Daily Building Practices: The Development of the Shopping Centre in Post-War Europe'* at the EAHN Conference, Turin (IT), June 2014.

Further, members of the research programme have editorial positions in key academic journals such as the Journal of Architecture and the Journal of Architectural Education.

## 1.2.3

## Facilities/assets

The department recognises its responsibility to actively invest in providing a platform for academic exchange and publication through four thematic series, which are supported by and partly produced within the department:

- DASH, book series Delft Architectural Studies on Housing;
- Footprint, peer-reviewed architecture theory journal;
- OASE, Dutch–Belgian peer-reviewed architecture journal;
- OverHolland, book series focusing on architectural and urban research in the Netherlands.

Further, the programme recently initiated a structural cooperation with the Jaap Bakema Study Centre (van den Heuvel, director) at Het Nieuwe Instituut (Rotterdam), which offers a direct connection to an international player in the field of architectural culture and a platform for research development and dissemination. Structural collaborations have also been established beyond our own cultural and geographical boundaries: in line with our issue *'Transcultural Approaches'*, a memorandum of understanding was signed with the Ethiopian Institute of Architecture, Building Construction and City Development.

The department also invest in facilities at the level of its collections and digital repository, such as the Repository on European Colonial Architecture (<http://colonialarchitecture.eu>), the Architectural Collections and Productions / Chair and Model Collection (<http://www.tudelft-architecture.nl/chairs/history-of-architecture-and-urban-planning/research>; <https://acap.weblog.tudelft.nl>) and the GIS Randstad database (under development) related to the research group AP4 Mapping Randstad, and the publication *Atlas of the Dutch Urban Landscape. A Millennium of Spatial Development*, 2016.



DASH, book series Delft Architectural Studies on Housing



Footprint, peer-reviewed architecture theory journal



OASE, Dutch-Belgian peer-reviewed architecture journal



OverHolland, book series focusing on architectural and urban research in the Netherlands

## 1.2.4

### Output

The following overview highlights a selection of the scientific output of the research groups, indicated by the group codes (the Architectural Project AP 1–4, and the Foundations F1 and F2).

#### Scientific Journals produced or co-produced by the programme

- DASH. Delft Architectural Studies on Housing (<http://dash-journal.com>)
- Footprint. ([www.footprint.tudelft.nl](http://www.footprint.tudelft.nl))
- Oase. Architectural Journal ([www.oasejournal.nl/](http://www.oasejournal.nl/))
- OverHolland. (<https://www.vantilt.nl/boeken/overholland-1/>)

#### Academic Articles (selected)

- **AP1** Pimlott, M (2014). *Between everywhere, connecting everything, and nowhere*. Idea Journal, 2013, 68-87.
- **AP1** Cieraad, IG (2013). *Children's home life in the past and present*. Home Cultures: the journal of architecture, design & domestic space, 10 (3), 213-226.
- **AP1** Heuvel, D van den (2011). *The Kasbah of Suburbia*. AA Files: annals of the Architectural Association School of Architecture, 2011(62), 82-89.
- **AP2** Teerds, PJ (2014). *Construction culture: A political perspective*. Architecture and Culture, 2(2), 213-223.
- **F1** Mota, N (2014). *Álvaro Siza's Bonjour Tristesse: A Symphony for a Big City*, The Journal of Architecture 19-5, 779-808.

#### Academic Book Chapters (selected)

- **AP3** Havik, K. (2013) *Architectural prescription: Investigating the balance between real and imagined*. Once upon a place: Architecture and fiction. Gadanho P & Oliveira S (eds). Lisbon., 307-315
- **AP4** Gramsbergen, EH (2015) *De bruikbaarheid van de stadsmorfologische begrippen van M.R.G. Conzen in het onderzoek naar de Hollandse stad*. Stadsperspectieven: Europese tradities in de stedenbouw. Schram A, Colenbrander B, Doevendans K & De Meulder B (eds.). Nijmegen: Van Tilt, 28-47.

- **F1** Avermaete, T.L.P. (2014) *The Place of Commonplace: The ordinary as alternative architectural lens in Western Europe. A Critical History of Contemporary Architecture 1960-2010*. Haddad EG & Rifkind D (eds.). London: Ashgate, 189-206.
- **F2** Schrijver, LS (2014). *Architectural Knowledge: Method or Mystery?* In M Buchert (ed.), *Reflexive Design: Design and Research in Architecture* (pp. 50-71). Berlin: Jovis Verlag.
- **F2** Stellingwerff, MC (2010). *Learning from 'Tugendhat'... Case-based involvement of architectural insights and communication skills*. In H Sorensen, S Juroszek & S Karczewska (eds), *Crossroads Crossovers* (pp. 221-226). Bozeman: School of Architecture, Montana State University.
- **F2** Radman A. (2015) *Sensibility is ground zero: On inclusive disjunction and politics of defatalization*. This Deleuzian century: Art, activism, life. Braidotti R & Dolphijn R (eds.). (Leiden: Brill Publishers. 57-86)

#### Academic books (selected)

- **AP2** Riedijk, Michiel (ed.) *Architecture As a Craft: Architecture, Drawing, Model and Position*. (Amsterdam: SUN Architecture Publishers, 2010)
- **AP2** Cavallo R, Komossa S, Marzot N, Berghauer Pont MY (eds), *New Urban Configurations*. (Amsterdam: IOS Press, 2014)
- **AP3** Marc Schoonderbeek (ed.), *Border Conditions* (Amsterdam: Architecture & Natura Press, 2010)
- **F1** Swenarton, M, Avermaete, TLP & Heuvel, D van den. *Architecture and the welfare state* (London: Routledge, 2015)
- **F2** Kaminer, Tahl, Miguel Robles-Durán, Heidi Sohn (eds) *Urban Asymmetries: Studies and Projects on Neoliberal Urbanization*. (Rotterdam: 010 Publishers, 2010)

#### PhD theses (selected)

- Susanne Komossa: *The Dutch Urban Block and the Public Realm; Models, Rules, Ideals*
- Nicola Marzot: *Beyond the typological discourse: The creation of the architectural language and the type as a project in the western modern city*
- Klaske Havik Urban Literacy: *A Scriptive Approach to the Experience, Use, and Imagination of Place*
- Sang Lee: *Architecture in the age of apparatus-centric culture*
- Merlijn Hurx: *Architect en aannemer: de opkomst van de bouwmarkt in de Nederlanden (1350-1550)*
- Willemijns Wilms Floet Het Hofje: *Bouwsteen van de Hollandse stad*
- Esther Gramsbergen: *Kwartiermakers in Amsterdam. Stedelijke instellingen als aanjagers van de ruimtelijke ontwikkeling, 1580-1880*.

The publications of the research staff are widely used – and this use is not confined to small academic circles. Rather, the dissemination of knowledge produced within the programme is often geared towards a larger circle of architectural practitioners. Therefore, instead of focusing on academic citations we provide an analysis of the availability of a selection of our books in libraries worldwide (note: these are physical books; of course, e-books will have a wider spread).

**Colonial Modern: Aesthetics of the Past, Rebellions for the future**

by Avermaete

Located in: 207 libraries

**Hotel Lobbies and Lounges: The Architecture of Professional Hospitality**

by Avermaete, Massey

Located in: 173 libraries

**Urban Literacy: reading and writing architecture**

By Havik

Located in: 113 libraries

**Alison & Peter Smithson: a critical anthology**

By Risselada

Located in: 118 libraries

**Urban asymmetries: studies and projects on neoliberal urbanization**

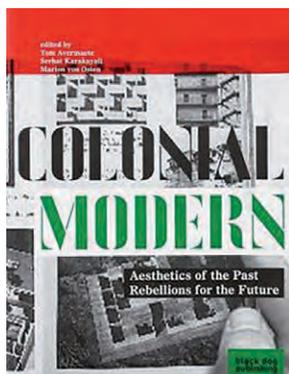
By Kaminer et al

Located in: 138 libraries

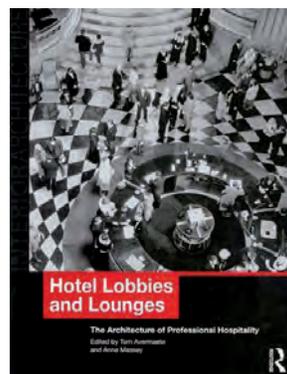
**Aesthetics of sustainable architecture**

By Lee

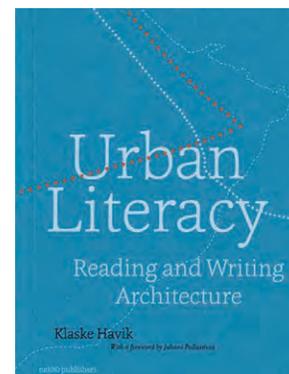
Located in: 153 libraries.



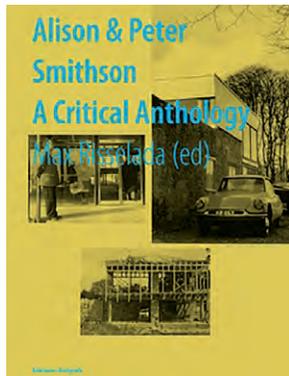
Found in 207 libraries



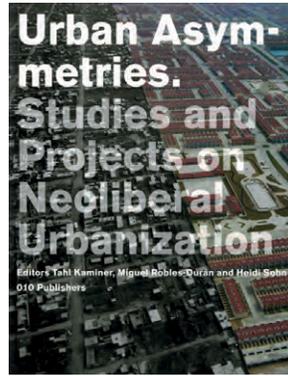
Found in 173 libraries



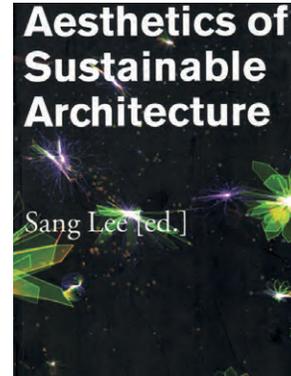
Found in 113 libraries



Found in 118 libraries



Found in 138 libraries



Found in 153 libraries

### 1.2.7

#### Recognition

As shown by the abovementioned activities, organising positions and use of our publications, our research output is widely disseminated in various ways. Our appearance at international conferences and events, and specifically our presence at such renowned events as the Venice Architecture Biennale, shows that our research programme is recognised widely and internationally. Members of our research programme have received awards recognising not only the scientific quality of the work but also its value for the field of practice. These awards include:

- 2010 1<sup>st</sup> Prize Prix de Rome, Architecture (Olv Klijn)
- 2011 CICA Award (International Committee of Architectural Critics) for theme issue OASE #81 '*Constructing Criticism*' of OASE Architectural Journal (Avermaete, Havik, Teerds)
- 2012 Regional Prize BNA (Dutch Architecture Association) (Dick van Gameren)
- 2013 Honorary mention Literaire René Pechère Prijs 2013 for Hans Teerds, Johan van der Zwart. *Levend Landschap, Manifest voor stad en land* (Amsterdam: SUN, 2012) (Hans Teerds)
- 2014 Dutch Architect of the Year Award for her research on architecture and literature (Klaske Havik)
- 2015 Architectural review Award for Best Research for article in *Architecture & Culture* (Hans Teerds)
- 2015 Norwegian State Architecture Prize 2015 (Daniel Rosbottom)



Casablanca Chandigarh, Exhibition, Canadian Centre for Architecture, Montreal, Canada, November 29, 2013 - April 20, 2014

### Context

The international distinction of the research performed at the Department of Architecture of TU Delft contributes to the attention that prospective PhD candidates pay to the The Architectural Project and its Foundations (APF) research programme. It is the intention of the department to keep this distinction as strong as possible in order to attract those PhD candidates who are able to both offer the highest quality research and contribute most effectively to the department's research priorities.

The APF research programme has a diversity of research groups, each with its own topic. The collective research foci, and the shorter term 'issues' (see Strategy), offer overarching topics that ensure collaboration and cross-fertilisation between the research groups. Due to this manner of organisation, which offers diversity within a defined framework, PhD candidates in the Architecture research group follow relatively individualised research tracks, thus developing their own positions in research, supported primarily by their supervisors while being integrated into the department's wider research groups.

The funding of PhD research remains a major concern for the department. It is our ambition to obtain more externally funded research projects that can support new PhD candidates.

The department's PhD candidates benefit from the various general courses offered by the Graduate School for Architecture and the Built Environment (GS A+BE). The department itself offers two courses within the Graduate School. In addition, the department is developing a stronger framework of specific research education in the form of PhD seminars focusing on architectural research approaches and methodologies, as well as on the specific themes of the research programme.

### Selection and admission procedures

In recent years, the department has improved the selection of incoming PhD candidates by establishing a departmental research committee that carries out in-depth evaluations of proposals and candidates. Each proposal needs to pass this committee, so that the department has a good overview of the level of incoming PhD candidates, the topics and the distribution of candidates over the whole spectrum of the research programme.

In addition, various research groups have developed a system of thematic calls for PhD research that allows prospective PhD candidates to be selected on the basis of their engagement with themes of the research group and their understanding of the architectural project as a cornerstone of architectural practice and reflection. Promising candidates are invited to appear before the research group, a visiting critic and a member of the departmental research committee.

### Supervision of PhD candidates internally and guidance of PhDs to the labour market

The research programme itself offers a foundation for PhD candidates to develop their skills within their research groups. The department has been actively investing in the development and further professionalisation of a three-fold system of support for PhD candidates:

- 1 The primary supervision responsibilities are carried by the main supervisor (a professor within the department) and, when possible, an additional day-to-day supervisor (an associate or assistant professor with a PhD degree);
- 2 At the secondary level (bringing together all PhD candidates within a research project or chair group), we organise small PhD seminars that are based on a close reading of texts and discussions on both method and content;
- 3 The third level (bringing together all researchers in the department) consists of peer-review colloquia, which we organise two or three times a year. During these seminars, external specialists in the relevant research fields are invited to give their opinions on the work of the PhD candidates. A month prior to the colloquium, a reader containing texts written by the candidates is prepared as a basis for these discussions. Each PhD candidate is required to participate in at least two peer-review colloquia, namely one after the first year of research (outline presentation) and one after approximately two and a half years (chapter presentation).

ENROLMENT			SUCCESS RATE								Total graduated		Not yet finished		Discontinued		
Starting year	Gender		Finished								Total graduated	Not yet finished	Discontinued				
	Male	Female	Total	≤ 4Y	≤ 5Y	≤ 6Y	≤ 7Y	≤ 8Y	≤ 9Y								
2006	0	2	2	0	0%	0	0%	1	50%	1	50%	1	50%	0	0%	1	50%
2007	2	0	2	0	0%	1	50%	1	50%	1	50%	1	50%	1	50%	0	0%
2008	0	1	1	0	0%	0	0%	0	0%	1	100%	1	100%	0	0%	0	0%
2009	1	0	1	0	0%	1	100%	1	100%	1	100%	1	100%	0	0%	0	0%
2010	1	1	2	2	100%	2	100%	2	100%	2	100%	2	100%	0	0%	0	0%
2011	0	2	2	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	2	100%
<b>Total</b>	<b>4</b>	<b>6</b>	<b>10</b>	<b>2</b>	<b>20%</b>	<b>4</b>	<b>40%</b>	<b>5</b>	<b>50%</b>	<b>6</b>	<b>60%</b>	<b>6</b>	<b>60%</b>	<b>1</b>	<b>10%</b>	<b>3</b>	<b>30%</b>

TABLE 2.5 Length of PhD candidacies and success rate of the PhD programme

## Self-reflection

The Department of Architecture has an excellent reputation and a unique international position in architectural design research, understood as a field of inquiry into a wide scope of issues that are explored through the specific heuristic of architecture. This heuristic implies the use of particular architectural methods and tools – such as typological and morphological study, architectural mapping and drawing – as well as of specific architectural ways of knowing, including spatial, material and designerly ways of inquiry. Projects in the research programme employ these disciplinary ways of knowing, methods and tools to explore broader societal and cultural issues and to situate these within theoretical, methodological and historical perspectives.

Since the start of the review period, the APF research programme has worked towards the greater integration of research ventures across departments, which has been achieved by the establishment of the current research groups. A next step was the formulation of overarching foci and issues across the research groups. Further, an improved selection of incoming PhD candidates has been achieved through the in-depth evaluation of proposals by the research committee, combined with a system of thematic calls for PhD research within the research groups.

The research programme is exceptional in that it combines professors who have an international profile in design practice (Kaan, Riedijk, Fretton, Maas, Rosbottom, Van Gameren) with professors who have a prominent scholarly profile (Avermaete, Hein). This encounter between practice-based and academic approaches offers the researchers within the department a unique view on the reciprocal relationship between practice and scholarship, and that between investigative work based in the profession and academic design-led research.

The department is continuously seeking to activate the specific investigative capacity that stems from this reciprocal relationship between practice-based and academically oriented research. This reciprocity between the two approaches enables the research programme to flexibly engage with both fundamental research themes and urgent societal matters.

The department's comprehensive MSc programme is unique, and it also indirectly contributes to the research programme: studios and seminars serve as investigative laboratories, while many of the MSc theses have a clear relationship with thematic fields present in the research groups and with the 'issues' formulated by the department. A majority of the department's research staff are also actively involved in teaching, which engenders an active relationship between research and education.

## SWOT analysis

### STRENGTHS

One of the greatest strengths of the department is the diversity, energy and enthusiasm of its research staff. This has endowed us with a strong innovative capacity and the ability to explore beyond the established boundaries of research and the structure of the chair groups. In addition, there are a great number of foreign students at the master's level, most of whom chose to study at Delft because of the international reputation of Dutch architecture.

The research programme resonates with this diversity, energy and reputation. The centrality of the "Architectural Project" within the research programme ensures the productive linkage between fundamental and applied research, theory and architectural practice. The output of our research is very well known and well received in the professional field; our staff's publications are well read and known by Dutch and international architects and architectural researchers; and our research staff's debates, exhibitions and lectures are widely attended and receive a good deal of media coverage. The research programme offers both focus and flexibility through its clearly formulated programme and the diversity of the topics and approaches of its research groups.

The department has an excellent reputation and a unique international position in design research, understood as a field of inquiry into a wide range of issues related to architectural design practice. Researchers of our programme are invited to give lectures, take up guest professorships, and participate in conferences and international events all over the world. The department's international orientation has promoted intellectual exchange. Members of the research staff are active in both formal and informal international networks.

### OPPORTUNITIES

There are also opportunities within the extensive master's programme that our department offers. We have many excellent master's students who could contribute more substantially to the research discussions and research output of the department. Many master's studios already have strong links to the topics and approaches of different research groups, while in the formulation of educational assignments, the linkage to our collective 'foci' and 'issues' of the department could be stimulated.

### WEAKNESSES

A significant weakness is the difficulty in acquiring external funding. The programme at the moment is mainly dependent on direct government funding. This poses a threat to the viability of research, particularly in the light of current budget constraints. In the logic of funding applications, the humanities, the applied sciences and the social & behavioural sciences are generally treated as separate areas. Although architecture shares characteristics with all of these areas, there is no perfect fit with any of them. This position "in between" categories, although challenging and productive, also has its drawback in the scientific rating of our research output. In the field of architecture, high-rated scientific journals are scarce, and even though our staff publish in peer-reviewed journals with high reputations, the scientific rating of these is simply different from that of the natural sciences.

### THREATS

The main challenge in the coming years will be to create and maintain cohesion, without losing the energy generated by the personal efforts of individual researchers. In other words, we must guarantee a certain level of autonomy while encouraging greater collaboration and more exchange of ideas; this is the central task of the research programme. Further, the difficulty in obtaining funding to attract new researchers and to recruit new research staff from our own master's students is becoming a threat. The department is actively applying for research grants to accommodate such candidates.



# D&H

## Design and History

Programme leader:  
**Carola Hein**

Main hall, restaurant and bookshop of the Rijksmuseum.  
P. Meurs & M.T. Van Thoor (eds.), *Rijksmuseum Amsterdam:  
Restoration and Transformation of a National Monument*, 2013.



## Design & History

### Scope

The cross-departmental Design & History (D&H) research programme is built on the common understanding that knowledge of the past, and the spaces it has created, is an important prerequisite for designing the future. This research programme explores a wide range of knowledge and instruments relating to the origins, restoration, conservation, revitalisation and transformation of built heritage. We are convinced that this complex task requires an integrated approach.

The Design & History programme brings together specialised expertise in diverse fields ranging from materials science to design, history and theory. Our perspective is that preserving building materials, transforming heritage structures and landscapes, and designing new buildings in existing surroundings is inextricably bound with the context of the location as well as the history, the place and the materiality of the building. The D&H programme is innovative, integrated and multidisciplinary.

Researchers from the departments of Architecture, Architectural Engineering + Technology (AE+T) and Urbanism collaborate to take on this challenge from the varied perspectives of their own disciplines, times and scale levels. By integrating these discipline-specific perspectives, the members of D&H are able to tackle the complexities that characterise current research questions, driven by a rapidly changing society. The D&H programme therefore offers the opportunity to develop multidisciplinary research approaches and methods in a holistic framework, combining historical analysis with the study of cultural values, urban settings or states of conservation.

We have chosen 'resilience' as our collective theme. We define resilience as the capacity of materials, buildings and cities as part of associated social systems to respond to or recover from diverse challenges. We include in this understanding resilience ranging from tangible structures (materials, buildings or cities) to environmental challenges, as well as the resilience of people and their cities when faced with political, economic or social threats. The rapid growth or shrinkage of cities and populations coupled with functional adaptation and climate change, mandate the development of resilient solutions coupled with an inclusive approach to heritage that comprises historical analysis and design.

We address this topic from a typical Dutch approach, referred to as integrated conservation, that enables preservation through development. It acknowledges that buildings, cities and cultural landscapes are in a constant state of change and that resilience in conservation dictates design for transformation. We are now starting to address the enormous challenges that historical landscapes and cities in the Netherlands and Europe face, ranging from regional transformation and shrinking cities to a stock of outdated and obsolete buildings. We study environmental challenges to our heritage, notably water-related ones, and address the need for a resilient and healthy transformation of the legacy of the 20<sup>th</sup> century through historical analysis, design and investigations into innovative materials. The growing academic and societal interest in heritage places the programme's focus at the centre of national and international interests.

D&H	2010		2011		2012		2013		2014		2015	
	Nr.	FTE										
Scientific staff	15	4,2	16	4,2	16	4,5	16	4,5	18	4,6	20	5,3
Researchers	13	4,4	9	4,2	9	3,6	8	2,4	7	2,5	6	1,9
PhD candidates	4		3		2		4		5		6	
<b>Total research staff</b>	<b>32</b>	<b>8,6</b>	<b>28</b>	<b>8,4</b>	<b>27</b>	<b>8,1</b>	<b>28</b>	<b>6,9</b>	<b>30</b>	<b>7,1</b>	<b>32</b>	<b>7,2</b>
Visiting fellows	34		31		30		20		16		16	
<b>Total staff</b>	<b>66</b>	<b>8,6</b>	<b>59</b>	<b>8,4</b>	<b>57</b>	<b>8,1</b>	<b>48</b>	<b>6,9</b>	<b>46</b>	<b>7,1</b>	<b>48</b>	<b>7,2</b>

TABLE 3.1 Research staff (composition of the research unit)

D&H	2010	2011	2012	2013	2014	2015
Refereed articles	8	7	8	12	9	7
Non-refereed articles	6	0	1	1	0	0
Book	23	15	3	5	7	8
Book chapters	64	39	28	36	21	32
PhD theses	2	4	0	1	1	3
Conference papers	19	12	12	12	14	8
Professional publications	19	13	8	10	14	13
Publications aimed at the general public	2	1	0	0	2	1
<b>Other Research Output:</b>						
Book reviews	4	3	9	3	4	4
Appearances on radio or television	0	0	0	1	1	3
Internal reports, lectures, posters, datasets	3	7	9	13	24	65
External reports	1	2	0	2	3	1
Editorships of books	20	7	7	3	6	12
Editorships of journals	9	15	14	15	16	16
<b>Total other Research Output</b>	<b>37</b>	<b>34</b>	<b>39</b>	<b>37</b>	<b>54</b>	<b>101</b>
<b>Total publications</b>	<b>180</b>	<b>125</b>	<b>99</b>	<b>114</b>	<b>122</b>	<b>173</b>

TABLE 3.2 Main categories of research output

D&H	2010		2011		2012		2013		2014		2015	
	K€	%	K€	%	K€	%	K€	%	K€	%	K€	%
Direct funding	829	69%	792	78%	488	63%	611	56%	593	49%	608	53%
Research grants	-	0%	39	4%	108	14%	226	21%	351	29%	152	13%
Contract research	256	21%	139	14%	63	8%	234	21%	288	24%	376	33%
Own contribution	-	0%	-112	-11%	-	0%	-72	-7%	-68	-6%	-65	-6%
Other	112	9%	164	16%	113	15%	94	9%	47	4%	68	6%
<b>Total funding</b>	<b>1.197</b>	<b>100%</b>	<b>1.021</b>	<b>100%</b>	<b>772</b>	<b>100%</b>	<b>1.094</b>	<b>100%</b>	<b>1.210</b>	<b>100%</b>	<b>1.138</b>	<b>100%</b>
Personnel costs	-1.359	93%	-1.101	85%	-794	93%	-962	91%	-1.003	87%	-910	87%
Other costs	-103	7%	-196	15%	-63	7%	-97	9%	-148	13%	-141	13%
<b>Total expenditure</b>	<b>-1.462</b>	<b>100%</b>	<b>-1.296</b>	<b>100%</b>	<b>-858</b>	<b>100%</b>	<b>-1.059</b>	<b>100%</b>	<b>-1.150</b>	<b>100%</b>	<b>-1.051</b>	<b>100%</b>
<b>Result</b>	<b>-265</b>		<b>-275</b>		<b>-85</b>		<b>35</b>		<b>60</b>		<b>87</b>	

TABLE 3.3 Funding (research unit's financing structure)

The Design & History programme investigates globally relevant issues and presents local solutions in the field of historical analysis, preservation and heritage design with a view towards the future. It does so by building on its diverse theoretical, methodological, professional and disciplinary strengths as well as national and international networks. Specifically, our core objectives are:

- to advance our role as a key national and international player in the integrated and multi-scalar debate on heritage issues, combining research in the fields of historical disciplines with that of heritage conservation, restoration and adaptive reuse, transformation, architecture and engineering;
- to apply our knowledge of the Dutch situation and its associated integrated conservation approach, recognised as the core element in the D&H programme in 2008, and transfer these into the international context by means of our continuing recognition as key partner in international networks;
- to strengthen relationships with professionals from the heritage field (practitioners and policymakers), in order to contribute to the solving of urgent problems, including the preservation through redevelopment of structures and buildings, cities and landscapes;
- to reinforce the basis of our research programme by expanding it with the help of a growing number of researchers; extending collaborations both within and outside the faculty; strengthening networks; attracting leading national and international researchers, increasing the volume of publication outputs; sourcing more direct and indirect funding and strengthening our position within the faculty;
- to stimulate the interaction between the D&H research programme and design and research education, thereby providing research opportunities for PhD candidates and MSc students.

We focus on the following research themes:

#### Historical Landscapes

Historical landscapes – ranging from small private gardens to industrial areas, and from polders to city centres – have evolved as a result of constant spatial and social change. D&H explores emerging temporal and spatial questions related to fields of history and heritage, adaptive reuse and design. (Carola Hein, Reinout Rutte, Everhard Korthals-Altes, Heritage Vector/Gerdy Verschuure, Marie-Thérèse van Thoor, Sara Stroux, TBD/Chair Heritage and Cultural Value).

#### Heritage and Water

Water and the abundance or the lack thereof has created and formed diverse heritage structures. A comprehensive and interconnected approach to water is necessary to develop resilient spatial and built-environment practices, especially within the perspective of anthropogenic climate change. (Reinout Rutte, Gerdy Verschuure, TBD/Chair Heritage and Cultural Value, Carola Hein, Barbara Lubelli, Rob van Hees).

#### Healthy Cities

All aspects related to healthcare research at the Faculty, including reuse, heritage and the historical evolution of building typologies in this field, are connected through the Health@BK platform. This platform is hosted by Design & History. (Cor Wagenaar, Wessel de Jonge, Heritage Vector/Vincent Nadin, Silvia Naldini, Ivan Nevzgodin, Lidwine Spoormans).

### The Legacy of the 20<sup>th</sup> century

Building on established research by group members, we take a multidisciplinary approach to investigating the history, preservation and sustainable adaptive reuse of the 20<sup>th</sup> century architectural heritage. (Marie-Thérèse van Thoor, Wessel de Jonge, Sara Stroux, Hielkje Zijlstra, Herman van Bergeijk, Leo Oorschot, Lidwine Spoomans, Marieke Kuipers, Wido Quist).

### Materials in heritage

Heritage preservation requires knowledge of historical and current materials use and properties, service life expectancy and extension as well as innovative solutions for conservation of heritage fabric. (Barbara Lubelli, Rob van Hees, Wido Quist, Herdis Heinemann, Hielkje Zijlstra, Wessel de Jonge, Silvia Naldini, Charlotte van Wijk, Herman van Bergeijk)

## 3.4

### Targets

Building on the recommendations of the Midterm Assessment Committee (2013), we have concentrated on bridging theory and practice as well as on connecting historical approaches and technology. To move further in this direction, we need:

- To attract adequate personnel for current and future vacancies. The selection of new professors for vacant posts and of faculty members is important in order to strengthen the coherence of the programme, expand its academic and professional reputation, and provide the intellectual and temporal capacity for funding applications and guiding PhD candidates.
- To increase the quantity and quality of research funding applications. We have applied for national and international funding with some success, and will continue to do so (NWO, STW, private and public institutions such as ministries, municipalities and provinces, H2020, FP7 programme, JPI, Getty Foundation, Volkswagen Foundation, Henkel Foundation, etc.). Grant applications will help grow the number of PhD candidates, postdocs and researchers assigned to the various D&H chairs and help fund our output.
- To attract national and international PhD candidates and postdoc researchers with own funding in place, and provide the work environment and supervision to enable them to finish in time. For the next 6-year assessment period, D&H aims to deliver a total of 12 PhD graduates.
- To maintain and improve our track record of output in academic and professional platforms, including through peer-reviewed scientific journal articles, international books and book chapters, reports, and national and international exhibitions, while at the same time increasing our societal impact.

## 3.5

### Environment

The Design & History research programme was established in 2008. It has since become a joint venture among the chairs History of Architecture & Urban Planning, Heritage & Design, Heritage & Technology, Heritage & Cultural Value and Cultural Heritage of the 20<sup>th</sup> Century. The chairs of Heritage and Spatial Design and Spatial Planning (both Urbanism) and the Chair of Architecture, Urbanism and Health (TU Delft/University of Groningen) joined the collaboration in 2015. When Hein was appointed professor of History of Architecture & Urban Planning in 2014, she brought with her an international

scholarly network and new research interests. The recent appointment of De Jonge (September 2015) as professor to the Chair of Heritage & Design, connected the research programme to the international field of conservation of 20<sup>th</sup>-century heritage, and to organisations like UNESCO, ICOMOS, DOCOMOMO International and APT. To increase our knowledge base and expand our reach, we cooperate closely with other Dutch and foreign universities. We have partnered with Leiden University and Erasmus University Rotterdam to form the joint multidisciplinary Centre for Global Heritage and Development (CGHD). In this structure, members of D&H lead the CGHD research group Heritage and Environment. We collaborate with the University of Groningen, the University of Amsterdam, VU Amsterdam and Eindhoven University of Technology. Our partnerships include many other Dutch institutions, including the Cultural Heritage Agency of the Netherlands (RCE), the Netherlands Organisation for Applied Scientific Research (TNO), the foundation for preventive conservation of monuments (Monumentenwacht), the Royal Netherlands Archaeological Society (KNOB) and the Netherlands Institute for Art History (RKD). The international networks of our group members allow us to collaborate with major universities, including KU Leuven and Vrije Universiteit Brussels (both Belgium), the Dutch University Institute for Art History (NIKI), Politecnico di Milano and Federico II Napels (Italy), Uppsala University (Sweden), HafenCity University Hamburg (Germany), National Technical University of Athens (Greece) and the Kyoto Institute of Technology (Japan). D&H also collaborates with international research institutes including, BBRI (Belgian Building Research Institute) and KIK/IRPA (Royal Institute for the Cultural Heritage) in Belgium, CNR (National Research Council) in Italy and LNEC (National Laboratory for Civil Engineering) in Portugal. Our members actively participate in professional organisations including ICOMOS, DOCOMOMO International, WTA, RILEM, APT and have close ties with The Getty Foundation. D&H members also serve UNESCO in various capacities.

### 3.6

#### Performance indicators

The Design & History group aims to have an impact in both academia and society. Multidisciplinary approaches in the field of heritage are relatively new but new scholarly networks, crosscutting academic positions and interdisciplinary journals have started emerging. To measure the impact of the D&H programme, we consider a wide range of performance indicators that are in line with the programme's multidisciplinary and innovative scope.

Members of our group have published in a broad range of cross-referenced peer-reviewed journals and have produced high-quality academic books and book chapters. A broad range of successful grant applications have provided funding for staff (PhD candidates and postdoc researchers) and for diverse events and publications. The role of D&H in the academic and professional world is demonstrated by the numerous keynote lecture invitations extended to our members. Our members hold editorships of international journals, are members of international committees, participate in co-funded centres, and collaborate with national and international research institutes, universities, government and industry. This further illustrates the global impact of D&H. Our work is also published in professional magazines and applied research reports. The societal relevance of our research in international discourse is reflected in our professional networks and the roles of group members in practice and policymaking. Our group's national and international exhibitions are another important performance indicator. We have used our physical collections (design objects and building materials), digital archives and laboratory facilities to develop exhibitions, as research materials in education, and in professional collaborations. This has maximised our impact in academia, professional practice and society in general.

		QUALITY DOMAINS	
		RESEARCH QUALITY	RELEVANCE TO SOCIETY
ASSESSMENT DIMENSIONS	ACTIVITIES, ORGANISATION, FACILITIES/ASSETS, OUTPUT	<p><b>Activities</b></p> <ul style="list-style-type: none"> <li>• Internationally funded research projects (Getty Foundation, JPI)</li> <li>• Nationally funded research projects (NWO, RVO, 3TU)</li> <li>• Organisation of academic conferences, seminars, colloquia</li> </ul> <p><b>Organisation</b></p> <ul style="list-style-type: none"> <li>• Participation in national and international centres and consortia</li> <li>• Collaboration with national and international research institutes</li> <li>• Membership of national and international scientific committees and networks</li> </ul> <p><b>Facilities/assets</b></p> <ul style="list-style-type: none"> <li>• Collections (chairs, decorative stone, wood, building materials)</li> <li>• Digital archives and websites</li> <li>• Laboratory facilities for study of building materials</li> </ul> <p><b>Output</b></p> <ul style="list-style-type: none"> <li>• Refereed journal articles</li> <li>• Academic books/book chapters</li> <li>• PhD theses</li> <li>• Conference papers</li> <li>• Editorship of peer-reviewed journals</li> <li>• Editorship of books</li> <li>• Curatorship of exhibitions</li> <li>• Keynotes at int. conferences</li> </ul>	<p><b>Activities</b></p> <ul style="list-style-type: none"> <li>• National research projects (ministries, museums, private institutions)</li> <li>• Advisor/election to professional associations</li> <li>• Membership of national and international professional committees</li> </ul> <p><b>Organisation</b></p> <ul style="list-style-type: none"> <li>• Participation in co-funded centres</li> <li>• Collaboration with professional institutes</li> <li>• Membership of knowledge networks of professionals and end-users</li> <li>• Role in practice and policymaking</li> </ul> <p><b>Facilities/assets</b></p> <ul style="list-style-type: none"> <li>• Collections (chairs, decorative stone, wood, building materials)</li> <li>• Digital archives and websites</li> <li>• Web-based tools</li> </ul> <p><b>Output</b></p> <ul style="list-style-type: none"> <li>• Professional journal articles</li> <li>• Professional books/book chapters</li> <li>• Media presence</li> <li>• Applied research reports</li> <li>• Editorship of professional publications</li> <li>• Professional book series</li> <li>• Curatorship of public exhibitions</li> <li>• Invited lectures at architecture institutes and other cultural venues</li> </ul>
	USE	<ul style="list-style-type: none"> <li>• Participation in European (JPI) and national (NWO, RVO, 3TU) consortia</li> <li>• Number of downloads of books and book chapter</li> </ul>	<ul style="list-style-type: none"> <li>• Media coverage of academic work, events, debates, exhibitions</li> <li>• Publications of architectural work of practicing professors and staff in professional journals</li> </ul>
	MARKS OF RECOGNITION	<ul style="list-style-type: none"> <li>• Prizes and awards</li> <li>• Member of research review panels</li> <li>• Invitations as keynote speakers to important conferences and seminars</li> <li>• Election to academic or academic professional associations</li> <li>• Editorship of academic journals</li> <li>• Honorary positions</li> <li>• Acquisition of research grants based on peer review JPI, NWO, RVO, 3TU</li> </ul>	<ul style="list-style-type: none"> <li>• Prizes and awards</li> <li>• Advisor/election to professional associations and practice</li> <li>• Practice chairs financed/co-financed by external partners</li> <li>• Long-term cooperation with government and industry</li> <li>• Invited public lectures and debates</li> </ul>

TABLE 3.4 Selected output indicators

## 3.7

## Results

Design & History has made a strong contribution to both academia and heritage practice. Projects pursued by the group testify to both the high quality specialist knowledge of its members and the multidisciplinary approach of the researchers involved. Despite being in a transition period (due to the departure of chair holders and faculty members and the resultant dips in output), our academic output in terms of numbers has again grown and our research content has become more coherent and focused.

The cooperation with other departments of the faculty and with other universities, universities of applied sciences and research centres at home and abroad, as well as with the practice, contributed to strengthening and enlarging our group's network. The dissemination of project results takes place in both academia and society, increasing the visibility of our group at the national and the international level.

Members of the programme initiated or participated in major externally funded projects and obtained funding for staff members, PhD candidates and postdoc researchers, as well as for other activities. This output is the foundation for the research themes sketched out above and underlined below.

## 3.7.1

## Activities



4TU lighthouse project: Architectures of the Black Gold

As part of our research on historical landscapes, we have started research on the landscape of oil in the Dutch Randstad. Thanks to funding from the 4TU Lighthouse project Architectures of the Black Gold (Hein, Koutamanis, Colenbrander) we have developed an open access website and an augmented reality tool to reinforce research done on energy landscapes within Design & History.

Research on the theme the 'Legacy of the 20<sup>th</sup> Century' has resulted in the acquisition of several projects funded by the government and/or private national and international institutions. Rietveld's Universe (book and exhibition), Sanatorium Zonnestraal (book), Rijksmuseum Amsterdam (book), Rietveld Schröder House (book & technical research), as well as the recently launched multi-departmental project Beyond the Current (Spoormans, de Jonge, Oorschot), are examples of research in this field, connecting design with history and technology.

The NWO-funded project Digital Research Environment European Colonial Heritage (Wagenaar, van Roosmalen) has unlocked thematically related but physically often separated sources on colonial heritage in one digital environment. The freely accessible repository provides data to be used for further research. The knowledge on the digital infrastructure itself can be transferred to other projects.

In the field of innovative materials in heritage, several research projects have been funded. In an RVO (Netherlands Enterprise Agency) sponsored project (supervisors van Hees and Lubelli), the PhD researcher (Granneman) collaborates with other national research institutes and universities as well as with companies and practitioners on the development and assessment of self-healing restoration mortar. Two other projects have received funding within the framework of JPI Cultural Heritage: EMERISDA, on tackling rising damp in buildings, and CHANGES, on the effectiveness of planned preventive conservation, maintenance and monitoring. Naldini, Lubelli, Van Hees and Heinemann work together in international teams, relating societal questions on the conservation of the built environment to scientific research.

### 3.7.2

#### Organisation

The extensive network of the Design & History members that links domestic and foreign universities, research centres, and public and private parties, provides the ideal multidisciplinary environment in which to engage in collaborative research, policymaking and education, with professional and societal application.

Hein (Design & History programme leader) and members of three other D&H chairs participate in the Centre for Global Heritage and Development (CGHD). The CGHD focuses on interdisciplinary research on and joint education programmes (minor, MSc and PhD levels) in theoretical and societal heritage issues and helps create a bigger platform for our goals. The D&H network has opted to explore the CGHD theme Heritage and Environment and developed a specific focus on Water and Heritage, reinforcing our extant research in the field.

We are convinced that research in the field of healthcare can be enriched through historical analysis and innovative design approaches. The D&H programme therefore hosts Health@BK, a faculty-wide platform that connects all aspects related to healthcare architecture and urbanism. The platform (Wagenaar) focuses on the interaction between science and design in order to explore and develop new avenues in the field.

Issues relating to the Legacy of the 20<sup>th</sup> Century are core themes in the multidisciplinary collaboration with the Kyoto Institute of Technology (Meurs, Van Thoor, Zijlstra, Spoormans, Hein, De Jonge). This programme enables researchers and students groups from the TU Delft to work in Japan on mutual projects – books, articles, design studio's and exhibitions – in the field of design and history.

The network MonumentenKennis was launched in 2015, supported by the Ministry of OCW. This project is a collaboration between the Chair of Heritage & Technology, the RCE and TNO. The intention is to develop a knowledge centre for the conservation of materials in heritage. The complementary expertise of the three partners is made available to professionals in the field, such as restoration architects, building conservation advisory bodies, heritage officers and craftsmen, via the web-based decision support system MDCS.

Members of the D&H group provide leadership to built heritage professions and serve as members of editorial boards of national and international academic, peer-reviewed journals: Planning Perspectives (Hein), Journal of Urban History (Hein), Portusplus, Online Magazine 2013 (Hein), Brussels Studies (Hein) Bulletin KNOB (Van Thoor - editor in chief - and Rutte), Restoration of Buildings and Monuments (Lubelli) and Simiolus (Korthals Altes), Cities and Health (Wagenaar).

D&H members are also active advisors to an intergovernmental organisation dealing with built heritage: UNESCO (Kuipers, Meurs, de Jonge, Clarke). Members serve on boards and committees of national and international organisations: ICOMOS (Kuipers, De Jonge, Clarke, Van Hees); The Getty Foundation (de Jonge); DOCOMOMO (De Jonge, Kuipers, Quist, Stroux, Meurs); Fondation Le Corbusier (De Jonge); RILEM (Van Hees, Lubelli); WTA (Van Hees, Quist, Van Bommel); Committee for Architectural Review and Monuments Amsterdam (Van Thoor).

Finally, the D&H group has a solid base in practice, thanks to the link with architectural firms and consultancies in the field of restoration and transformation (Jo Coenen Architects & Urbanists, Wessel de Jonge Architecten, Braaksma & Roos Architecten, SteenhuisMeurs).

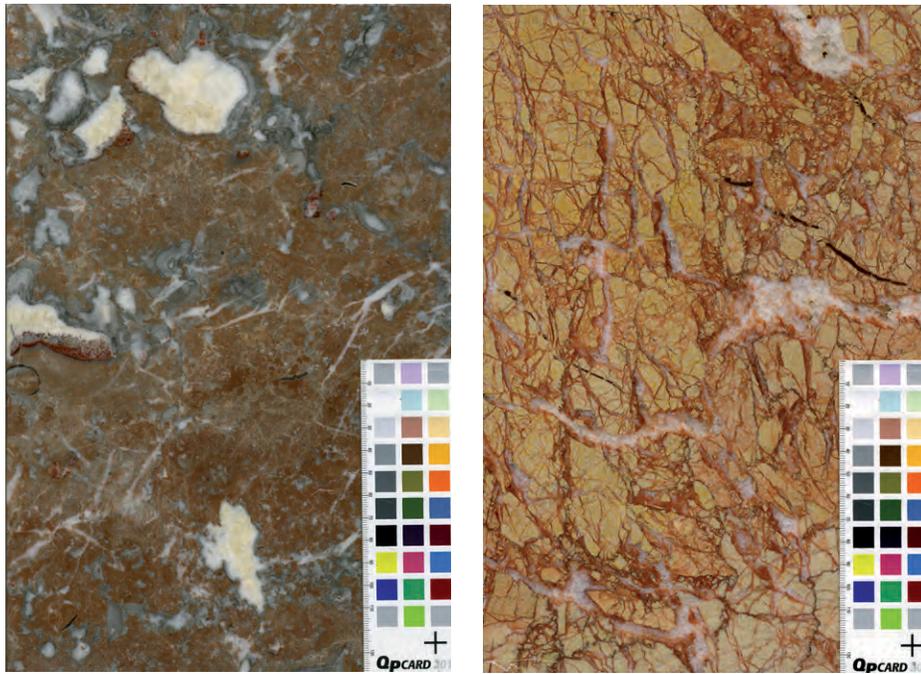
### 3.7.3

#### Facilities/assets

Members of the Design & History research programme are located throughout the building of the faculty and are consequently uniquely placed to connect the various departments and initiate and lead multidisciplinary discourses.

Past interests have led to D&H being entrusted with several teaching collections. These collections reflect the shifting educational strategies and technological capacity of the TU Delft Faculty of Architecture and the Built Environment (A&BE). While some of these collections were destroyed in the 2008 faculty building fire, the remaining collections have been identified as A&BE faculty heritage. D&H has redeployed these as important assets in teaching and research and as an important tool to connect research to history and design. D&H has produced research related to these collections and we are working on new web-based search and presentation tools.

Prime among the collections is the chairs collection. Containing over 300 chairs collected for teaching purposes since 1957, the collection is currently under the supervision of the Chair History of Architecture and Urban Planning (Van Wijk). It is acknowledged as one of the most important furniture collections in the Netherlands and is a source of knowledge about materials, construction and typologies for students and designers alike. In the past, the chairs were used as examples during lectures and as models during drawing lesson, but we now also use them as point of departure for research and design courses. Preliminary evaluations show that the close engagement with these unique objects improves students' design processes and products.



*High resolution scans of the collection of architectural stone are available through [www.stonecollection.eu](http://www.stonecollection.eu)*

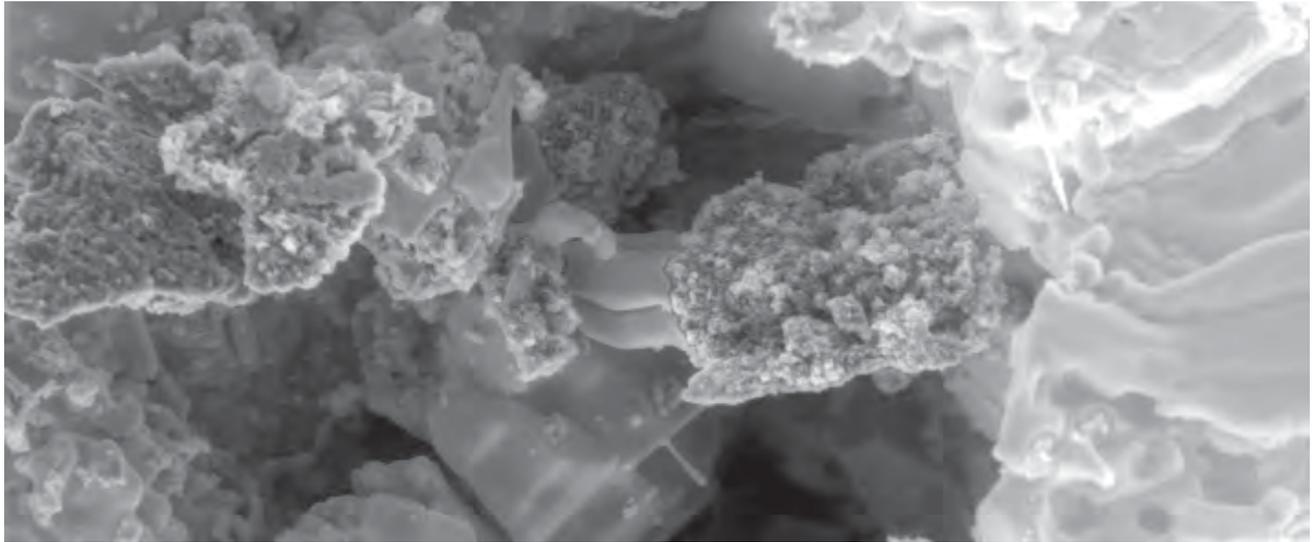
The Chair of Heritage & Technology curates an extensive collection of architectural stone (Quist). This collection came into being by combining a near-forgotten historical educational collection of building materials with a collection from the former Mineralogical Museum of TU Delft. It comprises over 750 unique pieces. This architectural stone collection has been unlocked as part of the MonumentenKennis project and will be available for researchers and professionals through this project's webpage. The Chair also curates a collection of approx. 800 construction timber samples, some dating back to the last quarter of the 19<sup>th</sup> century. These are used for educational purposes and academic as well as professional publications, augmented by a large number of historical building parts and many samples of historical building materials showing different types of damage. The faculty members of D&H are also planning additional research and educational activities around these collections that bring the expertise of the various group members of Design & History together.



*Biesbosch Bakkerskil fort.*



*Sampling of damaged stone for PhD research.*



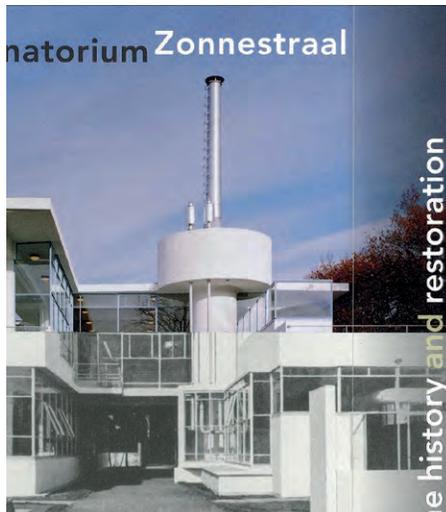
*Sodium chloride crystallization in a mortar (Scanning Electron Microscope image).*



*Research and education together with Kyoto Institute of Technology.*

The output of Design & History is broad and diverse. Academic output consists of peer-reviewed journal articles, monographs, edited books, book chapters, articles in professional journals, keynote lectures, conference presentations, PhD theses and exhibitions.

Select academic publications serve as examples with major output in all of our research themes. Academics praise the monographs *Atlas of the Dutch Urban Landscape* (Rutte, Abrahamse) and *Town Planning in the Netherlands since 1800* (Wagenaar) as milestones in the understanding of the Dutch urban and planning history. They also reflect the Design & History group's experience in the field of historical landscapes, and serve as foundation for our new focus on water heritage.



*Sanatorium Zonnestraal:*  
*the history and restoration of a modern monument*



*Rijksmuseum Amsterdam:*  
*Restoration and Transformation of a National Monument*

The series of books on remarkable monuments and their restoration/ transformation is exemplary for the multidisciplinary contribution of several D&H researchers. The first in the series was *Sanatorium Zonnestraal* (2010). It was followed in 2013 by *Rijksmuseum Amsterdam: Restoration and Transformation of a national monument* (eds. Meurs, Van Thoor). The third publication, on the Rietveld Schröder House, is in production. All books have a broad societal scope, are externally funded (including public and private partners) and are distributed via a publisher with a broad international network (Nai010-Publishers).

D&H research into innovative materials and techniques for the conservation of built heritage has led to cutting edge peer-reviewed journal articles. These are closely connected to international projects (EMERISDA) and to international academic groups (as the RILEM group on salt crystallisation chaired by Lubelli). Granneman, Van Hees and Lubelli contributed a chapter to the edited volume *Self Healing Materials: Pioneering Research in the Netherlands* (eds. van der Zwaag, Brinkman, 2015) based on their IOP research project on self-healing mortars.

Exhibitions also constitute an important output of the D&H group. The successful collaboration with the Centraal Museum Utrecht in the framework of the project 'Rietveld's Universe' (Van Thoor et al. 2010) resulted in a major exhibition in Utrecht, which later travelled to venues in Rome and Weil am Rhein, as well as a prize winning book/catalogue.

The faculty chair collection, documented in Chairs. The Delft Collection (Van Wijk, Woertman, Macel) is on permanent exhibition in the faculty building and is periodically exhibited in the TU Delft main library and in the Library Learning Centre. Other chairs are on loan throughout the country. This illustrates the importance of this collection. Over the last two years, D&H developed pop-up exhibitions across the TU Delft campus and used the chairs in design studios on various levels, the results of which have also been exhibited.



*Exhibition of chairs at Stedelijk Museum Kampen (photo: Hans Rozenbeek).*

### 3.7.5

#### Use

The research results achieved by Design & History group are disseminated and made available for use by society in multiple ways, going beyond standard dissemination instruments such as publication in professional journals.

For example, MonumentenKennis has developed an open-access online platform that shares practice oriented knowledge on the conservation of materials and buildings. We have also developed a specific interactive support tool for the inventorying and evaluation of damage to monumental buildings (MDCS). This too has been made available to researchers and practitioners.

*docomomo\_nl**Bulletin KNOB*

The Design & History programme has also organised seminars on a wide range of topics related to materials analysis and conservation in collaboration with various academic and professional organisations, such as DOCOMOMO\_nl, WTA NL-VL, KNOB and the Vlaams-Nederlandse Natuursteendagen, as well as a Planning History workshop. Each event attracted approximately 75–150 professionals. The response from professionals and public alike has been very positive, confirming the relevance of this research to the field. These events have enabled us to discuss relevant topics and to develop events that are referred to by academics, professionals and students.

Many Design & History members have been commissioned to share their specialist expertise on various topics, including consultancies on the ongoing conservation of some of the most iconic of Dutch buildings and monuments. Externally funded advisory research includes: participation in the advisory board for the restoration of the monumental tomb of Maarten Tromp in the Old Church in Delft (Lubelli); consultation in relation to the conservation works of the Eusebius Church in Arnhem (Quist); advisory consultation relating to the redevelopment of the Werkspoorhallen for the municipality of Amsterdam together with Stadgenoot Housing Corporation (Koopman, Roos, Stroux and Quist). Other commissions include reporting on the importance of Monumentenwacht (Van Hees and Naldini together with TNO). The country estate biotope as a method for preservation of the characteristics of country estates in their surroundings (introduced by Verschuure-Stuip in 2007) was formalised in provincial legislation by the Province of South Holland in 2011 and by the Province of Utrecht in 2013.

Thanks to a series of five handbooks financed by the Foundation Rondeltappe-Bernoster-Kemmers, our research is in the process of being translated back into education practice. The first two books in the series have already been published (Van Hees, Naldini & Roos, 2014 and Meurs, 2016) and the third (De Jonge & Kuipers) is due to be released at the end of 2016. This five-book series deals with essential D&H themes related to the valuation and preservation of heritage (such as value assessment, sustainability, adaptive reuse, etc.). They address both students and interested laymen. The series is not limited to a print edition: an e-book version of each handbook can be downloaded free of charge. This provides a much wider reach and increases the impact of our research.

## Recognition

The members of the Design & History programme enjoy wide national and international acclaim. This is reflected in the many positions researchers have on advisory boards, editorial boards of academic journals, scientific committees, quality teams, etc.

D&H researchers have held several presidencies of national professional organisations such as the Association of Conservation Architects (VAWR, Roos), WTA Nederland-Vlaanderen, (Van Hees), DOCOMOMO-nl (Quist) and the Centraal College van Deskundigen Restauratiekwaliteit (van Hees). Wagenaar was appointed to the Thomassen à Thuessink Chair at the University of Groningen in January 2014, and was subsequently appointed professor of History and Theory of Architecture and Urbanism in the same institution in September 2016.

Others too serve on boards of major organisations. Hein is a board member of the Society for American City and Regional Planning Historians (SACRPH), the Urban History Association (UHA) and the International Planning History Society (IPHS). She has also been invited to convene the biennial International Planning History Society (IPHS) conference in Delft in 2016 and has been invited to join several prize adjudication committees. De Jonge is a member of the DOCOMOMO International Advisory Board since 2012.

The international standing of D&H is further reflected in book contracts. The international publisher Routledge invited Hein to produce a handbook on planning history. In preparation and with funding from the KNAW, the Eesteren-Fluck & van Lohuizen Foundation (EFL) and the NWO (KIEM grant), Hein organised a “Planning History” workshop, 2015 at TU Delft that brought together some 40 acclaimed scholars. The workshop has received positive reviews in the academic press and will now lead to a major publication in the field.

The work of individuals has been recognised by numerous awards. Rutte was named Best Faculty Lecturer 2012, and in 2014 Kuipers won the first DOCOMOMO International Achievement Award. As coordinating architect of the adaptive reuse of BK-City, Roos received the Europa Nostra Award for Cultural Heritage: Conservation in 2011.

Chair holders and senior academic researchers are often invited as keynote speakers to international conferences. These are another indicator of the international standing of our members. Talks by De Jonge at IST Lisbon University and APT (Association for Preservation Technology) in Kansas City, and Hein at MIT, TU Berlin, Duisburg University, IN-EAST, ÖGFA (Österreichische Gesellschaft für Architektur) Wien, and the Macintosh School of Architecture in Glasgow serve as examples.

**Context**

PhD research in the Design & History programme encompasses a broad range of topics in line with our multidisciplinary, multi-scalar and long-term approach. These relate to the five D&H research themes:

- Historical Landscapes;
- Heritage and Water;
- Healthy Cities;
- The Legacy of the 20<sup>th</sup> Century;
- Materials in Heritage.

Our PhD candidates come from diverse backgrounds ranging from the natural sciences to the humanities. Members of the Design & History programme collaborate in advising PhD candidates, providing them with unique, crosscutting perspectives. During bimonthly D&H research meetings, we feature both faculty work and ongoing PhD research with the goal of fostering truly multidisciplinary approaches to history, heritage and design. We endeavour to provide PhD candidates with opportunities to cooperate with foreign and other Dutch universities to provide them with an optimal working environment and to stimulate networking. TU Delft has excellent libraries available for PhD research. PhD candidates also have access to the facilities of affiliated Dutch institutions including the RCE, Het Nieuwe Instituut, the National Library of the Netherlands and the Dutch National Archives. Furthermore, small-scale research can be done within the Heritage & Technology materials laboratory. Additional testing can be undertaken through collaborations within the broader TU Delft and with our external research partners.

The unique Dutch approach of integrated conservation and preservation through development in combination with the tight connection of the D&H group to Dutch heritage practice attracts a growing number of international PhD candidates and of visiting researchers (PhDs, professors).

**Participation in research schools**

Since January 2014, PhD candidates have been expected to participate in the Faculty Graduate School (45 Graduate School Credits) in order to broaden their skills base. Candidates who require more in-depth topic-specific knowledge have the opportunity to take part in tailor-made courses on, for instance, material characterisation. These are offered in collaboration with our research partners. Special courses and summer schools expand this general offering. Members of the Design & History group develop and lead courses that address the needs of our students. An example of such a course is Writing Research Proposals for Architecture and the Built Environment, ABE 009 (Wagenaar and Queena Qian (OTB)). Others participate in newly created courses such as Qualitative Research Methods (Van Thoor, Hein), or are developing new courses in line with the interests of our PhD candidates and their needs to bridge different cultures (Hein, Eisinga). Our PhD candidates can also participate in the educational programme of the Dutch Postgraduate School of Art History (OSK, Van Thoor, Verschuure) as part of their doctoral education.

**Selection and admission procedures**

The Design & History programme has a limited number of externally funded projects, and candidates can apply for vacant positions. We also regularly receive applications from interested candidates who intend to bring their own funding. The Graduate School and the various PhD admission committees screen these applications and discuss them

with potential supervisors. We aim to identify appropriate supervisory teams through exploratory preliminary conversations with potential PhD candidates. PhD candidates who are admitted to the programme still have to pass the go/no-go examination at the end of their first year.

### Supervision of PhD candidates internally

Appointed chair holders and senior researchers are actively involved with PhD research and supervision. In several instances, supervising teams are composed of members of different chairs and departments within the faculty. The bimonthly Design & History meetings as well as meetings within the CGHD network provide PhD candidates with a platform to present their research to their peers and a wider audience and to discuss their findings. A new course, entitled *Re-scape*, presented in the context of the CGHD network and including the VU Amsterdam, will offer students an opportunity to connect to their peers throughout the country. Connections are laid to the labour market by introducing PhD candidates to the larger academic and practice heritage networks.

Graduates of the Design & History programme take on a diverse range of jobs after completing their PhDs. Some graduates have remained in academia, either under the same chair where they conducted their research (Quist, Tanovic), in interfaculty research centres within TU Delft (Heinemann) or at other national universities (van Emstede). One graduate has obtained a position at a Dutch ministry (de Vent). External candidates have continued to work in their home institutions, such as the Dutch Cultural Heritage Agency (Polman) or in industry (Niemeijer). Next to the PhD candidates mentioned in the table, we have a considerable number of internal and external PhD candidates.

ENROLMENT				SUCCESS RATE													
Starting year	Gender			Finished								Total graduated		Not yet finished		Discontinued	
	Male	Female	Total	≤ 4Y		≤ 5Y		≤ 6Y		≤ 7Y							
2006	0	1	1	0	0%	0	0%	0	0%	1	0%	1	100%	0	0%	0	0%
2007	1	0	1	1	100%	1	100%	1	100%	1	100%	1	100%	0	0%	0	0%
2008	0	0	0	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
2009	0	0	0	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
2010	0	1	1	0	0%	1	100%	1	100%	1	100%	1	100%	0	0%	0	0%
2011	0	0	0	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
Total	1	2	3	1	33%	2	67%	2	67%	3	100%	3	100%	0	0%	0	0%

TABLE 3.5 Length of PhD candidacies and success rate of the PhD programme

## Self-reflection

The Design & History group's initial aim was to address the rapidly growing number of reconstruction projects, a consequence of a structural change in western Europe's economic and demographic conditions as well as a response to the need to work in more sustainable ways: whenever functional changes can be accommodated in existing buildings, renovations, restoration, revitalisation and modification is a much better strategy than replacing potentially valuable buildings and urban ensembles by new developments. Combining specific technical challenges with the need to assess the cultural heritage values of the existing buildings called for an integration of these two approaches, in both the assessment and the design phase. Design & History was to provide the integral research setting needed to fill obvious lacunae in the field. Although the group has faced many difficulties – notably vacant chairs and a consequent lack of strategic long-term visions – Design & History has demonstrated that it is capable of providing the knowledge and expertise that it promised to provide.

The multidisciplinary interdepartmental character of the Design & History programme offers many opportunities in both practice and academia. Although several clusters of collaboration exist, we have not been able to fully exploit the potential of cooperation, as we are often hampered by administrative blockages and required to work as separate sections instead of building a collective identity.

Already during the midterm assessment (2013) it was noted that, due to the lack of personnel, funding cycles are often interrupted. When a research project is being conducted, participants do not have sufficient time to prepare applications for new projects. Ideally, this should already have been done before a project is concluded. We aim to change this situation by spreading the efforts over more researchers. Moreover, we aim to collaborate in interdisciplinary calls at the national or international level.

A way to improve the symbiosis between group members is to develop collective educational tasks, notably a research master's track that expands on our existing minor course in the bachelor's programme. It would also enable us to better integrate our research projects in the master's education and prepare our students for the PhD tracks.

During the assessment period, Design & History had a relative small number of PhD researchers. The outcomes of their research have been widely published in national and international magazines, but none of the candidates finished within four years, sometimes because of personal issues. By creating a structure of internal and external presentations and cooperation, creating focused PhD courses, and devoting more time and effort to supervising candidates, we aim to stimulate quicker outcomes and more PhD research.

**STRENGTHS**

The Design & History research programme has a strategic combination of technical, social and humanities-based specialist skills and its design expertise. The combination of different fields of knowledge (ranging from history to preservation, design and technology) and the analysis of their interrelationship, its coverage of multiple scales (from landscape to buildings and materials) and its engagement with diverse theoretical and methodological backgrounds, gives the programme a solid and progressive position. The programme receives wide international acclaim. Its profile facilitates international funding applications and the exchange of knowledge and people. The programme takes advantage of the advanced technology offered by its location at a leading technical university that has outstanding expertise and facilities. This leadership in technology is enhanced by the collaboration with the University of Leiden, Erasmus University and VU Amsterdam, with national and international connections to built heritage-related academic and professional institutions (i.e. CGHD (LDE), TNO, RCE, UNESCO, ICOMOS and DOCOMOMO International) as well as professional organisations (IPHS, SACRPH, UHA).

**OPPORTUNITIES**

In the face of climate change, necessary energy transitions, migration, demographic change and rapidly transforming cities, there is a great urgency to find innovative and resilient solutions for historical structures, as well as for modern buildings and landscapes. International designers and researchers are increasingly interested in European expertise, specifically in innovative approaches that integrate preservation and development, a practice that the Netherlands promotes. They are also particularly interested in the tangible and intangible components of the experience of Dutch professionals and scholars in water-related heritage. Collaborations with ICOMOS NL and the National Heritage Agency on the theme of water can build uniquely on the strength of the Design & History Group. Programmes like UNESCO's Historic Urban Landscapes show the extensive need for novel concepts in the preservation and transformation of heritage. Similar interdisciplinary approaches are encouraged at a European level (see H2020 programme). Careful filling of the vacant positions and support from the faculty for the Design & History programme and its unique multidisciplinary, multi-scalar and long-term approach, will allow the group not only to engage with contemporary and future challenges, but even to lead the transformation of the built heritage field.

**WEAKNESSES**

The Design & History programme is the result of collaboration among chairs from three departments of the faculty, namely Architecture, Architectural Engineering + Technology and Urbanism. The faculty's department-focused administrative and management structure can be an obstacle to advancing our goals. As members of the Design & History group have to comply with both the programme's and the department's aims and wishes, there are occasional conflicts of interest.

Various chairs within the group have faced several long-term vacancies, slowing down the collaboration. The chair of Heritage & Spatial Design has been vacant since September 2015. In September 2016, the chair holder of Heritage & Cultural Value left the faculty. Furthermore, the chair holder of Architecture, Urbanism and Health is primarily located at the University of Groningen (only 0.3 FTE at Delft). The chair holders of Cultural Heritage of the 20th Century and Heritage & Technology will retire in 2017. The job descriptions for these positions have only partly reflected the needs of the Design & History group. These problems have not been entirely solved.

**THREATS**

To stabilise and increase the potential and scope of the Design & History programme, the group needs a solid number of mutually supportive researchers and inspired leaders. The ageing of key personnel and the current and upcoming chair vacancies result in an uneven distribution of researchers (and PhD candidates) in several areas of the programme. Pending staff retirements raise the question of continuity and of equal distribution of research in this interdepartmental collaboration. These threats are all the more tangible and identifiable because of the various management approaches and financial and research strategies of the three departments involved. Faculty and university management support is important to allow the D&H programme to thrive. This institutional support is crucial because the group's highly multidisciplinary approach does not match the more traditional grant schemes of some national and international funding institutions. Current administrative restrictions such as the prohibition on hiring existing personnel for newly opened positions, makes it difficult to create continuity in our collaborative research activities. To address these threats we are actively collaborating with other institutions and groups that experience similar threats. Through our collective work we hope to ultimately change the established culture of disciplinary and administrative separation.



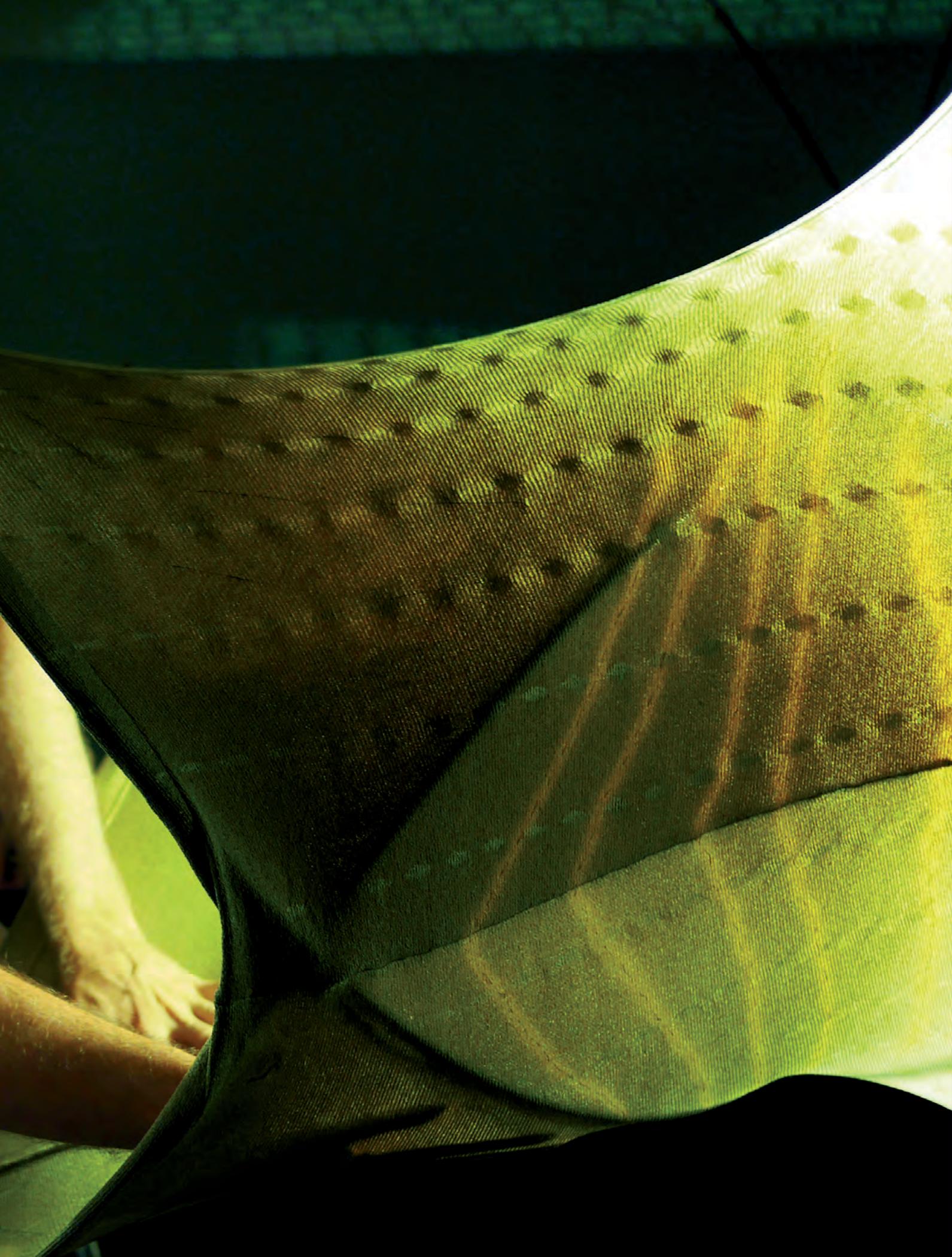
# Computation and Performance

Programme leaders:

**Kas Oosterhuis**

**Michela Turrin**

**Metabody (EU Culture grant): Audience interacting with a smart textile based real-time interactive spatial prototype at the Centre for European textile Innovation, France.**



## Computation & Performance

### Scope

The Computation & Performance research programme improves the design and performance of buildings and the built environment through scientific inquiry into novel ways of conceptualising, mapping, modelling, evaluating, optimising and operating building performance at multi-scalar levels. In this context, performance refers to both technical and qualitative performance, which concern both hard and soft aspects of architectural design and the built environment. Under this umbrella, the programme develops three interrelated research directions: Digitally-driven Architecture; Performative Architecture via Computation; and Structures.

**Digitally-driven Architecture (DA)** implies an architecture that is not only designed and fabricated by digital means, but also incorporates digital sensing–actuating mechanisms that enable buildings to become dynamic, acting and reacting in response to environmental and user-specific needs. The focus is on the development of numerically controlled design-to-production and operation chains that exploit the potential of parametrically driven, cyber-physical and wirelessly networked systems in architecture. DA builds upon Hyperbody's cutting-edge explorations of non-standard and interactive architecture. It currently focuses on two research agendas: Robotic Building (which deals with physically built, robotically augmented environments and robotically supported building processes) and S.M.A.R.T. Environments (which deals with real-time interactive environments, the Internet of Things and data-driven performative architectures).

**Performative Architecture via Computation (PAC)** aims at achieving measurable step changes in performance, towards a built environment that operates better and is designed by triggering innovative concepts and enriched qualitative values. PAC is developed at Design Informatics. It innovates and exploits computational tools, methods and techniques to enable the integration of technical aspects (such as structural, thermal and acoustic aspects) and soft aspects (such as perceptual, functional and social aspects) of architectural design, in an interdisciplinary digital workflow. To achieve this, computational means for form-finding, performance prediction, simulation and measurement, and for integrated information modelling, decision making and communication are exploited to generate performative architectural morphologies; fabricate these using advanced manufacturing tools and techniques; cope with conflicting design goals; enhance interdisciplinary collaborative design strategies; and algorithmically model topological-geometrical structures for design and analysis.

**Structures** looks at how materials science, structural mechanics and structural design can be used in an integrated way to add value to designs of components, buildings and the built environment and to develop multi-scalar innovative structures. Three primary strands are prominently explored: glass as a structural material (focuses on using cast glass as a structural material and aims at developing innovative shapes in structural archengineering design); structural mechanics as a design tool in architecture (focuses on developing a new approach to use structural mechanics, in a non-formula based way, as a design tool for architecture); and spanning structures in the urban environment (focuses on designing aesthetically appealing and infrastructurally vital spanning structures, i.e. bridges, aqueducts, etc.).

C&P	2010		2011		2012		2013		2014		2015	
	Nr.	FTE										
Scientific staff	8	3,1	8	2,3	9	2,5	16	4,0	15	3,8	14	3,9
Researchers	6	3,3	5	2,6	4	2,6	4	1,8	2	1,2	5	1,7
PhD candidates	15		18		20		18		16		17	
<b>Total research staff</b>	<b>29</b>	<b>6,4</b>	<b>31</b>	<b>4,9</b>	<b>33</b>	<b>5,1</b>	<b>38</b>	<b>5,8</b>	<b>33</b>	<b>4,9</b>	<b>36</b>	<b>5,6</b>
Visiting fellows	4		6		10		7		14		15	
<b>Total staff</b>	<b>33</b>	<b>6,4</b>	<b>37</b>	<b>4,9</b>	<b>43</b>	<b>5,1</b>	<b>45</b>	<b>5,8</b>	<b>47</b>	<b>4,9</b>	<b>51</b>	<b>5,6</b>

TABLE 4.1 Research staff (composition of the research unit)

C&P	2010	2011	2012	2013	2014	2015
Refereed articles	2	7	10	2	11	7
Non-refereed articles	1	1	1	0	0	1
Book	0	1	2	1	0	0
Book chapters	3	5	12	0	2	3
PhD theses	1	2	0	2	1	1
Conference papers	33	35	19	28	20	34
Professional publications	6	5	4	1	6	8
Publications aimed at the general public	2	0	0	0	0	1
<b>Other Research Output:</b>						
Book reviews	1	0	0	0	0	0
Appearances on radio or television	0	0	1	0	1	2
Internal reports, lectures, posters, datasets	8	7	13	10	16	32
External reports	0	1	0	0	3	0
Editorships of books	1	0	2	5	0	0
Editorships of journals	1	0	0	0	2	5
<b>Total other Research Output</b>	<b>11</b>	<b>8</b>	<b>16</b>	<b>15</b>	<b>22</b>	<b>39</b>
<b>Total publications</b>	<b>59</b>	<b>64</b>	<b>64</b>	<b>49</b>	<b>62</b>	<b>94</b>

TABLE 4.2 Main categories of research output

C&P	2010		2011		2012		2013		2014		2015	
	K€	%										
Direct funding	498	76%	572	95%	399	73%	373	68%	363	84%	435	87%
Research grants	-	0%	-	0%	-	0%	-	0%	-	0%	83	17%
Contract research	12	2%	1	0%	31	6%	-	0%	87	20%	82	16%
Own contribution	-45	-7%	-	0%	-	0%	-	0%	-51	-12%	-124	-25%
Other	188	29%	27	4%	119	22%	177	32%	33	8%	23	5%
<b>Total funding</b>	<b>653</b>	<b>100%</b>	<b>599</b>	<b>100%</b>	<b>550</b>	<b>100%</b>	<b>550</b>	<b>100%</b>	<b>432</b>	<b>100%</b>	<b>499</b>	<b>100%</b>
Personnel costs	-785	93%	-845	96%	-672	96%	-597	92%	-644	94%	-667	89%
Other costs	-57	7%	-35	4%	-29	4%	-49	8%	-38	6%	-82	11%
<b>Total expenditure</b>	<b>-842</b>	<b>100%</b>	<b>-880</b>	<b>100%</b>	<b>-701</b>	<b>100%</b>	<b>-647</b>	<b>100%</b>	<b>-682</b>	<b>100%</b>	<b>-749</b>	<b>100%</b>
<b>Result</b>	<b>-189</b>		<b>-281</b>		<b>-152</b>		<b>-97</b>		<b>-250</b>		<b>-250</b>	

TABLE 4.3 Funding (research unit's financing structure)

## Strategy

The strategy focuses on three key priorities.

*Building a solid critical mass* is crucial to performing high-quality research. In the past (2005–07), we invested in building a body of PhD students with internal funds. In the following period, we invested in increasing the number of self-funded PhD students and increasing the number of granted research projects to fund PhD candidates, junior researchers (who open doors to future PhD research) and postdocs (who can actively participate in seeking external funding, can support PhD students and are a solid financial investment).

*Consolidating and expanding collaborations with external groups and industry* is crucial to acquiring funding, strengthening the internal focus and developing high-quality interdisciplinary research. It serves to acquire both the critical mass and the multidisciplinary knowledge necessary to target the societal concerns and research topics in funding programmes. Within the AE+T Department, initiatives to exploit interdisciplinary collaborations – including joint projects and mutual cooperation – have been taken, and envisioning a future merger to enhance the already ongoing teamwork. Additionally, relations with other universities have been strengthened both formally (i.e. official agreements) and based on actions (e.g. by means of joint research projects and double PhDs). Finally, the relations with industries have also been increased (e.g. by means of joint research projects, co-supervised research-oriented MSc graduations and organised brainstorming sessions).

*Strengthening and profiling the internal research focus* has been a fundamental priority, which relates directly to the content of the research. Profiling the group was aimed at associating the programme more explicitly with three strong areas of research, not only to be attractive to self-funded PhDs and provide a focused outlook for research partners, but also to invest our limited internal resources effectively. The three interrelated and complementary research directions (Digitally-driven Architecture, Performative Architecture via Computation, and Structures) have thus been put at centre stage, with well-defined and strategically relevant distinctiveness. The topics cultivated at DA offer a strategic and strong connection to architectural theory and cultural and social disciplines, and embed the group within a vibrant contemporary debate on socio-technical architectural paradigms. PAC plays a strategic role in achieving robust engineer–architect collaborations, based on interdisciplinary teamwork. The focus developed at Structures combines in-depth structural engineering knowledge with expertise in material science. As such, the three pillars have been outlined to boost synergies among themselves, and to be reciprocally complementary in regard to collaborations with external partners and with the other groups within the AE+T Department (which is increasingly operating as an interdisciplinary team and is strengthened by the constructive interactions among its internally specialised research clusters).

## Targets

During the period 2010–15, the main targets were established in accordance with the strategy to coherently enhance the production of research outputs.

In order to *build a solid critical mass*, we targeted the growth of externally funded PhD researchers. We also attracted visiting and guest researchers who could contribute to our research. Increasing our external visibility was thus prioritised in order to achieve this target. This included our active participation in significant national and international exhibitions, alongside scientific conferences and academic networks.

In order to *consolidate and expand the collaborations* with external research groups and industry, we aimed at initiating a number of joint projects and joint publications. In order to develop joint projects, a large effort was invested in submitting research fund applications involving relevant industrial and academic partnerships. Moreover, we also targeted new formal agreements with other universities to initiate joint and double PhDs and increased our participation in well-reputed networks and other institutions.

*Increasing the production of publications and other research outputs* was also actively targeted. All staff members and PhD students were, and still are, encouraged to deliver at least one journal paper each year.

Above all, targeting an overall *re-profiling of our research focus* became a primary concern. In 2010–15, we re-profiled the research group and its main network on the basis of a few well-defined topics and with the aim of excelling internationally in a few well-defined research subjects. We did this by increasing the number of regular internal meetings and discussions, and by identifying streams of possible collaborations, internally and with external partners. In five or ten years, the main target will thus be to consolidate the selected topics and further enlarge the critical mass of the staff working on them. This will take the form of either one research group or, more probably, a cluster within the new collaborative framework of the AE+T Department, which will be empowered by the merging of C&P and GBI. Such a collaborative framework within AE+T is intended and expected to build upon the already established interdisciplinary collaborations as well as help in promoting new collaborations.

## Environment

DA, PAC and Structures, which constitute the Computation & Performance Group, have acquired major research funds (direct funding and recently awarded research grants), produced an outstanding number of publications and exhibitions, consolidated the national and international network, and developed new collaborations. In 2010–15, this occurred in an environment characterised by three main factors:

- 1 the economic crisis in the European construction industry;
- 2 the increased attention paid to the architectural and design sectors by major Dutch research funding organisations;
- 3 the increasing attention the topics on computational architecture are receiving.

The economic crisis in the European construction industry has led to a reduction in the internal budget for research. In 2010–15, funding PhD researchers, junior researchers and postdocs by means of government money was not possible. As a consequence, within C&P major efforts were made to secure funds from external sources. As there

has also been a substantial reduction in funds from European industrial partners and practice, the main sources of possible funding have been limited to research funding programmes. At the same time, Dutch research funding organisations (i.e. 4TU Federation and NWO) have paid increased attention to disciplines related to design, integrating architectural and construction topics in the government's 'top sector' policy. This is the case with the new NWO STW Programme 'Research Through Design' (RTD), launched in 2015 as a pilot programme. Moreover, the new lines of development for the National Science Agenda include themes of specific relevance for C&P, like the Intelligence in Construction theme, which focuses on such topics as 3D printing, robotics, automation, sensors, virtual infrastructure and BIM. Accordingly, some of the funding programmes have addressed such topics. The 4TU.Bouw 'Lighthouse Projects' are an example. To C&P, this new environment has provided the opportunity to more easily and successfully apply for funding, and in the near future, a further increase in research funding is expected. Additionally, the research topics addressed by C&P have become acknowledged as key priorities at outstanding universities worldwide. For instance, TUM now has a professorship in Architectural Informatics and another in Building Robotics; ETHZ has three professorships in Computational Design; robotic labs have been established or enlarged at almost all relevant universities (MIT, UCLA, Carnegie Mellon, Princeton, ETHZ, TUM, UIBK, TUV, etc.). At the same time, the recently appointed dean of the TU Delft Faculty of Architecture and the Built Environment has explicitly designated 'automation' as a vital item on the faculty's agenda. Overall, the academic environment is evolving in a very promising direction for C&P.

#### 4.6

### Performance indicators

Because of the transdisciplinary nature of C&P research, the following performance indicators are most relevant:

- research projects, as they are acquired according to our research topics and enable us to implement our line of research;
- published peer-reviewed journals, refereed papers and books, published software applications and prototypes, as they are our primary outputs and means to disseminate the newly generated knowledge. In this respect, their citations and downloads also have great relevance;
- participation in internationally relevant exhibitions, as it enables us to reach a wide audience in society, including professionals and laymen;
- application of scientific research outputs (such as methods, techniques and tools) in public and private sector projects, as the improvement of the built environment is our ultimate goal and direct impact on society. Moreover, these applications are also an incentive for follow-up research and a great visibility window;
- organisation of international conferences, symposia and workshops, as they are occasions for constructive benchmarks and cross-pollutions across the cutting-edge state of the art;
- international and national positioning and participation in consortia and networks, as they are a means to consolidate partnerships in research.

ASSESSMENT DIMENSIONS	QUALITY DOMAINS	
	RESEARCH QUALITY	RELEVANCE TO SOCIETY
ACTIVITIES, ORGANISATION, FACILITIES/ASSETS, OUTPUT	<p><b>Activities</b></p> <ul style="list-style-type: none"> <li>• <i>Research projects</i></li> </ul> <p><b>Organisation</b></p> <ul style="list-style-type: none"> <li>• <i>Organisation of international conferences</i></li> <li>• <i>International and national positioning</i></li> <li>• <i>Collaboration with stakeholders</i></li> <li>• <i>Participation in consortia and networks</i></li> </ul> <p><b>Facilities/assets</b></p> <ul style="list-style-type: none"> <li>• <i>Labs</i></li> </ul> <p><b>Output</b></p> <ul style="list-style-type: none"> <li>• <i>Refereed journal issues/articles</i></li> <li>• <i>Editorship of books</i></li> <li>• <i>Academic books</i></li> <li>• <i>Patents</i></li> <li>• <i>Exhibitions</i></li> </ul>	<p><b>Activities</b></p> <ul style="list-style-type: none"> <li>• <i>Research projects</i></li> </ul> <p><b>Organisation</b></p> <ul style="list-style-type: none"> <li>• <i>Organisation of international conferences</i></li> <li>• <i>International and national positioning</i></li> <li>• <i>Collaboration with stakeholders</i></li> <li>• <i>Participation in consortia and networks</i></li> </ul> <p><b>Facilities/assets</b></p> <ul style="list-style-type: none"> <li>• <i>Labs</i></li> </ul> <p><b>Output</b></p> <ul style="list-style-type: none"> <li>• <i>Refereed journal issues/articles</i></li> <li>• <i>Editorship of books</i></li> <li>• <i>Academic books</i></li> <li>• <i>Patents</i></li> <li>• <i>Exhibitions</i></li> </ul>
USE	<ul style="list-style-type: none"> <li>• <i>Citations and downloads</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Research projects and application of research outputs in professional practice</i></li> </ul>
MARKS OF RECOGNITION	<ul style="list-style-type: none"> <li>• <i>Awards</i></li> <li>• <i>Invited lectures</i></li> </ul>	<ul style="list-style-type: none"> <li>• <i>Awards</i></li> <li>• <i>Invited lectures</i></li> </ul>

TABLE 4.4 Selected output indicators

## Results

Despite severe cuts in research funding, the critical mass of the group remained roughly constant over time, with an overall increase from 29 staff members to 36 staff members and a slight decrease in research FTE's from 6,4 FTE to 5,6 FTE. Given the economic circumstances, this is a very good result. Of the research staff, slightly more than a half were PhD candidates (15/29 in 2010 – 17/36 in 2015). Of the 25 PhD candidates who worked in the group in 2010–15, only eight were standard PhD candidates (i.e. funded by the government), all of whom had enrolled by 2009. This shows that the group was able to attract PhD candidates funded from external sources.

Moreover, as an example of securing funding to hire new researchers, Design Informatics secured funding for a postdoc for two years via the STW OTP (NWO), for a junior researcher for two years via the STW RTD (NWO), and for four junior researchers for about half a year via other sources (e.g. 4TU.Federation, TU Delft Sport Engineering Institute, USE SCUT-TU Delft Joint Research Centre). In order to consolidate and expand the collaborations with external research groups and industry, a number of joint projects and joint publications were applied for or developed. To name some of the industrial partners:

- Festo, Blauwhoed, Topic embedded systems, Philips, Atelier Robotique, Delft Royal, HiCon, ABB, and KUKA collaborated with hyperBODY;
- Arup, Materialize, ESTECO, GLASSX, Peutz, and Ector Hoogstad Architecten collaborated with Design Informatics;
- ABT, MVRDV, and Siko collaborated with Structures.

Moreover, agreements or involvements with other universities and participation in networks include the following:

- Design Informatics participated in the Urban Knowledge Network Asia (UKNA, funded by the Marie Curie Actions IRSES, representing the largest academic international network on Asian cities) and in the Turkish Technical Universities Long-term International Project (TULIP, which is a cooperation between TU Delft, Middle East Technical University and Istanbul Technical University; it includes joint PhD candidates and it is led by C&P staff member Prof. Sevil Sariyildiz);
- hyperBODY participated in consortia involved in doctoral education with ENSHA EAAE, such as Observatory, postgraduate education E-Archidoct and graduate education Continuum; and is part of key networks on robotics, such as the Delft Robotics Institute, Centre National de la Recherche Scientifique (France), Italian Institute of Technology (Italy), Centro di Studi Industriali (Italy);
- The Structures group is part of key networks and activities related to glass, including the European COST Action TU0905 Structural Glass 2010-2014, the European COST Action TU1403 Adaptive Facades 2015-2019, the international Challenging Glass Conference organisation; the research on glass at Ghent University, Cambridge University, University of Minho and Faculty of Civil Engineering & Geosciences TU Delft.

Finally, a number of roles have been assumed by our staff members at other Institutions. For example:

- Prof. Sariyildiz was appointed dean of the Faculty of Architecture, Interior and Environmental Design at Yaşar University, Turkey, in October 2012; as distinguished guest professor at Pennsylvania State University at the departments of Architecture, Landscape Architecture and Architectural Engineering in 2011; and as project leader of the TÜBİTAK project on Energy-efficient Studio Buildings in Turkey;
- Dr Henriette Bier was a member of the PhD admissions committee of Oslo School of Architecture and Design AHO in 2013;
- Dr Nimish Bitoria was a board member of OCEAN Research and Design Network (Norway) in 2015;
- Dr Michela Turrin was 'excellent overseas instructor' at South China University of Technology and affiliate (with awarded research funds) at the State Key Laboratory of Subtropical Building Science of SCUT in 2014/15.

In order to strengthen and profile the internal research focus, internal meetings and discussions were held, while the external visibility was prioritised among the targets through, for example, being part of relevant exhibitions. For example:

- Research projects from hyperBODY and Design Informatics were exhibited at BouwBeurs 2015, Jaarbeurs 2015 and the 3TU Innovation & Technology Conference 2015;
- Projects from hyperBODY were exhibited at Dutch Design Week 2015, at the CAUP Gallery as part of the DADA 2015 in Shanghai, at the Media Lab Prado in Madrid in 2014 and at the DIG-It International Science Exhibition at TU Delft in 2014. The group also received invitations to show its work at upcoming prestigious exhibitions.

The period 2010–15 did not see the fulfilment of our one journal paper per PhD candidate and staff member target; however, major improvements were made: the group had 3.5 times as many articles published in refereed journals in 2015 than in 2010. Moreover, the impact and use of these articles were extremely high. For example:

- Turrin M., von Buelow P., Stouffs R. '*Design explorations of performance driven geometry in architectural design using parametric modelling and genetic algorithms.*' Advanced Engineering Informatics 25.4 (2011): 656-675 has been cited 110 times according to Google Scholar;
- Bier HH; *Interactive Building in Advances in Internet of Things* has been downloaded 2,437 times.

The extensive use of our outputs concerns not only publications, but also the digital tools developed within the group, for example:

- Nourian, P & S Rezvani, *SYNTACTIC Design Methodology and Computational Design Toolkit Space Syntax*. Currently having an international user group of 338 members; video viewed 21K times;
- Nourian, P & S Rezvani, *CONFIGURBANIST Spatial Network Analysis Methodology implemented in the computational toolkit Cheetah*. Currently having an international user group of 140 members; video viewed 11K times.

Finally, patents such as the '*Combination of a Connector for Glass Elements and Such Glass Elements*' by Fred Veer (Structures) were internationally awarded in 2015 (developed under Valorisation Grant 1 and Valorisation Grant 2 STW subsidies).

**Funded Research Project: EU Culture Programme: METABODY Media Embodiment  
Tékhne and Bridges of Diversity**

METABODY develops technologies, tools, techniques and devices that will be integrated in the first fully intra-active architectural pavilion, which will tour throughout Europe as an observatory of diversity and a laboratory of cultural diversity that will highlight the importance of non-verbal communication and embodied expressions as a primary substrate of nature cultures. The project will elaborate a critique of the tendencies of both homogenisation and pre-emption (adaptation to the new, assimilation of the new and programmed diversification) that information technologies operate in perceptions, affects and subjective formations, where the irreducible and changing differences of embodied expressions and relations are reduced to linear patterns of simulation and standardised processes of media contagion, within a mechanistic tradition where movement is reduced to measurable coordinates. At the same time, new concepts and pragmatics of space-time, relations, corporeality, cognition, perception and affection will be elaborated for new technological paradigms exceeding mechanism and computation, which will take into account movement as multiplicities of intracorporeal sensations and affections irreducible to localisable points and trajectories, to measurable coordinates of space-time or form-pattern.



*Metabody (EU Culture grant, Media Lab Prado, Madrid, Spain):*

*Performance artists interacting with a multi-modal wall component which responds in real time to body movement and gestures via tactile, sonic and light based modulations.*

- Funds/Grant: €2.5 million, of which €200,000 was allocated to hyperBODY
- Role of hyperBODY: Associate partner
- Principal Researcher: Dr Nimish Bioria
- Coordinator: Reverso
- Duration: July 2013–July 2016.
- METABODY started in July 2013, with the support of the European Commission (EU Culture).
- [www.metabody.eu](http://www.metabody.eu)
- <http://www.hyperbody.nl/research/projects/metabody/>

**Funded Research Project: STW Open Technology Programme: ADAM – Acoustics by  
parametric Design and Additive Manufacturing**

ADAM focuses on geometry-related sound absorption, customised to meet specific requirements. Design Informatics plays a major role in the project, focusing on computational tools (parametric modelling, performance simulation and optimisation) that enable the design of highly customisable performance-driven solutions for noise and reverberation control, and on the field of additive manufacturing (3D printing), which allows for the industrial manufacturing of complex geometries and products in unique pieces.

- Funds/Grant: €523,000, of which €112,000 was allocated to Design Informatics for personnel
- Duration: January 2015–January 2019
- TU Delft team: Prof. Arjan van Timmeren (leader – Environmental Technology); Dr Martin Tenpierik (co-applicant – Building Physics); Dr Michela Turrin and Prof. Sevil Sariyildiz (co-applicants – Design Informatics); Foteini Setaki, MSc (PhD candidate funded by STW – Environmental Technology); postdoc funded by STW.
- Users committee board: Materialise, Petuz, Merford, Arup.
- <http://www.stw.nl/nl/content/acoustics-parametric-design-and-additive-manufacturing>



*Interdisciplinary design based on performance simulations.*



*DoubleFace. A Trombe Wall designed based on interdisciplinary digital form-finding.*

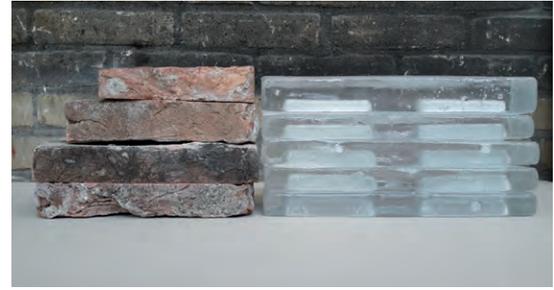
#### Funded Research Project: 4TU Federation and STW Research Through Design Programme: DoubleFace & DoubleFace 2.0

The aim of DoubleFace is to develop a new Trombe wall system that will passively improve the thermal comfort of indoor and semi-indoor spaces by means of lightweight materials for latent heat storage, while allowing as much daylight as possible to pass through. The first phase of the project (DoubleFace) was a 4TU Lighthouse project that focused on the performance of the new product (proof of concept). Based on the outputs of the first phase, DoubleFace 2.0 continues the project with more emphasis on the generation of design alternatives. While few architectural works gain an aesthetic advantage from technical aspects (which are often seen as constraints limiting creativity rather than as inspiring principles that become part of the design identity), DoubleFace 2.0 aims at designing the novel Trombe wall system to have high technical performance and to show that its engineering performances are an integral part of the design identity of the product. Advanced materials like PCM and aerogel are used in combination with novel rapid prototyping techniques (like additive manufacturing) and advanced computational means (like evolutionary algorithms) along with design intuition. The contribution of Design Informatics focuses on the digital design process and manufacturing, to support a deeper integration between design generation and engineering performance assessment and to allow for freedom in realising complex geometries as well as production of customised design variations.

- DoubleFace - Lighthouse project, 4TU.Federation
- Funds/Grant: €50,000, of which €34,000 was allocated to Design Informatics
- Duration: July 2014–February 2015
- <https://www.4tu.nl/bouw/en/lighthouse2014/doubleface>
- DoubleFace 2.0 – STW Research Through Design Programme
- Funds/Grant: Granted €250,000, of which €95,000 was allocated to Design Informatics for personnel
- Duration: 2016–2018
- <http://www.stw.nl/nl/content/double-face-20>
- Principal Researchers: Michela Turrin (Design Informatics), Martin Tenpierik (Building Physics),



*Application of cast glass in Architecture, co-developed by the Structural Glass Group.*



*Cast glass in the form of shaped blocks, produced at TUDelft by the researchers.*

### Funded Research Project: Glass

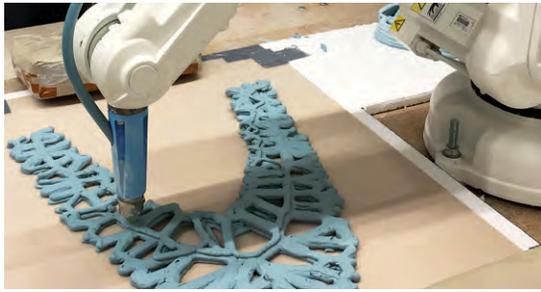
Glass in architecture is usually limited to the use of float glass sheets. From a mechanics of materials point of view, thin sheets of glass are not suitable for compressive application because of the buckling risk. Cast glass in the form of specially shaped blocks is more appropriate for compressive loads. The study of cast glass in compression started with the PC Hooft project, which provided a clear research objective and funding for research, as well as industrial partners in the fields of adhesives and glass casting. It has evolved into several successful research projects, including stacked columns of cast glass elements, precision cast glass blocks that require no post-processing, and the use of specially designed glass blocks to fill in missing stone parts during the restoration of monuments. The acquisition of a glass melting oven in 2015 allows the group to conduct its own casting and do independent research.

- Funds/Grant: Funding has been obtained for the research by Warenaar BV; at the end of 2015 a €50,000 grant was obtained from the 3TU Lighthouse projects; a Horizon 2020 FET application is being prepared.
- Duration: Start October 2013–ongoing
- Principal researcher: Dr F.A. Veer
- Researchers: Christian Louter MSc PhD, Ate Snijder MSc, Prof. Rob Nijssse MSc,
- F. Oikonomopoulou MSc, T. Bristogianni MSc and L. Barou MSc (CiTG).

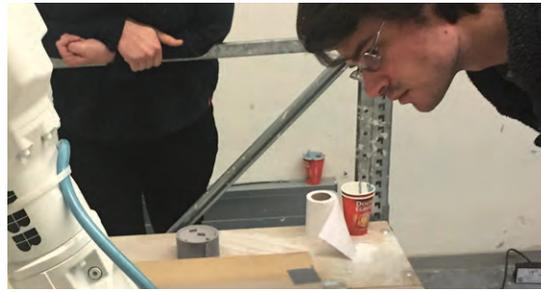
### Funded Research Project: 4TU Federation: Robotically Driven Construction of Buildings

Robotically Driven Construction of Buildings (RDCB) was an exploration into holistic/integral design-to-production solutions for the robotically driven construction of buildings by involving the disciplines of architecture, robotics, materials science, construction and building technology, and structural design. The team integrated knowledge from the individual disciplines in order to develop new numerically controlled manufacturing techniques and building design optimisations for adding creative values to buildings in a cost-effective and sustainable way.

- Funds/Grant: €50,000
- Duration: February 2014–February 2015
- Team: TU Delft: Henriette Bier (leader – Robotic Building), Sina Mostafavi (Design-to-Robotic-Production), Ana Anton (Design-to-Robotic-Production), Serban Bodea (Design-to-Robotic-Production) and Peter Rem (Resources and Recycling). Eindhoven University of Technology: Theo Salet (Structural Design).
- <https://www.4tu.nl/bouw/en/lighthouse2014/roboticallydrivenconstructionofbuildings/>



A robot depositing material where needed for a structurally optimized configuration.



Researchers working on Robotically Driven Construction.

#### 4.7.2

### Organisation

C&P initiated, organised and co-organised several conferences that attracted internationally known speakers and participants from academia and industry from all over the world. The results of workshops and presentations were disseminated in peer-reviewed conference proceedings and academic books.

**eCAADe 2013 31<sup>st</sup> International Conference – Association for Education and Research in Computer Aided Design in Europe – held at TU Delft (general chairs: Sevil Sariyildiz and Rudi Stouffs)**

The 2013 conference of the Association for Education and Research in Computer Aided Design in Europe (eCAADe – founded in 1983) at TU Delft was titled “Computation & Performance”. It addressed the role of computation in the consideration of performance in planning and design, where performance denotes the ability of buildings and cities to meet various technical and non-technical requirements (physical and psychological) placed upon them by owners, users and society at large. The 2013 conference had 230 registered participants, of whom 210 paid the registration fee (the other 20 were keynote speakers, special guests and organisers). At the moment (eCAADe 2016 has just been held), eCAADe 2013 is still the eCAADe conference with the highest number of submissions and the highest number of participants; thus, the most successful in this regard. The conference also resulted in two books:

- Stouffs, RMF & Sariyildiz, IS (eds) (2013). *eCAADe 2013: Computation and Performance – Proceedings of the 31<sup>st</sup> international conference on education and research in computer aided architectural design in Europe*, Delft, the Netherlands, 18–20 September 2013, Volumes 1 and 2, Delft: eCAADe (Education and Research in Computer Aided Architectural Design in Europe) and Faculty of Architecture, Delft University of Technology.

**Challenging Glass conferences 2 & 3, 2010 & 2012, TU Delft (TU Delft personnel involved: Christian Louter, Fred Veer, Rob Nijse)**

Challenging Glass is an international biennial scientific conference that focuses on the architectural and structural use of glass in the built environment. The conference was initiated at TU Delft in 2008 and 2016 saw its 5<sup>th</sup> edition. It is one of the leading conferences in the field and is recognised for its high scientific quality. The conference typically attracts around 200 participants from 25 countries around the world. During the conference, five keynote presentations are given and around 90 peer-reviewed papers are presented; later, these are published in high-quality conference proceedings (indexed in Scopus). The reviewing process is carried out by a scientific committee of 15 experts in the field. The editions in 2010 and 2012 at TU Delft were successfully held according to the standards.

### Critical and Clinical Cartographies Conference 2014, TU Delft (co-chair: Henriette Bier)

The conference was organised by the Theory Section and hyperBODY of TU Delft in cooperation with Industrial Design, Designing Health Research programme, and the Bio Mechatronics and Bio Robotics Section of the Department of Bio Mechanical Engineering, TU Delft. The conference was highly multidisciplinary and engaged in the practice of cartography in order to map the ever-shifting thresholds between the organic and the inorganic, the innate and the acquired. It helped to identify how robotically augmented, responsive environments, like those developed at hyperBODY, can support healthcare, and it explored non-human agency and human–robot interaction as advanced by the Robotic Building group at hyperBODY.

#### 4.7.3

#### Facilities/assets

##### protoSPACE and protoFAB - by hyperBODY

hyperBODY facilities – such as protoSPACE and protoFAB, which is equipped with a new KUKA robot – have been instrumental in advancing research in fabrication and interaction design. Recognised as one of the few labs in Europe that provide cutting-edge research and development opportunities (<http://www.archdaily.com/336849/5-robots-revolutionising-architectures-future/>), it regularly offers workshops with world-renowned specialists. hyperBODY's Robotic Building section aims to advance robotic applications in architecture by investing in multi-headed industrial robots in order to perform applied research on multi-mode robotic production at building scale. Furthermore, Robotic Building explores the integration of robotic devices into the built environment. The S.M.A.R.T. Environments section aims to advance its Interactive architecture and cognitive sciences strand into the Design for Health as well as workplace innovation domains. S.M.A.R.T. will also advance its material systems and performative architecture strands to develop energy efficient real-time adaptive building skin systems with an underpinning in material engineering (smart textiles and composites) and ubiquitous computing.

- <http://www.hyperbody.nl/protospace/>
- <http://www.hyperbody.nl/protofab/>

##### Additive Manufacturing Lab – by Design Informatics and Structures

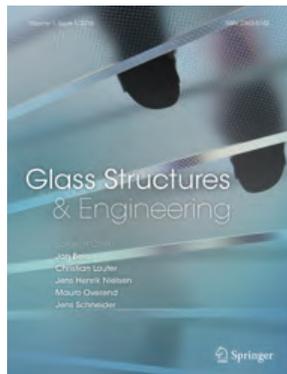
The Additive Manufacturing Lab is an initiative of Design Informatics and Structures. The Lab was established in 2014/15 to support both research and education; it is now attracting a very wide range of researchers and is being used to blend MSc education and research. It facilitates activities related to additive manufacturing (3D printing). The goal of the lab has two components: the development and building of machines for producing low-cost, large-scale, lightweight architectural components; and the rationalisation of the design process for additive manufacturing, within a formal approach to the functional demands of the large building components.

##### Glass processing laboratory

The Structures group has a small laboratory that can melt glass, cast glass and process float glass for various research topics. The laboratory is used together with the Glass group in the Faculty of Civil Engineering & Geosciences.

In the past six years, C&P has produced relevant output in terms of papers published in peer-reviewed journals, refereed papers and books, and published software applications and prototypes. The emphasis was on publishing C&P research results in peer-reviewed journals with high impact, including the TU Delft Footprint journal, which has been indexed in Scopus since 2014.

- Journal: Belis, Louter (TU Delft), Nielsen, Overend, Schneider (editors-in-chief); *Glass Structures & Engineering*
- Journal: Bier, H. and Knight, T. (2010): FOOTPRINT #10, *Digitally-driven Architecture*, Stichting Footprint; and Bier, H. and Knight, T. (2014): FOOTPRINT #15, *Dynamics of Data-driven Design*, Stichting Footprint
- Book: Biloria, N. (2011). *Interactive Corporate Environments: Developing real-time interactive corporate environments incorporating computational techniques* (Paperback), VDM Verlag Dr. Müller Publishers
- Oosterhuis, K. (ed.) (2012). *Hyperbody: First Decade of Interactive Architecture*. Jap Sam Books.
- Book: Oosterhuis, K and Bier, HH (eds.). *Robotics in Architecture, IA#5*, Jap Sam Books, Heijningen, 2013
- Stouffs, R., & Sariyildiz, S. (eds.) (2013). *Computation and Performance*, Volumes 1 & 2



Belis, Louter (TU Delft), Nielsen, Overend, Schneider (Editors-in-Chief); *Glass Structures & Engineering*



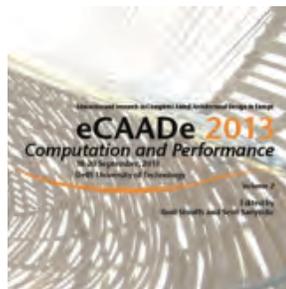
Oosterhuis, K and Bier, HH (eds.): *Robotics in Architecture, IA#5*, Jap Sam Books, Heijningen, 2013



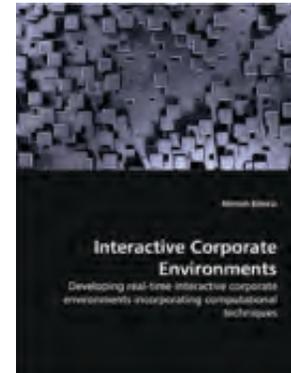
Oosterhuis, K. (Ed.). (2012). *Hyperbody: First Decade of Interactive Architecture*. Jap Sam Books.



TU Delft Footprint: Bier, H. and Knight, T. (2010): FOOTPRINT #10, *Digitally-driven Architecture*.



Stouffs, R., & Sariyildiz, S. eds. (2013). *Computation and Performance*, Volumes 1 and 2.



Biloria, N. (2011), *Interactive Corporate Environments* [Paperback], VDM Verlag Dr. Müller Publishers



*Crystal House:1 project based on cast glass block masonry, realized in Amsterdam with the Structural Glass Group.*

#### 4.7.5

#### Use

In addition to the use of its academic outputs (e.g. via citations of articles), the group has been particularly successful in implementing projects that have direct applications in real practice. Below are two examples.

##### CRYSTAL HOUSES, AMSTERDAM

The Structural Glass group was one of the partners in the realisation of the Chanel shop façade in PC Hooft Straat in Amsterdam. An innovative design based on cast glass block masonry was made for Warenaar BV by MVRDV architects. ABT was structural engineer for the project and it subcontracted the research and development of the glass block masonry system to the Structural Glass group. Two years of multidisciplinary research that started in 2013 solved all technical problems and the façade was built in 2015 and 2016; it was officially unveiled in April 2016. The façade is unique in that it is the only one in the world built only of glass blocks and adhesive without any supporting structure. The façade has received great acclaim from architects and has resulted in several scientific publications and invited and keynote lectures at important conferences, such as the Challenging Glass 5 and the Inglass 2016 conferences. A follow-on project is under discussion. The Crystal Houses received the Public Award at the 2016 Dutch Design Awards.

##### PULSE PROJECT – 3D printed shading system

The PULSE project is a multifunctional building for the TU Delft campus. Its main façade was initially conceived based on the use of a customised sun-shading system, optimised for varying day-lighting requirements based on programmatic distribution and specified viewing areas. Using parametric modelling and simulations software coupled with genetic algorithms, the sun-shading has been optimised for customised requirements. As a result of the optimisation, each individual panel is uniquely defined parametrically, leading to a nearly endless variation in shape. The production of these complex and different geometric items is made possible by additive manufacturing (3D printing), and an interdisciplinary team collaborated to pioneer the use of additive manufacturing techniques at a scale that has not yet been attempted before. The work on form-finding, structural design, optimisation for daylight and minimal material use, and additive manufacturing has been developed in an intensive collaboration between Ector Hoogstad Architecten and a TU Delft team at Design Informatics and Structures, together with a team at Yasar University.

C&P research has profited from international recognition, which is reflected in regular invitations to speak and present research results, accept awards, and appear in media worldwide.

#### Selected Awards

- Turrin, M, P von Buelow, RMF Stouffs; Best paper award for: *Structural morphologies and sun transmittance control: integrated parametric design using genetic algorithms*. ICCCBE 2010: 13<sup>th</sup> international conference on computing in civil and building engineering, Nottingham, UK, 30 June–2 July 2010.
- Turrin, M, ER van den Ham, A Kilian, IS Sariyildiz; Best paper award for: *Integrated design of a large span roof: a parametric investigation on structural morphology, thermal comfort and daylight*. ICCCBE 2010: 13<sup>th</sup> international conference on computing in civil and building engineering, Nottingham, UK 30 June–2 July 2010.
- Liu Cheng, A, Bier, HH; Best poster award for *An Extended Ambient Intelligence Implementation for Enhanced Human-Space Interaction*. ISARC 2016 (<http://www.isarc2016.org/awards.html>)

#### PhD thesis, cum laude

- Louter, P. C. (2011). *Fragile yet ductile: structural aspects of reinforced glass beams*. TU Delft, Delft University of Technology.

#### Selected International Invited Lectures and Media Presences

- Bier, H; Robotic Building at TEDx Delft (<http://tedxtalks.ted.com/video/Robotic-Building-Henriette-Bier>) viewed 583 times.
- Bioria, N; Invited talk Inter-performing Environments at University of Boras, Sweden, 2015.
- Bioria, N; Invited talk Digital Morphogenesis, South East University of China, Guangzhou, China, 2014.
- Bioria, N; CNN International - Interview: *Future cities and smart home applications*, 2015.
- Oosterhuis, K. (2015) *Unchaining The Building Chain*, at Dubai Chamber of Commerce Dubai UAE
- Oosterhuis, K. (2014) *Internalizing Continuous Variation*, at Doha Architects Forum Doha Qatar
- Oosterhuis, K. (2014) *Powerlines*, at the International Convention of Architecture Budapest HU
- Oosterhuis, K. (2013) *Tag Make Move Evolve, Alive* (Advancements in Adaptive Architecture) ETH Zürich CH
- Oosterhuis, K. (2011) Towards A New Kind Of Beauty, TEDxDelft NL Sariyildiz, I.S.; opening speech for the 'World Interior Day – Design for All', İzmir-TR (May 2015).
- Sariyildiz, I.S.; opening speech for the 'Tire Symposium', İzmir-TR (Feb. 2015).
- Sariyildiz, I.S, (2012) Keynote speech: '*Performative Computational design*', ICONARCH I Architecture & Technology-International Congress of Architecture – I, Proceedings book, ISBN:978-978-605-86483-9, 15-17 November 2012, Konya – TR, pp. 313-344.
- Sariyildiz, I.S (2011) public lecture on '*Design Computation for Sustainability*' at the Palmer Lipcon Auditorium at the Palmer Museum of Art on Penn State's University Park campus.
- Sariyildiz, I.S., (2010), Keynote speech: '*Information Technology & Sustainability*', 1<sup>st</sup> INTERNATIONAL GREENAGE SYMPOSIUM, (1.Uluslararası Yeşilçağ Sempozyumu) Mimar Sinan Güzel Sanatlar Üniversitesi, 8 December 2010, Istanbul.

**Context**

Research into computational and performative design production and operation processes is considered essential in today's academic and professional world. This is evidenced by the huge amount of interest that researchers express in joining our research group as PhD candidates or postdocs.

PhD research topics concern all the areas of performance and computation driven design of buildings and the built environment that are profiled in the 'Scope' section of this report.

Despite the major successes the group had in funding junior and other researchers, for the time being it is realistic to acknowledge that it is a challenge to acquire funding for PhD candidates due to the crisis in the building sector. Nevertheless, we shall continue to apply for EU and national research foundation funding, as well as being attractive to self-funded excellent PhDs.

In addition to the faculty's facilities, the research group has a wide range of study and research facilities, including:

- protoSPACE laboratory for multidisciplinary collaborative design and new media research established by Hyperbody in 2006, as well as ProtoFAB (<http://www.hyperbody.nl/protofab/>) and Robotic Building lab (with 1 KUKA robot), which are Hyperbody's NC and robotic fabrication laboratories, in 2009–13;
- Additive Manufacturing Lab established by Design Informatics and Structures in 2014, offering facilities and extensive expertise in small- and large-scale additive manufacturing;
- Glass processing laboratory, where glass can be melted and cast, and float glass can be processed.

**Participation in research schools**

Within Computation and Performance, most of the PhD candidates are not doing their research at other research schools and are following their Doctoral Education programme mostly at TU Delft. However, especially in Design Informatics, there are ongoing PhD research projects that were developed for the double PhD degree with South China University of Technology. Moreover, N. Bioria, H. Feng and K. Oosterhuis initiated and established the Sino-Dutch Research Centre for Building in Extreme Climates at Harbin Institute of Technology, China, in March 2014, and the Centre's activities include the active exchange and guidance of PhD researchers from Harbin Institute of Technology. Moreover, the staff are actively involved in PhD education at international levels; for example, H. Bier participated in e-archidoct (Virtual Campus on Post-master Studies in Architecture) in 2007–10.

**Selection and admission procedures**

In recent years, the self-funded candidates who apply for admission to the Graduate School for Architecture and the Built Environment and want to do their PhD as part of Computation and Performance have been subject to the selection procedure for AE+T PhD students. For this, an AE+T PhD selection committee has been established to assess the quality of applications and their relevance to the research at AE+T. Staff from Computation and Performance are part of the selection committee.

### Supervision of PhD candidates internally and guidance of PhDs to the labour market

At least one professor and one co-supervisor or day-to-day supervisor (usually a senior researcher who holds a PhD) supervise each PhD student. The supervisor and co-supervisor are always from the chair group with which the PhD student is affiliated. If the interdisciplinary character of the research project warrants a second supervisor (again, a professor) from a different chair group or research programme, this second supervisor is brought into the research project. Double supervision is becoming more and more the norm in order to increase collaboration and cross-fertilisation. PhD students have monthly meetings with all their supervisors, and more frequent meetings with their day-to-day supervisors. PhD students are encouraged to participate in symposia, workshops and international conferences in order to learn from other participants and to receive feedback on their work.

### Exit numbers

In 2010–15, as a result of the increase in self-funded PhD research, more PhD candidates combined their research with practice. Although this enabled them to better relate their research to societal needs and challenges it took them longer to finish their studies.

Starting year	ENROLMENT			SUCCESS RATE								Total graduated		Not yet finished		Discontinued	
	Gender			Finished								Total graduated	Not yet finished	Discontinued			
	Male	Female	Total	≤ 4Y	≤ 5Y	≤ 6Y	≤ 7Y	≤ 4Y	≤ 5Y	≤ 6Y	≤ 7Y						
2006	0	1	1	0	0%	0	0%	0	0%	1	0%	1	100%	0	0%	0	0%
2007	2	1	3	0	0%	0	0%	1	33%	1	33%	1	33%	2	67%	0	0%
2008	2	1	3	0	0%	0	0%	0	0%	0	0%	0	0%	2	67%	1	100%
2009	2	0	2	0	0%	0	0%	0	0%	0	0%	0	0%	1	50%	1	100%
2010	3	0	3	0	0%	0	0%	0	0%	0	0%	0	0%	2	67%	1	33%
2011	4	0	4	0	0%	0	0%	0	0%	0	0%	0	0%	4	100%	0	0%
<b>Total</b>	<b>13</b>	<b>3</b>	<b>16</b>	<b>0</b>	<b>0%</b>	<b>0</b>	<b>0%</b>	<b>1</b>	<b>6%</b>	<b>2</b>	<b>13%</b>	<b>2</b>	<b>13%</b>	<b>11</b>	<b>69%</b>	<b>3</b>	<b>19%</b>

TABLE 4.5 Length of PhD candidacies and success rate of the PhD programme

## Self-reflection

Overall, the accomplishments in the period 2010-15 fulfilled the targets we had established.

### Research quality

In terms of research quality, key targets were achieved. The group received external funding and more recently was awarded prestigious grants (awarded by 2015; not used by 2015) from science foundations. Although this income was not sufficient to satisfy the financial needs, it is clear evidence that the quality of the Computation and Performance group is recognised. The number of papers in peer-reviewed publications increased significantly, and the co-authorships included some with top international experts.

### Relevance to society

As architectural design and engineering are disciplines grounded in professional applications for the built environment, outstanding research results imply direct societal impacts. From this perspective, the group successfully implemented research in industry and saw the application of its research outputs architectural works that are famous throughout the world. The Crystal House in Amsterdam is the most exemplary case at this point.

### Viability

The current attention that the 4TU Federation, NWO STW and other science foundations are paying to topics related to automation and computation offers the group good prospects. The group has survived a period of serious austerity measures and expects the coming period to be more productive. The robust collaborations developed by a large part of the group across AE+T may be further empowered by the expected merging of C&P and GBI, whereby increased interdisciplinarity and fertile cross-pollution would promote our research and the research directions we have already embraced and profiled.

## SWOT analysis

### STRENGTHS

Our research bridges fundamental technical research and application design, and includes both mono-disciplinary and interdisciplinary research. Staff members with a strong scientific background in architecture, civil engineering, material science and/or computer science contribute the fundamental technical research, while part-time researchers with positions in practice keep a finger on the pulse of societal needs and changes and help to strengthen our collaborations with practice. The laboratories established by the group (such as protoSPACE for multidisciplinary collaborative design, protoFAB and roboFAB for digitally and robotically driven fabrication, the Additive Manufacturing Lab and the glass processing laboratory) are one-of-a-kind research and experimental development environments.

### OPPORTUNITIES

There is increasing pressure from developers/users and from legislation to increase building and built-environment performance and to improve design quality and reduce the total costs related to building/built environment forms and configurations. The solution is automation. Increasing use of parametric modelling, collaborative design and BIM, computational design processes integrated with automated evaluations and optimisations, the exploration of real-time collaborative design processes, CNC production techniques, and the study of dynamically adaptive buildings and building systems offer opportunities to support this revolution. This is attracting key partners; moreover, researchers and PhD students elsewhere are increasingly interested in joining us.

### WEAKNESSES

Despite some recent major successes, we are still not successful enough in obtaining funding from national and European research and science foundations (e.g. NWO, STW and the European Commission). This is a problem common to most research groups in the faculty, partly because there have not been many opportunities to perform research on design and technology for the built environment. Thus, greater effort is required. Our research output in international peer-reviewed journals (preferably with significant citation index ranking) has increased, but must be further increased.

### THREATS

Requiring research staff to spend more time on teaching and other activities. This threatens to have an impact on the critical mass required to develop and maintain a research group and programme, and to reduce the supervisory support available to PhD candidates to develop their research projects and their own research capacity. We must also guard against joining the rat race of proposal writing and chasing funding opportunities from national and European research and science foundations. In the same vein, we must refrain from focusing only on short-term successes while failing to maintain our strategic advantages.



# Green Building Innovation

Programme leader:  
Ulrich Knaack

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**Tillmann Klein overseeing the installation of a pilot project temporarily replacing a section of the façade on the low-rise building of the Faculty of Electrical Engineering, Mathematics and Computer Sciences at TU Delft.**



# Green Building Innovation

## Scope

Society must undergo a transition towards an economy that is based on renewable or recyclable resources and a built environment that is largely self-sustaining. The greatest challenge lies in the alteration of existing urban areas and buildings: as more than 90% of the building stock of the near future is already built, effective improvements can only be achieved by taking immediate action to improve entire regions, cities, districts, neighbourhoods and buildings, as well as building components. In the vision of the Green Building Innovation (GBI) programme, these changes can best be effected by keeping the comfort and health of people in focus.



Mobile Workspace Bucky Lab

GBI	2010		2011		2012		2013		2014		2015	
	Nr.	FTE	Nr.	FTE	Nr.	FTE	Nr.	FTE	Nr.	FTE	Nr.	FTE
Scientific staff	26	6,8	25	6,7	24	6,0	19	5,2	20	5,1	17	4,5
Researchers	13	6,1	15	7,3	13	5,0	11	3,9	10	4,2	11	4,8
PhD candidates	32		32		33		30		30		31	
<b>Total research staff</b>	<b>71</b>	<b>12,9</b>	<b>72</b>	<b>14,0</b>	<b>70</b>	<b>11,0</b>	<b>60</b>	<b>9,2</b>	<b>60</b>	<b>9,3</b>	<b>59</b>	<b>9,3</b>
Visiting fellows	21		19		23		18		16		17	
<b>Total staff</b>	<b>92</b>	<b>12,9</b>	<b>91</b>	<b>14,0</b>	<b>93</b>	<b>11,0</b>	<b>78</b>	<b>9,2</b>	<b>76</b>	<b>9,3</b>	<b>76</b>	<b>9,3</b>

TABLE 5.1 Research staff (composition of the research unit)

GBI	2010	2011	2012	2013	2014	2015
Refereed articles	3	6	11	11	14	8
Non-refereed articles	2	4	0	0	0	0
Book	5	9	6	4	2	5
Book chapters	15	20	5	7	3	0
PhD theses	2	0	5	7	4	2
Conference papers	48	33	15	22	18	11
Professional publications	20	20	11	24	14	14
Publications aimed at the general public	7	0	3	4	2	1
<b>Other Research Output:</b>						
Book reviews	0	0	1	0	0	0
Appearances on radio or television	0	0	0	0	1	2
Internal reports, lectures, posters, datasets	2	5	11	24	17	36
External reports	1	4	2	1	1	2
Editorships of books	0	1	1	3	1	3
Editorships of journals	8	4	0	4	0	4
<b>Total other Research Output</b>	<b>11</b>	<b>14</b>	<b>15</b>	<b>32</b>	<b>20</b>	<b>47</b>
<b>Total publications</b>	<b>113</b>	<b>106</b>	<b>71</b>	<b>111</b>	<b>77</b>	<b>88</b>

TABLE 5.2 Main categories of research output

GBI	2010		2011		2012		2013		2014		2015	
	K€	%										
Direct funding	1.045	56%	1.239	51%	919	55%	862	67%	1.069	46%	1.116	49%
Research grants	30	2%	43	2%	57	3%	157	12%	193	8%	16	1%
Contract research	700	38%	1.094	45%	771	46%	334	26%	1.095	47%	953	42%
Own contribution	-	0%	-	0%	-100	-6%	-111	-9%	-60	-3%	100	4%
Other	88	5%	37	2%	13	1%	48	4%	46	2%	86	4%
<b>Total funding</b>	<b>1.863</b>	<b>100%</b>	<b>2.412</b>	<b>100%</b>	<b>1.660</b>	<b>100%</b>	<b>1.289</b>	<b>100%</b>	<b>2.343</b>	<b>100%</b>	<b>2.270</b>	<b>100%</b>
Personnel costs	-1.487	88%	-1.849	92%	-1.307	82%	-1.406	99%	-1.620	83%	-1.489	81%
Other costs	-212	12%	-152	8%	-293	18%	-16	1%	-326	17%	-339	19%
<b>Total expenditure</b>	<b>-1.698</b>	<b>100%</b>	<b>-2.001</b>	<b>100%</b>	<b>-1.600</b>	<b>100%</b>	<b>-1.422</b>	<b>100%</b>	<b>-1.946</b>	<b>100%</b>	<b>-1.828</b>	<b>100%</b>
<b>Result</b>	<b>165</b>		<b>411</b>		<b>59</b>		<b>-132</b>		<b>397</b>		<b>442</b>	

TABLE 5.3 Funding (research unit's financing structure)

## Strategy

The Green Building Innovation (GBI) research programme is based on stable, basic competences and focused on urgent sustainability themes. GBI is organised according to its three competences: Energy & Climate, Comfort & Health, Facades & The Making. The societally and scientifically urgent issues are carbon neutrality, adaptivity, circularity and the aging of the population. GBI themes continuously undergo actualisation and adjustment. An additional focus will be put on the transition to 'fully reusable' and 'fossil-free' production and performance; smart grids and networks in the built environment; smart adaptivity; the multi-functionality of components, products and materials; and a comfort- and health-supporting and stimulating environment for different age categories.

GBI develops strategies towards self-sustainability: gaining operational energy should compensate for new component production. Therefore, building surfaces should actively generate electricity. New façade and climate components have to maximise their local responsiveness towards operational energy performance and user comfort. Monitoring and adaptation will be key, as will be the recyclability of building. Advances in the Internet of Things mean that future building components will increasingly be locally responsive and intelligent: they will share information and recognise the users, and remember their preferences. In a world that has to switch from selling products to selling services, operational satisfaction and monitored quantities will be centralised. Better performance by decreasing user freedom will not work – but the impact of unpredictable user behaviour can be minimised by feedback and adaptive occupancy control. The GBI group will provide methods, tools, technologies and guidelines that contribute to accomplishing these future targets.

The GBI group aims to initiate and implement viable and suitable projects in cooperation with partners from the academic world, consulting companies, and other commercial and industrial bodies. By working with the TU Delft Valorisation Centre and 4TU.Bouw (Dutch centre of excellence for the built environment), and engaging in activities for the faculty at E2BA (EU-linked cooperation for grant development and acquisition in Brussels), we have learnt about the qualities of good proposals and developed a structural approach to major scientific funding organisations, such as the EU, NWO, STW and TKI. GBI keeps the number of PhD candidates constant or growing. This can only be realised with external funding, and is therefore related to research projects worth €220,000 or more. Where externally funded PhDs are not possible, we admit PhD candidates with scholarships or other forms of funding for topics that are relevant to the programme. Together with the Graduate School, GBI provides PhD candidates with proper supervision and encouragement. This is supported by an additional tier between the professors/associate professors and the PhD candidates, formed by young doctorates who can take responsibility for day-to-day doctoral supervision and research project leadership. GBI professors receive many requests to supervise PhD candidates, some of whom bring their own funding. The selection process is very stringent in order to select only the very best candidates and to keep the number per professor at a level that ensures proper supervision.

GBI has again shown itself to be relatively independent of faculty funding by acquiring external funding for its projects. Due to the way the faculty is funded, GBI receives no financial support from it (typically needed for non-funded research activities such as acquisition, publication, supervision and co-funding with non-100%-funded programmes), although this was requested in the last two research evaluations. To secure a workable environment, GBI may decide to reduce the acquisition of external funding

and mainly concentrate on 100%-funded (but limited) grants, although it is clear that this will reduce GBI's performance and output and visibility to scientific colleagues.

Another development is the merging of GBI with Computation & Performance (C&P) – another research programme within the department of Architectural Engineering + Technology. Because the C&P programme has thematic overlaps with GBI, we are considering restructuring both programmes in order to promote collaboration and the further development of both research groups. This self-evaluation report, however, only deals with the GBI programme in the past period.

## 5.4

### Targets

The mission of the GBI research group is to expand the realm of technical possibilities in architecture and urban design, and to facilitate the full chain in the building industry by providing knowledge to improve the design of the built environment in a sustainable and healthy way. GBI aims to be an excellent research group in the area of sustainable adaptive technology for the built environment, and to continue to build a worldwide reputation for its science-based green innovation at various scale levels. Both the building industry and research funding institutes should consider the GBI group the foremost partner for research involving sustainability and innovation.

The GBI group aims to continuously enhance its competences, qualities and output in order to promote the long-term intrinsic value of its area of expertise. For the medium-term viability of its research focus, the group focuses on socially urgent themes that often straddle the boundaries of building technology; key themes include carbon neutrality, adaptivity to climate change, functionality and circularity, including the use and reuse of buildings and materials. An emerging theme is the wellbeing (i.e. the health and comfort) of the end-users of the built environment in relation to sustainability and climate change issues, such as children in the classroom and elderly people in their homes.

Two levels or targets have been identified for the group: at a strategic level, the group has to ensure that it remains a stable and mature research group with a constant flow of high-quality PhD research and research output. This includes a strategically identified focus per competence (Energy & Climate, Comfort & Health, Facades & The Making), defined by constantly adapted roadmaps. In addition to this, the close interaction between the groups and cooperation in projects has to be constantly improved. At a working level, the group must ensure a constant output of projects and publications (one paper per person per year), and keep the number of PhDs constant, improve their quality and support them to finish within four years.

As a consequence of the strategic focus on 100%-funded research projects, GBI is facing a limitation in potential financial resources. To maintain its current level of performance, GBI will have to invest more in European programmes. Notwithstanding the challenges and limited success rates of EU-funded projects in general, the group is successful as a leading, coordinating and participating partner.

## 5.5

### Environment

Improved technology will not automatically lead to happiness for all. It has to be adapted to human nature and the environmental challenges – humans are at the core of all of

GBI's activities. The faculty and the university in general represent a perfect environment for GBI's research: they have intrinsically driven students and staff, a great reputation that opens doors and networks, and a systematic approach to developing research.

In line with this, in his inauguration lecture our new dean, Peter Russell, defined the faculty's future themes with three A's: Africa, Agility and Automation. GBI feels closely linked to the themes. First, GBI collaborates with South Africa (University of Pretoria and CSIR) on sustainability themes. Second, GBI is active in the field of automation in production technology, for example additive manufacturing and climate-efficient buildings (Solar Decathlon house, Leasing Façade, thinking skin). GBI aims to be a driver of this technology and its human-centred implementation, instead of getting accustomed to technology that has driven us. We get our energy from innovation, but we foster our calibrating role as designers and engineers between the building industry practice and society. In this respect, Senselab is focused on individuals and their wishes and demands (conscious and unconscious), and looks at scenarios and interaction.

Benefitting from the Graduate School as support for our PhDs and scientific staff, having the Valorisation Centre and contract managers as backup for the development of research proposals, and running the redeveloped and well-respected MSc in Building Technology (with a focus on climate design, facade design and structural design), the faculty provides a healthy ground for research. In contrast, the constant complexity of handling budgets and employing scientific staff is a challenge. At a national level, GBI, being embedded in TU Delft, is closely linked and continuously being asked to respond to emerging scientific questions. Industries as well as other academic institutes are also interested in regular cooperation in the 4TU programme. The same applies to the international level, which is evidenced by the intense networks developed by GBI subgroups.

In this context, GBI has managed to acquire a lot of funded research projects. In 2015, GBI was granted two STW Research Through Design projects worth €250,000 each, namely '*Double Face 2.0*' and '*Beyond the Current*'. In early 2016, it was granted two €250,000+ EU projects: '*Smart Urban Isle*' and '*Planheat*'.

The four projects were a victory for the AE+T department and a sign of appreciation of the direction and content of GBI research. The first two projects show that STW is becoming more sensitive to technical design, under the influence of the government's 'top sector' policy.

## 5.6

### Performance indicators

The GBI group traditionally covers technical aspects of the built environment, energy consumption and construction technologies. This has led the group to propose innovative concepts at various scales in response to significant issues in terms of their societal and scientific value. The best evidence of the value placed on these contributions by stakeholders is probably the continuing demand for contributions in the form of research and scientific consultancy, as well as repeated requests for the presentation of earlier findings and proposals. Provinces, municipalities and the construction industry continue to approach the group's research staff concerning innovative projects that are seen as cutting edge by both the market and the academic world. Extra effort was devoted to increasing the visibility of the output by focusing on scientific papers in international peer-reviewed journals (starting with PhD candidates at the earliest stage of their studies), the development of a scientific journal

and book publications. Other evidence lies in the honorary functions of the GBI group's key staff on boards and committees, most notably:

- The position of Eekhout (retired 2015) in the Royal Dutch Academy of Arts and Sciences (KNAW) and his special professorship at the University of Nottingham (UK).
- Luscuere's guest professorship in Tianjin (China).
- Knaack's professorship at Technical University of Darmstadt (Germany) and guest professorship at Pennsylvania State University (USA) in 2011, Istanbul University of Technology (Turkey) in 2012, Technical University of Munich in 2014 and the Royal Art Institute Copenhagen in 2015/16/17.
- Dobbelsteen received an honorary position as MSSl Visiting Fellow at the University of Melbourne (Australia) in 2012 and has been a Distinguished Scholar at the University of Pretoria since 2016.
- Klein has a guest professorship at TU Munich (2015/16/17).

Further evidence lies in attracting visiting professors to TU Delft. For example, the GBI group invited Professor Stefan Behnisch in 2015 and Professor James O'Callaghan in 2016.

ASSESSMENT DIMENSIONS	QUALITY DOMAINS	
	RESEARCH QUALITY	RELEVANCE TO SOCIETY
ACTIVITIES, ORGANISATION, FACILITIES/ASSETS, OUTPUT	<p><b>Activities</b></p> <ul style="list-style-type: none"> <li>• Research projects</li> <li>• Experimental (building) projects</li> </ul> <p><b>Organisation</b></p> <ul style="list-style-type: none"> <li>• Organization of international conferences</li> <li>• International and national positioning</li> <li>• Participation in / organization of consortia and networks</li> </ul> <p><b>Facilities/assets</b></p> <ul style="list-style-type: none"> <li>• Lab's</li> <li>• Mobile Lab's</li> </ul> <p><b>Output</b></p> <ul style="list-style-type: none"> <li>• Referred journal articles</li> <li>• Editorships of books</li> <li>• Editorships of journals</li> <li>• Academic books</li> <li>• Book series</li> </ul>	<p><b>Activities</b></p> <ul style="list-style-type: none"> <li>• Research projects</li> <li>• Experimental (building) projects</li> </ul> <p><b>Organisation</b></p> <ul style="list-style-type: none"> <li>• Organization of international conferences</li> <li>• International and national positioning</li> <li>• Collaboration with stakeholders / Industry</li> <li>• Participation in / organization of consortia and networks</li> </ul> <p><b>Facilities/assets</b></p> <ul style="list-style-type: none"> <li>• Lab's</li> <li>• Mobile Lab's</li> </ul> <p><b>Output</b></p> <ul style="list-style-type: none"> <li>• Referred journal articles</li> <li>• Editorships of books</li> <li>• Editorships of journals</li> <li>• Book series</li> </ul>
USE	<ul style="list-style-type: none"> <li>• Citations and downloads</li> </ul>	<ul style="list-style-type: none"> <li>• Citations and downloads</li> </ul>
MARKS OF RECOGNITION	<ul style="list-style-type: none"> <li>• Invited lectures</li> <li>• Awards</li> <li>• Guest / visiting professor function</li> <li>• prizes</li> </ul>	<ul style="list-style-type: none"> <li>• Invited lectures</li> <li>• Awards</li> <li>• Guest / visiting professor function</li> <li>• prizes</li> </ul>

TABLE 5.4 Selected output indicators

## Results

GBI's research is closely linked to societal issues in the field of sustainable development, in interaction with the existing technology and technological innovation. Many of its research projects, both completed and ongoing, were initiated with parties from the public and commercial market and have served (or are serving) both scientific development in new areas and dissemination in the built environment or building industry. The impact of GBI's research is generally highly visible: the results have been adopted by stakeholders outside the university, for example in the planning, design and manufacturing sectors. In addition to measurable parameters such as funding, publications and PhDs, the group is also interested in real world results – to secure the human-centred experiences. This results in several activities at various scales.

### Real built houses

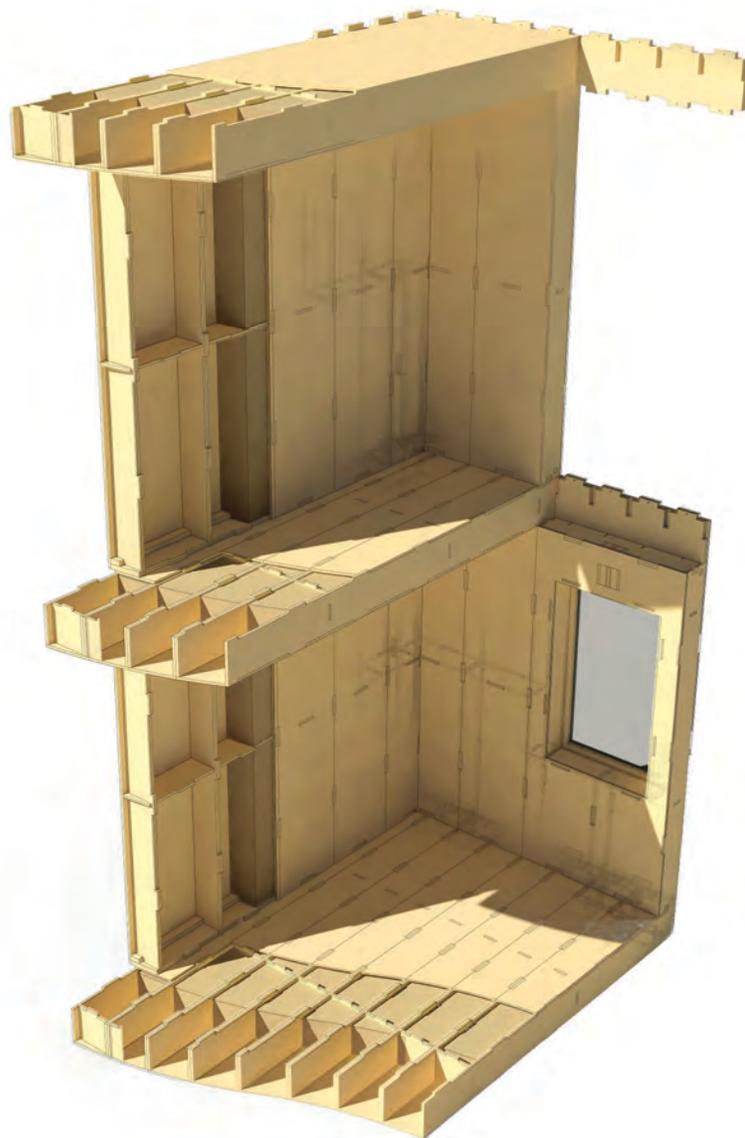
The most prominent example is the participation in the Solar Decathlon Europe 2014 project in Versailles, where GBI won first prize for Sustainability and for Communication & Social Awareness, and second prize for Energy Efficiency and for Construction Management, Health & Safety. An additional skin was applied to a typical Dutch 1960s terraced house to make the building net zero-energy, to improve comfort conditions and to refit the dwelling for contemporary living. After the competition, the mock-up house was rebuilt at the Delft Green Village demonstration park as the first example of inspiring building innovation. In addition, other projects had a similar demonstration value, such as the 2012 energy-neutral Concept House apartment in Heijplaat (close to the RDM research campus in Rotterdam) and the experimental dune-friendly holiday houses at the Oerol festival, built by students from the Bucky Lab.



*Prêt-à-loger, the TU Delft entry for the Solar Decathlon Europe 2014 competition.*

### Prototypes and mock-ups

The Bucky Lab is a prominent MSc course within the faculty: here, students are trained to develop technical concepts for innovative constructions and to build them as 1:1 prototypes. This is structurally linked to the research activities and used to evaluate and improve the results. Prototypes of these research results are developed and built as test cases at the TU Delft campus. Other examples are the Leasing Façade, a service component integrating the façade system for refurbishment (at the faculty building of Electrical Engineering), and the PD Lab, a prototype of a prefabricated timber construction, following the maker house technology. These prototypes are developed, built and tested for future investigation of their performance in terms of energy, functionality and comfort.



*PD Lab, prefabricated timber construction*

### Experience environments

Taking people as a starting point, the physical experience is a key aspect of our research. To enable this experience and to evaluate the results, projects like the SenseLab, indoor environmental experience rooms (built in the TU Delft Science Centre) and the Lightvan (a mobile daylight evaluation room) have been developed.

The objective of these projects is to have people and students experience environmental phenomena in order to learn, and to help students and researchers understand these phenomena and their consequences for the human body. The SenseLab in particular was created to enable experimental evaluation of the behaviour and performance of people, especially children and students, in different scenarios, as well the use of different design concepts, systems and materials.

GBI initiates and organises a wide range of projects. Although the five examples below are just a selection of what GBI does, they do reflect the various competences and research themes.

#### Prêt-à-Loger project for the Solar Decathlon Europe 2014

Participation of the TU Delft team (GBI in cooperation with the MBE department) in the Solar Decathlon Europe 2014 in Paris with the design and building of an additional skin to a typical 1960s terraced house (in Dutch: *rijtjeshuizen*, literally row houses) to improve the dwelling's performance in energy, comfort and space. First prize for Sustainability and for Communication & Social Awareness; and second prize for Energy Efficiency and for Construction Management, Health & Safety.

<http://www.pretaloger.nl>

#### EU-FP7: research project City-zen

City-zen supports and demonstrates the development energy-efficient cities. A methodology and tools are built for cities, industries and citizens to reach the EU's 20-20-20 targets. GBI was leading partner in the acquisition of the project and is now leading WP4 and the City-zen Roadshow, which brings the City-zen approach, methods and technology to cities across Europe. The Roadshow is linked to the SWAT Studio course of the Building Technology master's programme.

<http://www.cityzen-smartcity.eu/nl/home-nl/>

#### 2ndSkin - Façade Refurbishment for Multifamily Social Housing

This pre-fabricated and lightweight building envelope acts as a building's second skin. This low-carbon solution allows existing buildings to be easily upgraded and meet eco-friendly building requirements.

[http://bta.climate-kic.org/innovation\\_projects/2ndskin/](http://bta.climate-kic.org/innovation_projects/2ndskin/)

<https://facadeworld.com/2016/05/03/2ndskin-energy-neutral-apartments-by-renovation-with-an-integrated-facade-approach/>

#### Mass Customised Building Systems

Subtractive techniques (like 2.5D CNC milling/printing) already have significant applicability in the realisation of buildings. MaCuBs is developing and applying building systems created by these subtractive digital fabrication techniques. Through research, design, prototypes and pilot projects, MaCuBs explores the potential of these digitally fabricated building systems. Many aspects of the new industrial revolution are involved: open-source knowledge, fab-labs, mass-customisation, local production, file-to-factory, new business models, new collaborations between architect and client, and new kinds of ornamentation.

<http://www.ataindex.nl/wp-content/uploads/2015/01/MaCuBs-projects-flyer.pdf>

### Taskforce Real Additive Manufacturing

MSc programme from the AE&T chair groups of Design of Construction, Design Informatics, Hyperbody and Structural Design, with the PD lab.

As a result of several active PhD and MSc projects, 3D Printing for buildings has become a focus point. This task force combines the activities of an interesting triple session in Darmstadt, Eindhoven and Delft with a lot of material specialists, engineers and designers developing concepts for building components or complete buildings being made by a new generation of printers. The programme will be developed towards a European Training Network application in 2017.

<https://facadeworld.com/2013/09/23/am-envelope/https://facadeworld.com/2015/12/25/additive-manufacturing-triple-sessions-darmstadt-eindhoven-and-delft/>

## 5.7.2

### Organisation

GBI participates in many consortia for national and international collaboration and also in scientific and professional expertise centres. Members of the group play an important role in many of these consortia.

#### 4TU.Bouw

The four Dutch universities of technology (TU Delft, Eindhoven University of Technology, University of Twente and University of Wageningen) are collaborating in the 4TU. Federation to strengthen and pool their technical knowledge and creativity with the aim of producing sufficient numbers of highly qualified engineers and technical designers, conducting outstanding and socially relevant research of an international standard, and promoting cooperation between research institutes and businesses. The overall objective of 4TU.Bouw is to contribute to the wellbeing of the Netherlands.

Ulrich Knaack, scientific director

<https://www.4tu.nl/bouw/en/news/!/409569/3TU.Bouw%20Spring%202015%20edition/>

#### European Network for Sustainable Regions (ENSR)

ENSR is a network of academic partners from the UK (Queens University Belfast), Belgium (VITO, ThinkE), Italy (University of Siena) and the Netherlands (TU Delft/GBI) working on sustainable transitions of cities and regions. It was founded in 2012, after a few successful research projects in the Netherlands (SREX and energy potential studies) and after involvement in carbon studies for the Danish zero-energy island of Samsø. The consortium prepared the City-zen proposal, which was granted EU FP7 funding. In City-zen, the ENSR partners run the successful Roadshow workshops.

Andy van den Dobbelen, founder

#### CIB W116 Smart and Sustainable Built Environments

CIB W116 Smart and Sustainable Built Environments is a CIB working commission that promotes international research, application and education in the field of the integrated development of smart and sustainable built environments. It also facilitates global networking, the dissemination of information, and technology transfer to businesses and industries. W116 initiated the international journal of Smart and Sustainable Built Environments and organises the successful SASBE conference series, of which SASBE2009 (in Delft, chaired by Andy van den Dobbelen) received the

2010 PC commendation from CIB. In 2013, Jay Yang and Andy van den Dobbelsteen received the CIB Best Coordinators Award for W116.

Andy van den Dobbelsteen, co-chair until 2013  
<http://www.cibw116.org/>

#### COST Action TU 1403 the Adaptive Façade Network

Multifunctional and adaptive building envelopes can provide step-change improvements in the energy efficiency and economic value of new and refurbished buildings, while improving the wellbeing of building occupants. This COST Action will facilitate the sharing of experimental data, the development of modelling and simulation techniques, and the sharing of common evaluation methods.

Ulrich Knaack, member of steering committee and head of WP4  
[http://www.cost.eu/COST\\_Actions/tud/TU1403](http://www.cost.eu/COST_Actions/tud/TU1403)

#### Metropole Region Rotterdam The Hague, Roadmap Next Economy

The Roadmap Next Economy (RNE) is a roadmap for the upcoming next 10–20 years with scenarios that will help society to react optimally to worldwide economic, environmental and technical developments.

Peter Luscuere, chair of Transition Pathway Circular Economy  
<http://mrdh.nl/rne>

### 5.7.3

#### Facilities/assets

In general, the research group is not equipped with laboratories or a large amount of equipment. Mainly computational instruments are used for investigation. The mobile Bucky Lab workshop offers facilities for technical mock-ups. As part of the research activities in the field of indoor environment and building physics, two labs for human evaluations have been developed: SenseLab and Lightvan. Furthermore, the Prêt-à-Loger house functions as a living lab for indoor climate, domestic appliances, energy technology and building services. The group cooperates with partners in the university to secure physical testing, if needed.

#### SenseLab

SenseLab, a playground for the senses, is located in the Science centre. Single and combinations of environmental conditions can be experienced and tested. The SenseLab is built around the four IEQ factors (indoor air, thermal, lighting and acoustical quality), including:

- The Experience room: a room of circa 7.2 x 4.8 m<sup>2</sup> gross focussed on research on integrated perception of IEQ for different scenarios (schools, offices);
- Four “test rooms” for each of the four factors: two circa 2.4 x 3.9 m<sup>2</sup> gross and two circa 2.4 x 2.6 m<sup>2</sup> gross, focussed on education.

The funding of SenseLab comprises of the fellowship of Prof. Bluysen and funding from 18 sponsors.

2014–15: initiation + design, June 2016: start building, 1 Dec 2016: opening.

### The Lightvan

The Lightvan is a 4TU Lighthouse project. It facilitates daylighting research on wheels, in order to get close to research subjects who are less mobile, such as elderly people, for optimum energy reductions. Partners are TU Delft and Eindhoven University of Technology, with VELUX Nederland, Romazo, and Aldus Bouwinnovatie as industry partners.

<https://www.4tu.nl/bouw/en/LHP2014/thelightvan/>



*Lightvan, mobile light laboratory*

### Bucky Lab

Industrial partners sponsored the Bucky Lab experiments.

Within the master's programme, Bucky Lab designs, develops and builds architecture and building construction related prototypes. It is a "get your hands dirty" approach in which the students learn how to translate concepts from sketches to working prototypes. Bucky Lab tries to live the spirit of Buckminster Fuller: What ever you can imagine, you can also build!

Within the semesters assignment the students get in touch with an industrial partner and a real demand or product request. In cooperation with these industrial partners we are able to incorporate research and education. Next to this the results of the bucky lab is used for further investigations during graduate projects, phd researches as also ongoing product developments with industry partners.

<https://facadeworld.com/category/bucky-lab/>

<http://buckylab.blogspot.nl/>

<http://spool.tudelft.nl/index.php/spool/article/view/962/1106>

## Output

The group produces a substantial number of peer-reviewed journal articles, conference papers, scientific books, professional publications and PhD dissertations (the last-mentioned are published internally in the Architecture + the Built Environment series) GBI has produced an average of four PhD graduates per year since 2010. In addition, GBI staff members have been asked to participate in various PhD defence panels.

### Articles

In 2009, GBI had only two peer-reviewed journal papers on its output list. This historical low had various causes, some of which were external. Nonetheless, one of the causes was the lack of a tradition of publishing in journals by PhD candidates and research staff. In 2010, GBI started promoting peer-reviewed journal articles by offering “Writing a journal article” courses (given by Frank van der Hoeven and Andy van den Dobbelsteen). In 2011, a “journal paper meter” was introduced. For this meter, every paper was mentioned and celebrated in the department and represented 5 cm on the meter. By the end of 2011, the department had 21 papers on its list, most of them written by GBI researchers. In 2012, there were 29 papers on the list. Since then, GBI publishes around 20 peer-reviewed journal articles per year.

In 2015, the department of AE+T introduced its Code of Conduct for PhD researchers. The Code lays down rules on, for example, the minimum number of peer-reviewed papers per year.

### Journal of Façade Design & Engineering

Journal of Façade Design & Engineering is an open access journal that presents new research results and new proven practice of the field of facade design and engineering. The goal is to improve building technologies, as well as process management and architectural design.

Editor-in-Chief: Tillmann Klein  
<http://jfde.tudelft.nl>

### The Healthy Indoor Environment: How to assess occupants' wellbeing in buildings

The Healthy Indoor Environment is intended to help architects, building engineers and anyone concerned with the wellbeing of building occupants to better understand the effects on health and comfort of spending time in buildings. In three clear parts dedicated to mechanisms, assessment and analysis, the book looks at different indoor stressors and their effects on wellbeing in a variety of scenarios with a range of tools and methods.

Philomena M. Bluysen  
 Routledge, Abingdon, 2013, ISBN 9780415822756

### Sustainable Energy Landscapes – Planning, Design & Development

This peer-reviewed book presents a comprehensive overview of the latest knowledge on sustainable energy systems and their impact on urban and rural landscapes, with examples of planning, design and education across the world. The book has become the international standard for this new scientific area.

Stremke S. & Dobbelsteen A. van den (eds.)  
 CRC Press, 2012

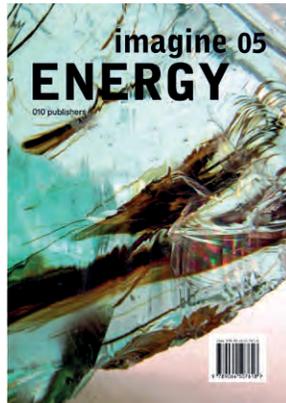
### Imagine Book series

The imagine series champions ideas, new technical concepts and physically built results. It is intended for designers and architects: to inspire them and to create a culture of imagination.

Editors: Ulrich Knaack, Tillmann Klein, Marcel Bilow



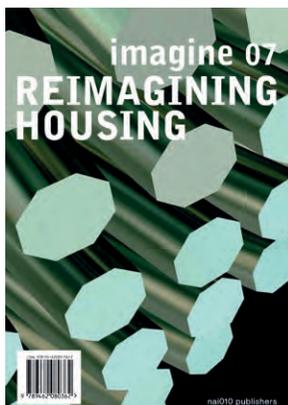
2010 #4 Rapids



2011 #5 Energy



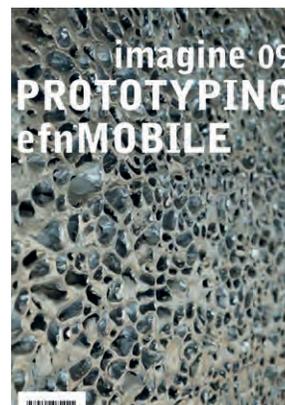
2012 #6 Reimagining the Envelope



2012 #7 Reimagining Housing



2015 #8 Concretable



2016 #9 Prototyping enf Mobile.

### The Future Façade conference series

This ongoing series was launched in June 2007. Between 2010 and 2015, the Façade Research Group organised:

- FE9 – Unobtainium (2015)
- FE7 - Facade Value (2013)
- FE6 - Low Carbon–High Architecture (2011)
- FE4 - Next Generation (2010)

The group produces a substantial number of journal articles and scientific books (see table). The figures below show some general citation figures and an example of our involvement in national and European standards.

#### Dissemination of research results

Almost all research projects conducted by GBI are done with partners from the private and public market. Industrial partners are in it for the uptake of innovative concepts (for instance, with research by the Façades & The Making research competence). Public parties such as municipalities and provinces use the research results in their planning and development (such as with the Energy & Climate competence group) and in the improvement of indoor environments of buildings (as with the Health & Comfort competence group).

#### From academia to the general public

GBI has always advocated the dissemination of its results to academic, professional and layman audiences. Therefore, publications range from scientific peer-reviewed papers to newspaper articles, and conferences organised by the GBI group always involve both academics and market parties. In addition, GBI staff are frequently asked to give external presentations to academics, professionals and the general public.

#### Media coverage

The best indicator of successful use is perhaps the number of interviews held with staff members and the extent of media coverage, both in traditional media such as television and radio, and on social media, such as Twitter, Facebook and Instagram (however, the relevant statistics are not registered well in the current administrative system). The absolute pinnacle of media attention was reached by GBI's Solar Decathlon team, which has so far managed to appear in three national TV items, three French TV programmes and various documentaries. Twitter and Facebook were bursting with news coverage of the Prêt-à-Loger house.

#### Link to education

GBI research is used intensively in educating students at the faculty of Architecture and the Built Environment. The Building Technology master's programme in particular pays a lot of attention to the most recent results from research, and students are involved in ongoing research and PhD projects. The best students are invited to publish with researchers and PhD candidates, which is appreciated in both directions.

#### Klimapedia.nl / Kennisbank Bouwfysica

GBI is contributing enormously to this inter-university site on climate design and building physics – a source of shared knowledge between technical universities and other higher education institutes.

#### Highest Hirsch Index scores (Google Scholar)

- 1 Philomena Bluysen (21)
- 2 Andy van den Dobbelsteen (16)
- 3 Martin Tenpierik (14)
- 4 Rob Roggema (10)
- 5 Mohammad Taleghani (9)
- 6 Ulrich Knaack (8)
- 7 Peter Luscuere (7)

### CEN/TC169 European Daylight Standard

As chair of the Dutch Daylight Standard committee NEN 2057, Truus Hordijk has written the proposal for a European Daylight Standard. As a member of the CEN/TC169 WG11, she has done work for this European Standard. The draft European Standard has now been submitted for public enquiry.

### 5.7.6

#### Recognition

GBI is widely recognised for its scientific performance and its initiation of green innovation, at both a personal and a project level.

### De Duurzame 100 / De Duurzame 50

Andy van den Dobbelen was no. 67 on “De Duurzame 100” list of the Trouw newspaper (related to all sustainability activities) and no. 6 on De Duurzame 50 list of ABN AMRO bank (related to sustainable real estate) in 2015.

<http://www.trouw.nl/tr/nl/14148/De-Duurzame-100-2015/integration/nmc/frameset/duurzame-100-2015/ranglijst.dhtml>

<http://www.duurzame50.nl/duurzame-50-2016/c/andy-van-den-dobbelen>

### IDEC (Interior Design Educators Council) 2016 book award

This prestigious award was given to Philomena M. Bluysen for her book “The Healthy Indoor Environment: How to assess occupants' wellbeing in buildings”.

<http://www.idec.org/i4a/pages/index.cfm?pageID=3507>

### AE+T Award

The department's AE+T Award was given to Mohammad Taleghani, who finished his PhD work on time in 2014, with no less than nine published peer-reviewed journal papers, including one in a journal with an impact factor of 6 – a rarity in the scientific area of building research.

### CIB Best Coordinator Award

Andy van den Dobbelen and Jay Yang were given the CIB Best Coordinator Award for their work for CIB working commission 116, Smart and Sustainable Built Environments.

<http://www.cibworld.nl/site/news/newsletter.html?year=2013&number=5>

### Solar Decathlon Europe 2014

The TU Delft team, with their Prêt-à-Loger house with a skin, received two first prizes and two second prizes, and came third overall, less than 3 points (out of a total of 1000) behind number 1, Roma Tre.

<http://www.solardecathlon2014.fr/en/competition>



*Prêt-à-Loger project for the Solar Decathlon Europe 2014*



### Context

PhD candidates are central to the research activities of the Green Building Innovation (GBI) group. They are the engine and deliver the power and imagination for future developments. In general, candidates are linked to one of the research competences – namely Energy & Climate, Comfort & Health and Facades & The Making – and the professors, associated professors and assistant professors who “drive” them. PhD candidates working within the group usually fall under only one of these competences, but some overlap with two or more. However, the cross-boundary scientific and societal innovation and sustainability themes link all candidates. There is a strong link within the GBI group between PhD research and MSc theses: the Building Technology MSc programme was developed to structurally support the research activities of the PhD candidates by allowing the latter to announce themes that are related to their research, and by linking the scientific knowledge of the candidates to motivated students, and vice versa – a link that is rarely found in architecture faculties. The group's International Façade master's programme and its cooperation with the building industry is an example of this. Financing a PhD is always a challenge. GBI research is carried out at the level of projects and at that of individual PhD candidates. Depending on the project and the possibilities, candidates are either fully or partly financed by projects or individual grants. This results in three main resources:

- National or European public grant funding of projects.
- Contract funding from industry or public organisations.
- Direct PhD funding by individual grants, personal funds or companies (if a company directly finances their own PhD candidate in the GBI environment, a bench fee is requested to secure the company's commitment).

In 2015, the department of AE+T introduced its code of conduct for PhD research, which in addition to existing guidelines clarifies procedures, agreements and figures for PhD candidates and their supervisors. The procedure for acceptance (regarding both in finances and content), expected output (number of peer-reviewed papers) and rules of engagement between supervisors and PhD candidates (frequency and maximum number of candidates for supervisors and daily supervisors) are clearly explained. The quality of supervision and output is better secured by these rules. This can already be noticed with recently accepted candidates.

### Participation in research schools

TU Delft offers an excellent infrastructure for courses on starting a PhD, design research methods, presentation skills, writing a dissertation and scientific writing in English to improve research skills. These courses are organised by the faculty's Graduate School for Architecture and the Built Environment (GS A+BE) and they support the quality improvement of our PhDs. It is a welcome tool to secure quality and reduce the workload of the daily supervisors. Craig Martin from the GBI group is the mentor for the AE+T PhDs candidates in the GS A+BE.

### Selection and admission procedures

A significant number of requests to participate in the GBI programme are received from potential national and international PhD candidates. All applications are assessed by our research organisation in order to maintain quality. After applications have been checked by the faculty's central research administration, they are judged by our GBI board. Only a small number of applications are granted. This systematic approach allows us to improve the quality of our research and reduce the workload of the daily supervisors and promoters.

### Supervision of PhD candidates internally and guidance of graduates to the labour market

The supervision of the PhD projects is developed and executed by each team of the themes Energy & Climate, Comfort & Health and Facades & The Making. Each PhD has one or more promotors, depending on the complexity or the integrated approach of the proposal, and a daily supervisor to ensure constant development. All PhD candidates draw up a personal education plan with their supervisors and discuss their progress (or otherwise) in annual result & development meetings. During these meetings, the candidate and the supervisor write a report and complete an evaluation form.

We hold regular PhD sessions, in which each project is presented and individually evaluated in relation to its development time- and content-wise. The two annual meetings of the Façade Research group is an example of this. To keep the interaction within the group, general meetings are held both for the programme as a whole and on a thematic basis.

PhD candidates are encouraged to contribute to and participate in national and international conferences, symposia and workshops, present and obtain feedback on their interim results, build up an international network and learn from other research projects.

Evaluations carried out within our PhD population have shown that there is considerable interest in a parallel development of their skills in the academic and the engineering world. The PhD period clearly supports the latter world. To secure the step into practice and provide the PhD candidates with the needed skills, during their period with the GBI group PhDs are frequently confronted by cooperation with engineering companies and industries as well as academic parties, triggered to develop their own networks, and requested to express the value of their results for the practical use in engineering.

The high number of successful careers forged by former PhD candidates in industry (key positions in research, development and management) and science (key positions in research institutes and professors at international universities) are clear evidence of the success of this double focus strategy.

ENROLMENT	Gender			SUCCESS RATE								Total graduated		Not yet finished		Discontinued	
	Starting year	Male	Female	Total	Finished								Total graduated	Not yet finished	Discontinued	Discontinued	
					≤ 4Y	≤ 5Y	≤ 6Y	≤ 7Y	≤ 4Y	≤ 5Y	≤ 6Y	≤ 7Y					
2006	1	3	4	0	0%	0	0%	1	25%	2	50%	2	50%	2	50%	0	0%
2007	2	2	4	0	0%	2	50%	3	75%	3	75%	3	75%	1	25%	0	0%
2008	1	3	4	0	0%	0	0%	1	25%	1	25%	1	25%	3	75%	0	0%
2009	5	2	7	3	43%	4	57%	5	71%	5	71%	5	71%	2	29%	0	0%
2010	7	2	9	1	11%	2	22%	2	22%	2	22%	2	22%	6	67%	1	11%
2011	2	0	2	1	50%	2	100%	2	100%	2	100%	2	100%	0	0%	0	0%
<b>Total</b>	<b>18</b>	<b>12</b>	<b>30</b>	<b>5</b>	<b>17%</b>	<b>10</b>	<b>33%</b>	<b>14</b>	<b>47%</b>	<b>15</b>	<b>50%</b>	<b>15</b>	<b>50%</b>	<b>14</b>	<b>47%</b>	<b>1</b>	<b>3%</b>

TABLE 5.5 Length of PhD candidacies and success rate of the PhD programme

## Self-reflection

In recent years, the Green Building Innovation group has matured: its structure, systematics, finances and output have become stable. The research group feels confident about its current size and is ready to target more large European collaborations, projects and grants.

As explained, GBI in itself is a close collaboration of three research clusters. This has already brought the research members a lot of mutual benefit. Under the umbrella of the department of Architectural Engineering + Technology, closer collaborations are being established between different research groups, including those from the research programmes of Computation & Performance and Design & History. There is much more internal consultation and an increasing number of shared projects. PhD research prospers from this integration. Joint participation in education modules (TE technology and ON design courses in the bachelor's track, plus different A and AE+T modules in the master's tracks) also creates practical collaboration between individual research members.

Widening of its scope will be a tactical improvement for both GBI and the department. A process of 'closing the gaps' between the research groups of AE+T seems to have started. From GBI, for example, there is close collaboration and cross-linking between Façade Research (Knaack, Konstantinou) and Computation & Performance (Turrin) on 3D-printing and of the Façade group (Klein, Azcarate Aguerre) with the Glass group of C&P (Nijse, Veer) on the circularity of glass, on automation in facade construction with TOI (Nourian), and the reuse of 1960s and 1970s office buildings with Heritage (de Jonge). Likewise, there is close collaboration between GBI's Climate Design section (e.g. van den Ham, van den Dobbelssteen) and Heritage & Architecture (Roos, Zijlstra, De Jonge, Van Thoor).

Due to developments within the department of AE+T, it is expected that in the near future the GBI group will merge with the Computation & Performance group. GBI feels primarily responsible for making a great success of this new conjunction and is looking forward to the opportunities that will accompany this broader range of research capacity.

## SWOT analysis

### STRENGTHS

The efficient and stable GBI group is run by high-potential assistant and associate professors and experienced professors who cooperate very well. All are eager to take on new assignments and to collaborate with other academic institutes and market parties. The programme is relevant and urgent to society and science, and the group initiates 3TU (now 4TU), TKI, NWO/STW and Horizon 2020 projects. The group's staff include a growing proportion of PhD candidates and PhD graduates. Productivity per FTE research staff is relatively high. The GBI group's published output is well balanced between scientific, expert and popular publications. The department of Architectural Engineering + Technology has excellent connections and partnerships and is a forerunner in inter-university collaboration.

### OPPORTUNITIES

There are many opportunities for funding and partnerships in the area of sustainability, climate and energy. Many parties both from academia and national and international markets have shown interest in cooperating with the GBI research group. Significant moves in the acquisition of new staff have been made. Assistant and associate professors have been installed in the departmental sections of Climate Design and Architectural Technology. Furthermore, the University is financially supporting a full-time chair in Indoor Environment for five years. The chair of Product Development (Emeritus Prof. Eekhout) will succeed to another chair in 2017. The integration and interaction of the existing MSc programme and its sub-programmes in climate design, structural design and façade design have improved research and provide a constant resource for young ambitious researchers. The time has come for the GBI group to focus on larger European collaboration and apply for more European grants, as the chair of Climate Design & Sustainability already does. An example will be applying for the Horizon 2020 Innovative Training Networks, where young PhD candidates are exchanged with other leading European universities. For that, the strategic positioning of people in European call development and funding networks will be crucial.

### WEAKNESSES

Like other groups in the Faculty of Architecture and the Built Environment, the GBI group has received funding from major scientific funding organisations, such as NWO/STW, that do not usually provide many opportunities for technology or design-focused research. More effort could be put into acquiring funding in several subject areas. The GBI group can still improve publications in international peer-reviewed CFIS journals. Finally, cooperation with other groups should be promoted in order to develop more interaction.

### THREATS

Cuts in direct government funding will reduce funds for fundamental and specialist research in the basic GBI competence areas; this may lead to too much focus on short-term goals. Decoupling primary research funding from output performance removes the incentive to publish more and to improve the quality of publications. A lot of time is currently spent on preparing project proposals and administration, instead of on research itself.

Related to the problem of research funding is the pressure within the university system to engage in teaching activities in order to reduce costs. As a consequence, a significant number of staff are required to teach rather than being allowed to carry out research.

In addition, the financial system within the faculty compels the department of AE+T (GBI included) to go for 100%-funded research grants only, which rules out NWO/STW and 4TU grants, which do not fund current staff. This situation exists because the faculty's financial system does not sufficiently support non-externally funded activities such as acquisition (or the success of it), co-funding (e.g. co-funded hours and the fourth year of a PhD project), publications and conferences. As a consequence, the number of possible funds will decrease and therefore a lower success rate, a smaller budget and less output might be expected.

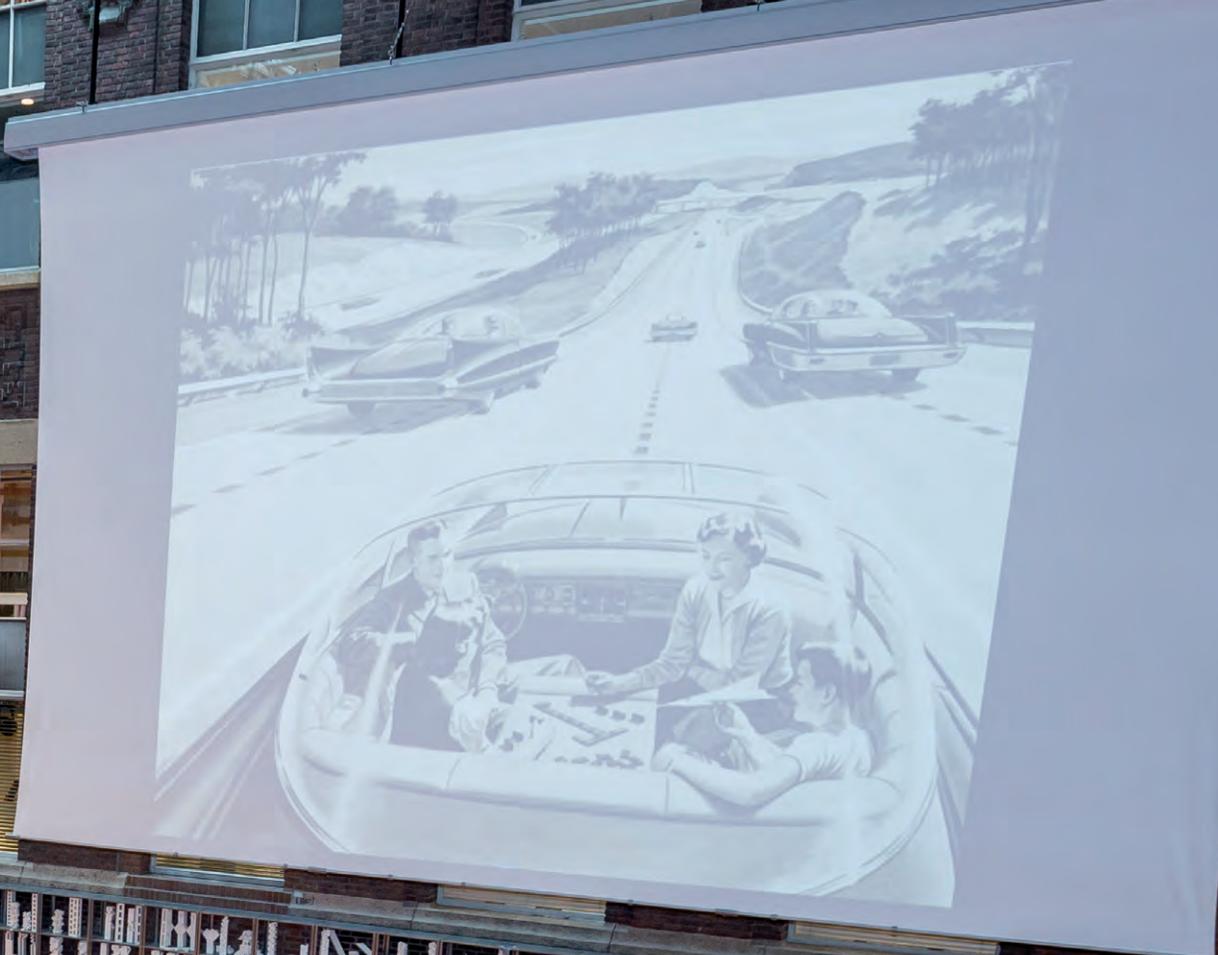


# Urbanism

Programme leaders:  
**Vincent Nadin**  
**Wil Zonneveld**

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Rients Dijkstra delivering a presentation on autonomous cars during the CITY & HIGHWAY seminar, April 7th 2016 in the Oostserre at BK City.



Urbanism research at TU Delft reflects the long-standing Dutch tradition that combines knowledge from urban design, spatial planning, landscape architecture and environmental technology.

The Urbanism group is concerned with the design and planning of cities and regions, and the consequences for a more sustainable and fair urban environment. The group has a world-class international reputation for its socially relevant applied research, scholarship and education. The research agenda reflects our understanding that the quality of the urban environment makes a critical contribution to the social, economic and environmental performance of societies. Urbanism has a huge part to play in the quality of places, often allocating great advantages to some and costs to others. We take the Dutch model of urbanism into the international arena in order to explain practice and develop solutions, whilst being sensitive to local conditions.

The Urbanism research programme is substantial, comprising (in 2015) 93 research staff (21 FTEs) and 39 PhD candidates. This is down from 102 research staff (20.3 FTEs) and 45 PhD candidates in 2010, reflecting changes in the composition of the Urbanism Department. The declining number of PhD candidates is the effect of a policy to slow recruitment and to concentrate on improving completions, as explained below. The financing of urbanism research, as shown in Table 6.3, has changed significantly since 2010. There has been a 50% increase in direct funding and a twentyfold increase in research grants. These figures demonstrate the reorientation of research in Urbanism, as set out in our strategy in 2010.

Since 2010, the research programme has been reorganised to emphasise both the deepening of knowledge in disciplinary specialisms and problem-solving around socially relevant research themes. Thus, the organisation of the programme comprises:

- Four disciplinary sections that give depth to our specialisms:
  - Urban Design;
  - Strategic Spatial Planning;
  - Landscape Architecture;
  - Environmental Modelling.
- Eight research theme groups that to some degree are multidisciplinary and user-defined:
  - Delta Urbanism;
  - Design of the Urban Fabric;
  - Metropolitan Spatial Structure;
  - Regional Design;
  - International Planning and Developing Regions;
  - 3D Geoinformation;
  - Smart Cities & Urban Metabolism;
  - History and Heritage Vector.

URBANISM	2010		2011		2012		2013		2014		2015	
	Nr.	FTE										
Scientific staff	36	10,8	33	10,6	31	10,0	28	9,7	25	7,9	28	9,2
Researchers	21	9,5	25	9,4	30	11,9	34	12,9	28	13,5	26	11,8
PhD candidates	45		47		44		43		39		39	
<b>Total research staff</b>	<b>102</b>	<b>20,3</b>	<b>105</b>	<b>20,0</b>	<b>105</b>	<b>21,9</b>	<b>105</b>	<b>22,5</b>	<b>92</b>	<b>21,4</b>	<b>93</b>	<b>21,0</b>
Visiting fellows	31		30		36		43		37		36	
<b>Total staff</b>	<b>133</b>	<b>20,3</b>	<b>135</b>	<b>20,0</b>	<b>141</b>	<b>21,9</b>	<b>148</b>	<b>22,5</b>	<b>129</b>	<b>21,4</b>	<b>129</b>	<b>21,0</b>

TABLE 6.1 Research staff (composition of the research unit)

URBANISM	2010	2011	2012	2013	2014	2015
Refereed articles	6	10	24	29	40	34
Non-refereed articles	4	6	7	1	5	5
Book	13	11	15	5	10	8
Book chapters	44	35	69	20	54	27
PhD theses	1	6	8	5	9	6
Conference papers	45	34	42	22	49	34
Professional publications	25	22	41	39	33	19
Publications aimed at the general public	3	17	4	3	7	6
<b>Other Research Output:</b>						
Book reviews	2	0	2	1	1	0
Appearances on radio or television	7	2	0	3	1	5
Internal reports, lectures, posters, datasets	28	43	63	59	103	134
External reports	9	5	7	14	10	11
Editorships of books	6	2	9	5	13	10
Editorships of journals	3	4	4	6	5	9
<b>Total other Research Output</b>	<b>55</b>	<b>56</b>	<b>85</b>	<b>88</b>	<b>133</b>	<b>169</b>
<b>Total publications</b>	<b>196</b>	<b>197</b>	<b>295</b>	<b>212</b>	<b>340</b>	<b>308</b>

TABLE 6.2 Main categories of research output

URBANISM	2010		2011		2012		2013		2014		2015	
	K€	%										
Direct funding	1.346	62%	1.394	59%	1.563	59%	1.698	61%	1.433	50%	1.934	55%
Research grants	-	0%	35	1%	204	8%	175	6%	220	8%	782	22%
Contract research	514	24%	462	20%	551	21%	720	26%	1.060	37%	991	28%
Own contribution	-	0%	-	0%	-	0%	-75	-3%	-265	-9%	-550	-16%
Other	318	15%	477	20%	341	13%	280	10%	409	14%	385	11%
<b>Total funding</b>	<b>2.178</b>	<b>100%</b>	<b>2.368</b>	<b>100%</b>	<b>2.659</b>	<b>100%</b>	<b>2.797</b>	<b>100%</b>	<b>2.857</b>	<b>100%</b>	<b>3.542</b>	<b>100%</b>
Personnel costs	-2.003	87%	-1.961	95%	-2.562	94%	-2.562	92%	-2.063	80%	-2.562	81%
Other costs	-295	13%	-102	5%	-155	6%	-219	8%	-508	20%	-602	19%
<b>Total expenditure</b>	<b>-2.298</b>	<b>100%</b>	<b>-2.063</b>	<b>100%</b>	<b>-2.717</b>	<b>100%</b>	<b>-2.782</b>	<b>100%</b>	<b>-2.570</b>	<b>100%</b>	<b>-3.164</b>	<b>100%</b>
<b>Result</b>	<b>-120</b>		<b>305</b>		<b>-59</b>		<b>16</b>		<b>287</b>		<b>378</b>	

TABLE 6.3 Funding (research unit's financing structure)

## Strategy

The Urbanism research programme has the underlying mission to advance the understanding and role of urbanism in achieving sustainable and socially just outcomes through interventions in complex urban systems. We aim to provide opportunities for talented researchers to 'make a difference' with regard to the urgent challenges of contemporary urbanisation around the world, and to maintain our position as a distinctive and pre-eminent international centre for urbanism research.

Our objectives are:

- to make a lasting and visible contribution to the theoretical understanding of, intellectual debate on and practical action regarding the urgent challenges of urban development around the world;
- to foster a flourishing and cohesive PhD research community of candidates and supervisors that sustains a long-term research endeavour, building depth and breadth of knowledge over time;
- to build strong interconnections between the research programme and master's and post-master's education, making effective use of the high-quality student body.

In order to reach these objectives, and following the 2010 and 2013 reviews, we have formulated the following strategy:

- to focus research resources, staff interests and recruitment on a limited number of priority research themes in which TU Delft Urbanism excels, making room for emerging themes that build on existing competences and outcomes;
- to consolidate PhD research around the research themes through rigorous selection and the monitoring of performance and supervision, in cooperation with the Graduate School;
- to drive research activity forward by vigorously pursuing selected external funding grants, with an accent on 'blue chip' sources and partners;
- to concentrate the work of staff and PhD candidates on higher quality academic dissemination, whilst maintaining the visibility of urbanism research through valorisation across the full range of media, high-profile events and online learning;
- to identify and strengthen relations with key local and international strategic research partners and networks, and within the university through the Delft Research Initiatives (DRIs);
- to provide master's education input to the research programme through a reform of the master's graduation projects;
- to ensure through the appraisal process that all relevant staff are competent in research supervision, publication and writing funding proposals.

We will continue to give priority to topics where there is evidence of excellence. The programme will build on these foundations to 'open the door' to contemporary theoretical and professional questions. For example, the Delta Urbanism theme has its roots in research on reconciling the problem of vulnerability to flood risk and dense urbanisation. This theme now engages with current theories of urban complexity and resilience. The Regional Design theme has grown out of the unique experience of the Netherlands in using design in governance and consensus building, and it now applies that knowledge to questions of institutional capacities to deal with the risks associated with climate change. We will make use of our research capacity to work in partnership with international organisations to explore problems in other regions, and to develop bespoke research projects and results that are tailored to specific conditions and cultures.

## Targets

In the period 2010–15 we set ourselves the following targets:

- to achieve a substantial increase in indirect and contract research funding with a balance between national and international projects, and to switch publication priorities from edited books to realise a substantial increase in the number and quality of academic peer-reviewed journal papers;
- to reach agreement on the number and content of departmental research themes.
- to completely replace the in-house PhD candidate funding with scholarships, to improve completion rates towards the four year target; and to substantially strengthen supervision teams and monitoring;
- to strengthen research management by holding monthly meetings of research leaders and organising broader research meetings and seminars; and to raise our profile by organising or co-organising a major international conference at least once every two years.

The targets for the next five to ten years are (2015 as a base year):

- to focus staff resources on the successful completion of current major externally funded projects according to work plans, and to build publication into the project programmes with at least two peer-reviewed journal articles per project.;
- to build on our recent experience of successful external funding bids to develop and win 'blue-chip' proposals in all themes;
- to develop and win a major joint research project in collaboration with our strategic partners in China (and, after 2017, in Latin America);
- to produce one academic peer-reviewed journal paper (Web of Science or Scopus) per FTE researcher each year, including PhD candidates from year two;
- to target PhD recruitment, external funding proposals and publications around the research themes to continue to build a selective track record of international excellence; and to complete all full-time PhD candidate projects in four years;
- to recruit five to eight PhD candidates each year and to widen supervision opportunities to all qualified staff, thus creating a committed team of both experienced and junior supervisors;
- to strengthen the annual PhD monitoring process through presentations to external peers to create a 'flagship event' to which all PhD candidates contribute (in addition to 'go, no-go' in year one);
- to improve the visibility of the Urbanism research programme through a revised and combined Urbanism research website (if necessary, independent of TU Delft), and publication of an updated research programme every two years.

## Environment

The most significant external factor for the Urbanism programme is the profound change in the national spatial planning agenda: policy ambitions have been scaled down drastically and austerity measures are in place. At the same time, the country faces fresh challenges associated with, for example, climate change, migration and the energy transition. The turbulence in the policy environment for urbanism has provided a stimulus for research and led us to take a fresh look at our theme priorities. For example, the research themes have taken up new questions on the urbanism response to climate change, resilience and the danger to the cultural heritage posed by neoliberal policies. These challenges are not confined to the Netherlands and our expertise is in demand

internationally. Under these changed conditions, the ambition of the national spatial planning research agenda has declined, reducing contract funding possibilities, which are only partially compensated for by other sources, including the Delft Research-based Initiatives (DRIs) and Delft Global. Nevertheless, the Urbanism programme has been able to acquire substantially more external research funding, as noted above, a trend that has accelerated into 2016.

The internal research environment has been positive, with new opportunities for collaboration arising from the merger of the OTB research institute into the faculty. The move of Professor Stoter and her research group on 3D Geoinformation to Urbanism in 2015 allows us to more effectively link technology, policy and design expertise. The appointment of Carola Hein to the chair of History of Architecture and Urban Planning in the Architecture Department has already resulted in effective cooperation in the joint research theme on History and Heritage, helping to build critical mass for joint funding proposals and cooperation on the major conference of the International Planning History Society. The Department of Management in the Built Environment appointed Professor van Bueren to the chair of Urban Development Management, and he is now cooperating with Urbanism on research proposals on urban development and planning in China.

The Urbanism programme has had strong support from external sponsors. The Ministry of Infrastructure and Environment has sponsored the appointment of Professor Vanstiphout to the chair in Design and Politics (2011–16). The Van Eesteren–Fluck–van Lohuizen (EFL) Foundation and the Dutch National Delta Programme have sponsored the appointment of Professor Palmboom to the Van Eesteren Chair (2013–16). These appointments connect Urbanism research to important government and civic organisations and the social relevance of research.

## 6.6

### Performance indicators

The choice of output indicators following the Standard Evaluation Protocol is given in Table 3 in the Appendix. Under the heading 'activities, organisation, facilities/assets, output', we include the organisation of conferences that were connected to European or global organisations and were the outcome of open bidding processes. The acquisition and organisation of such events are recognition of the quality and vigour of the Urbanism programme, and enable contact and collaboration with societal and professional partners.

We have added 'special theme issues' of journals to 'outputs' because this has become an important means to introduce and provide access to less experienced authors, and a valuable dissemination form for large research projects. We have also retained authored and edited books as a key indicator especially when leading international publishers are involved, and we are now doing more to promote the use of blogs and websites for the wider dissemination of research themes. In relation to 'relevance to society', our indicators relate to evidence of the policy and practice orientation of research and scholarship; thus, curatorships and exhibitions are important criteria, especially when targeting an international audience.

ASSESSMENT DIMENSIONS	QUALITY DOMAINS	
	RESEARCH QUALITY	RELEVANCE TO SOCIETY
ACTIVITIES, ORGANISATION, FACILITIES/ASSETS, OUTPUT	<p><b>Activities</b></p> <ul style="list-style-type: none"> <li>• Internationally funded projects</li> <li>• Nationally funded projects</li> <li>• Outreach: Organization of conferences &amp; seminars connected to European or global organizations</li> <li>• Outreach: Inter- and Intra-university academic conferences and seminars</li> </ul> <p><b>Organisation</b></p> <ul style="list-style-type: none"> <li>• Participation in international academic centres</li> <li>• Participation in international academic networks</li> <li>• Participation in academic consortia</li> </ul> <p><b>Facilities/assets</b></p> <ul style="list-style-type: none"> <li>• Accommodation</li> <li>• Library</li> <li>• ICT networks &amp; data storage</li> <li>• Databases</li> </ul> <p><b>Output</b></p> <ul style="list-style-type: none"> <li>• Peer-reviewed journal articles</li> <li>• PhD dissertations</li> <li>• Academic books</li> <li>• Special Issues of Scopus indexed journals</li> </ul>	<p><b>Activities</b></p> <ul style="list-style-type: none"> <li>• Commissioned research projects</li> <li>• Outreach: Curatorships and exhibitions</li> <li>• Outreach: Conferences and seminars targeting practitioners and end-users</li> </ul> <p><b>Organisation</b></p> <ul style="list-style-type: none"> <li>• Participation in co-funded centres</li> <li>• Participation in knowledge networks including professionals and end-users</li> </ul> <p><b>Facilities/assets</b></p> <ul style="list-style-type: none"> <li>• No indicators; see text</li> </ul> <p><b>Output</b></p> <ul style="list-style-type: none"> <li>• Peer-reviewed journal articles</li> <li>• Applied research reports</li> <li>• Professional books</li> <li>• Professional journal papers</li> </ul>
USE	<ul style="list-style-type: none"> <li>• Examples of extensive use of Urbanism outputs</li> </ul>	<ul style="list-style-type: none"> <li>• Examples of extensive use of Urbanism outputs</li> </ul>
MARKS OF RECOGNITION	<ul style="list-style-type: none"> <li>• Major personal grants and projects</li> <li>• Member of research review panels</li> <li>• Editorship of academic journals indexed in Scopus</li> <li>• Honorary positions</li> </ul>	<ul style="list-style-type: none"> <li>• Awards</li> <li>• Practice chairs (co-)financed by external partners</li> <li>• Awards</li> <li>• Key advisory positions</li> <li>• Key positions in practice</li> <li>• Partner in private urbanism office</li> </ul>

TABLE 6.4 Selected output indicators



Before 2010, foundations were laid through a number of well-cited publications, including Meyer (1999) *City and Port; Transformation of Port Cities* and Hooimeijer, Meyer and Nienhuis (2005) *Atlas of Dutch Water Cities*. Since 2010, major projects have followed in collaboration with social partners, for example the 'Studio Coastal Quality' (*Atelier Kustkwaliteit*), co-financed by the Ministry of Infrastructure & Environment, four coastal provinces, the Municipality of The Hague, Van Oord Dredging Company and the Netherlands Architecture Fund (2011–14). The research findings were adopted and integrated in the 2013 National Coastal Vision (*Nationale Visie Kust*) See <https://goo.gl/PgYSxb>.

Another example is the NWO-funded project on 'Integrated Planning and Design in the Delta' (IPDD), which focused on the Rotterdam region. TU Delft led the partnership with a large consortium, including the Ministry Infrastructure and Environment (Delta Programme), Rotterdam Port Authority and the World Wildlife Fund. The main outcome of the project was an outline for a 'Robust Adaptive Framework as a New Spatial Concept', which was explicitly applied in the 2014 National Delta Programme. The same stakeholders commissioned the first implementation project of the IPDD programme from TU Delft.

Since 2013, the Van Eesteren Chair, co-funded by the Dutch National Delta Programme, has undertaken research on the IJsselmeer area and the challenges of sea level rise, extreme river discharges, fresh water supply and urban development. The chair group is collaborating closely with national, provincial and local authorities and expert groups from different backgrounds. The main report will be presented in 2017.

After the major flood in New Orleans in 2005 research became international, and included developing countries where the social aspects of delta urbanisation are particularly acute. This is exemplified by the 'Dutch Dialogues' that preceded the formulation of the 2014 Greater New Orleans Urban Water Plan. The 'Dialogues' project, co-led by TU Delft, was an initiative of New Orleans-based practitioners and citizens, supported and financed by the American Planning Association and the Royal Embassy of the Netherlands. During the period 2007–10, research and design workshops were organised by an American–Dutch consortium of engineers, designers and academics in order to formulate comprehensive design and planning principles for more integrated water-management systems in the urban fabric. This work eventually led to the Greater New Orleans Urban Water Plan, which has been accepted as a strategic policy document by all stakeholders. See <http://livingwithwater.com/>

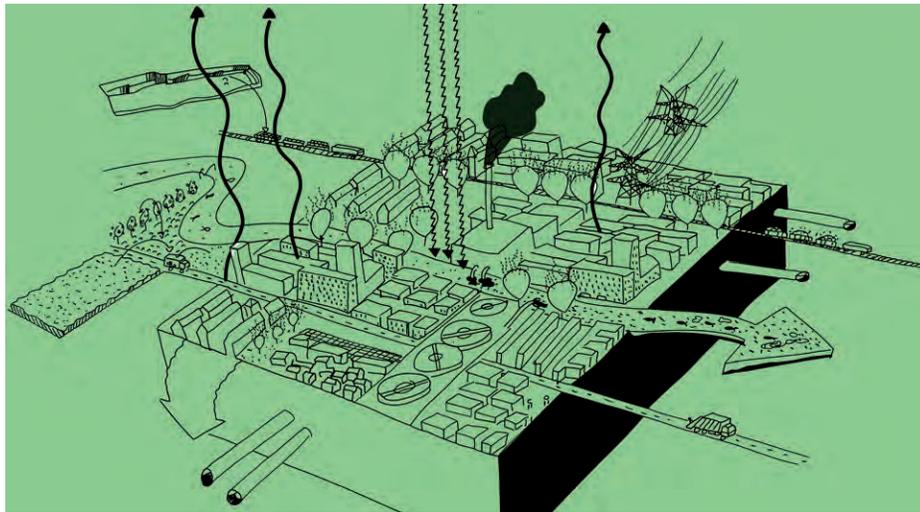
The Delta Urbanism group collaborates intensively with the Delta Alliance, an international network of knowledge institutes in and on delta regions (<http://www.delta-alliance.org/>). In 2015, the Dutch Ministry of Foreign Affairs commissioned TU Delft and the Delta Alliance to write a mission statement on urbanising deltas for the 2016 UN–Habitat III conference in Quito. The Dutch delegation to the conference will use the paper to argue the importance of putting the issue of urbanising Deltas on the 'New Urban Agenda' of UN Habitat with high priority.

#### Smart Cities and Urban Metabolism

Urban metabolism (UM) is a multidisciplinary and integrated approach to examining the material and energy flows in the complex systems of metropolitan territories. UM can be used in planning and design to inform interventions for transforming metropolitan structures towards more sustainability. The Urbanism research programme has made a significant contribution to the national and international visibility of this concept. For example, between 2008 and 2011, the EU FP7 project Sustainable Urban Metabolism for Europe (SUME, [www.sume.at](http://www.sume.at)) used urban development scenarios in combination with

an agent-based UM model to demonstrate the potential for transforming in ways that would require lower amounts of energy and material resources.

Wandl and van der Hoeven have conducted a series of urban heat island studies, relating human wellbeing to the temperature in the city and investigating how this is influenced by its morphology. The first studies proposed planning and design principles for the two largest Dutch cities: Amsterdam and Rotterdam. A subsequent commission from those cities aims to build up a citizen sensing network to develop the methodology further. <http://books.bk.tudelft.nl/index.php/press/catalog/book/436>



IABR - 2014 - *Urban by Nature*

The International Architecture Biennale Rotterdam (IABR) 'Urban by Nature' was curated by Dirk Sijmons. It illustrated the importance of the concept of UM for urban planning and design. It included the group's study of urban agriculture and urban ecology in Rotterdam, and the potential for more liveable, low-carbon cities and sustainable phosphorus flows (Tillie & Kirsimaa). This led to the 'Smart City Planner', in collaboration with Rotterdam Municipality, which links international comparable city data to GIS mapping and potential actions in neighbourhoods. It is currently used by Rotterdam and will be extended to more cities in cooperation with CBS and the World Council on City Data.

In 2015, the research group successfully applied for two Horizon 2020 projects. It is leading the project 'Resource Management in Peri-urban Areas: Going beyond Urban Metabolism' (REPAiR) (Wandl & Van Timmeren). The other project, Urban strategies for Waste Management in Tourist Cities (UrBAN-WASTE) (Stead), employs the UM approach to study innovative technologies for waste management and prevention in cities experiencing high levels of tourism.

#### Landscape Architecture of the Lowlands

The Urbanism programme is very active in the landscape architecture of polders. Water levels are artificially controlled in these reclaimed areas so that people can live and work there, but the polders are under threat. Increasing flood risk due to sea level rise, ongoing subsidence due to intense drainage and rapid urbanisation all call for urgent action. The programme has sought to increase knowledge and raise awareness of these challenges whilst providing clues for policymaking, planning and design.

### Polder map of the Netherlands

S. Nijhuis & M.T. Pouderoijen, TU Delft



*Poldermap of the Netherlands*

The research addresses polder landscapes as cultural expressions – rather than only as results of water engineering – employing mapping, case studies and comparative research as means to understand the similarities and differences between these 'polderscapes'.

Prior to 2010, foundations were laid in important publications including *Sea of Land* (Reh, Steenbergen & Aten, 2007) in collaboration with the Water Board of North Holland, and *The Polder Atlas of the Netherlands* (Steenbergen, Reh, Nijhuis & Pouderoijen, 2009) in partnership with Nieuw Land. The Polder Atlas generated extensive media publicity, public debate and positive reviews, having been presented to the government advisor for Landscape, Ytje Feddes. Since 2010, the Dutch Agency for Cultural Heritage and the Ministry for Infrastructure and Mobility have provided funding for the GIS-based *Comprehensive Polder Map of the Netherlands* (Nijhuis & Pouderoijen, 2013), the first systematic overview and database of polders in the Netherlands in a digital format.

This is now an authoritative reference in landscape research. It was followed by the *Dike Atlas of the Netherlands* (Pleijster et al. 2014), an initiative of the Dutch government and a private partner. The research group together with Nieuw Land recently initiated the project *Polder landscapes of the world* (Nijhuis & Van der Most, 2016). In collaboration with partners such as the International Council on Monuments and Sites NL (ICOMOS

NL), LDE Centre for Global Heritage Development (CGHD), Beijing Forestry University, UNESCO-IHE and the Danish Agency for Culture, the team explores polder landscapes around the globe.

From the beginning, the polder research has been strongly interlinked with education, making use of the programme's publications. In research and design studios, students engage in design explorations for the sustainable transformation of the lowland landscapes using books such as *Dutch Lowlands* (De Wit, 2008) and *Water Insight* (Bobbink, 2012), which provide the foundations for understanding the particularities of landscape. In the framework of the research programme, students play an active role at the national Oerol Festival through 'design & make' projects that put knowledge into practice in on-site experiments, and interacting with the public through performances. Future extension of the research is planned. It will include further international publications and exhibitions in cooperation with social partners, alongside more academic outputs.

## 6.7.2

### Activities

#### Selected internationally funded projects

- NODES: New Tools for Design and Operation of Urban Transport Interchanges (EU F7) 17 partners representing local government administrations, public transport operators, research centres and consultants and European associations (2012–15). <http://www.nodes-interchanges.eu/>
- PICH: The impact of urban planning and governance reform on the historic built environment and intangible cultural heritage (JPI Cultural Heritage). Five partners; Lead TU Delft (2015–18). <https://planningandheritage.wordpress.com/pich-2/>
- PLEEC: Planning for Energy Efficient Cities (EU F7); 18 partners from 13 European countries, including six mid-sized cities, nine universities and three industry partners. Lead: Eskilstuna Energy Miljö (SE) (2013–16) <http://www.pleecproject.eu/partnership.html>
- RUFUS: Rural Urban Futures (FP7); eight partners; lead Leibniz Universität Hannover. (2008–11) <http://www.rufus-eu.de/>.
- UKNA: Urban Knowledge Network Asia (EU F7 Marie Curie Action): the largest academic international network on Asian cities, bringing together over 100 researchers and practitioners from 16 institutes in Europe, China, India and the United States. In collaboration with the International Institute for Asian Studies, Leiden University (2012–16). <http://www.ukna.asia/>.

#### Selected nationally funded projects

- 3D4EM: Implementation of a 3D GII for integrated 3D environmental modelling (STW Maps4Society), 14 partners, lead: Urbanism (2015–20). <http://www.3d4em.nl/>
- 3DSM: Simplification of digital terrain models using feature-based 3D methods (STW–Open Technology), nine partners, lead: Urbanism (2013–17). <https://3d.bk.tudelft.nl/projects/3dsm/#stw-users-committee>
- ADAM: Acoustics by Parametric Design and Additive Manufacturing (STW–Open Technology, lead: Urbanism (2014–18). <http://www.stw.nl/nl/content/acoustics-parametric-design-and-additive-manufacturing>
- IPDD: Integrated Planning and Design in the Delta (NWO–VerDuS), lead: Urbanism, plus advisory board of Ministry Infrastructure and Environment (Delta programme), Rotterdam Port Authority and World Wildlife Fund (2011–14) <http://urd.verdus.nl/ipdd>
- MFFD: Multifunctional flood defences (STW–Perspectief), > 15 partners including user community, lead: Urbanism (2012–16). <http://www.flooddefences.nl/>

#### Selected commissioned research projects: public bodies and/or societal groups

- Design Studio Coastal Quality, Delta Programme Coast & five other investors (2011–12) <https://goo.gl/tMqpL9>
- Hotterdam & Amsterwarm: two urban heat island projects, Knowledge for Climate Research Programme, with municipalities & 3TU (2014–15) <http://www.hotterdam.eu/>
- Mapping Wuhan. A Morphological Analysis of the Spatial Structure and the Urban Transformation of Wuhan, Wuhan Land Use and Spatial Planning Research Centre/ WLSR, Wuhan (2015–16) <http://www.wlsp.org.cn/News/5/497.html>
- Spatial Data Infrastructure, Geonovem (since 2015) <https://goo.gl/EUCg1K>
- Vertical Village, Why Factory Project, MVDVRV & others (2008–15). <https://goo.gl/S7WqKQ>

#### Examples of conferences for European or global organisations

- Association of European Schools of Planning (AESOP) Congress 2014, jointly hosted by TU Delft and Utrecht University and PhD School on theme of “From Control to Co-evolution” (<http://www.congrexprojects.com/aesop>).
- Regional Studies Association Conference, Delft, 2012, with OTB, conference theme: 'Networked regions and cities in times of fragmentation: Developing smart, sustainable and inclusive places' ([www.regionalstudies.org/conferences/archive/P10](http://www.regionalstudies.org/conferences/archive/P10)).
- 10<sup>th</sup> international Conference on Geo-information for Disaster Management (Gi4DM), 2015, Montpellier, France, <http://www.gi4dm.net/2015/> (co-organiser).

#### Main examples inter- and intra-university academic conferences and seminars

- Complexity, Cognition, Urban Planning and Design 2<sup>nd</sup> TU Delft International Conference on Complexity and Design, 2013 (first conference 2009)
- Deltas and Ports of the Future, major conference, TU Delft, 2016, and five seminars DIMI-on-Tour, 2015.
- Exploring the Visual Landscape, TU Delft, 2012, with Wageningen University and Ghent University.
- Third New Urban Languages Conference 2015: Tales and Images of Social Justice (<http://spatialplanningtudelft.eu/?p=3733>).

#### Conferences and seminars targeting practitioners and knowledge end-users (3–5)

- 3D and Environmental modelling, 2015, <https://goo.gl/tMqpL9>
- Delft/The Hague Cities Workshop as part of the 2015 world conference of ISOCARP
- First (1/2015) and second (9/2015) Knowledge Conference on “The Future of the IJsselmeer Area” initiated from the Van Eesteren Chair (3<sup>rd</sup> 6/2016).
- New Urban Configurations; International Seminar on Urban Form, 2012. [www.urbanform.org/](http://www.urbanform.org/)
- Shaping regional futures: Mapping, designing, transforming! Munich, 10/2015 (TUD & TUM; [https://www.events.tum.de/frontend/index.php?folder\\_id=165](https://www.events.tum.de/frontend/index.php?folder_id=165)).

#### Curatorships, exhibitions and events

- 6<sup>th</sup> edition IABR “Urban by Nature”, <http://iabr.nl/en/editie/urbanbynature> 70,000 visitors, 9 mobile exhibitions, 52 events, 7 publications and 19 web films.
- 7<sup>th</sup> edition IABR 'The Next Economy' 2016, [http://iabr.nl/en/editie/ct\\_credits2016](http://iabr.nl/en/editie/ct_credits2016)
- British entry for the 2014 Venice Architecture Biennale, <https://goo.gl/h76Cgg>
- Exhibition “Design as Politics” within 5<sup>th</sup> IABR 2012 “Making City”, <https://goo.gl/mU1eaG>
- Iranian entry for the 2014 Venice Architecture Biennale, <https://goo.gl/P8dESH>
- Why Factory exhibitions & event, <http://thewhyfactory.com>

### Organisation

#### Participation in international academic centres and consortia.

- AMS: Amsterdam Institute for Advanced Metropolitan Solutions.  
<http://www.ams-amsterdam.com/>
- USE: Joint Research Centre on Urban Systems and Environment with South China University of Technology (SCUT). <https://usecentre.wordpress.com/>
- JRC Spatial Information, Wuhan University and TU Delft  
<http://jrc.tudelft.nl/spatial-information/>
- Planning Heritage Consortium: core partners in five countries (in cooperation with the History and Design Programme), <https://planningandheritage.wordpress.com>
- Network on Delta Urbanism with USA, supported by the Dutch Embassy and the Ministry of Foreign Affairs, with Universities of New Orleans, New York, Houston and Berkeley.

#### Examples of participation in international academic networks

- IDEA League: TU Delft, RWTH Aachen, ETH Zürich & Chalmers Gothenburg,  
<http://idealeague.org/>
- IFOU: International Forum on Urbanism, <http://ifou.org>
- ISPRS: International Society for Photogrammetry and Remote Sensing,  
<http://www.isprs.org>
- IIAS: International Institute of Asian Studies, Leiden <http://iias.asia/>
- NALACS: Netherlands Association for Latin American and Caribbean Studies,  
<http://www.nalacs.nl/>
- ECLAS: European Council of Landscape Architecture Schools, <http://www.eclas.org/>

#### Examples of participation in (inter)national networks with practitioners and end-users

- OSK: Dutch Postgraduate Research School for Art History, <https://goo.gl/DVAdtD>
- ISOCARP Scientific Committee: International Society of City and Regional Planners,  
<http://isocarp.org/contacthead-office/scientific-committee/>
- SCUPAD: Salzburg Congress on Urban Planning and Development,  
<https://goo.gl/F8GKSo>
- European Spatial Data Research, <http://www.euroedr.net>
- Open Geospatial Consortium, <http://www.opengeospatial.org>
- WCCD: World Council on City Data, vice-president Nico Tillie, <https://goo.gl/0Ab7AB>

### Facilities/assets

- Accommodation: entire department concentrated in one wing, facilitating interaction and cohesion, ample rooms and facilities for medium-sized conferences and seminars.
- Library: departmental library in the Urbanism wing of BK City: 2,100 books.
- ICT networks & data storage, Geoinformation: <http://godzilla.bk.tudelft.nl>.
- 4TU data storage capacity (data for large projects) & TU Data repository: storage of specific datasets, plus ample server capacity within TU Delft.
- Databases: datasets on the heat island effect in Rotterdam, Amsterdam and The Hague
- About 15 GPS tracking datasets.



Urbanism books

6.7.5

Output

Five most important scientific outputs in the past six years

- Biljecki, F., Stoter, J., Ledoux, H., Zlatanova, S. & Çöltekin A. (2015) *Applications of 3D city models: state of the art review*, *Journal of Geo-Information*, 4(4): 2842–2889.
- Dühr, Colomb, & Nadin (2010) *European Spatial Planning and Territorial Cooperation*, London: Routledge.
- Portugali, J., Meyer, H., Stolk, E. & Tan, E. (eds) (2012) *Complexity Theories of Cities Have Come of Age*, Springer, downloaded over 26,000 times, top 25% most downloaded e-books in the Springer collection.
- Steenbergen, C. M. & Reh, W. (2011) *Metropolitan Landscape Architecture*, THOTH, Dutch version awarded the 2013 René Pechère prize for best publication on garden and landscape architecture.
- Wohl, S. (2015) *Considering how morphological traits of urban fabric create affordances for complex adaptation and emergence*, *Progress in Human Geography*, January 2015: doi: 10.1177/0309132514566344.

Five most important societal publications and outputs in the past six years

- Amsterdam Institute for Advanced Metropolitan Solutions (AMS). Urbanism is lead partner for TU Delft (in partnership with Wageningen University, MIT and others). Van Timmeren is scientific director (since 2015) of this public–private institute where engineers, designers, digital engineers and natural/social scientists jointly develop

and valorise interdisciplinary metropolitan solutions in cooperation with enterprise, municipalities and local residents.

- Meyer, Bregt, Dammers & Edelenbos (2014) *Nieuwe Perspectieven voor een verstedelijke delta* (English edition 2015, *New Perspectives on Urbanizing Deltas*): presentation of the IPDD results, in collaboration with the Dutch Delta programme, Port of Rotterdam and World Wildlife Fund.
- Nijhuis, S. and Pouderoijen, M. (2013) *An Interactive Polder Map of the Netherlands*.
- Sixth edition International Architecture Biennale Rotterdam "Urban by Nature", <http://iabr.nl/en/editie/urbanbynature> curated by Sijmons, attracted 70,000 visitors; nine mobile exhibitions; 52 events, seven publications and 19 web films.
- Van der Hoeven, F. and Wandl, A. (2015) *Hotterdam: How space is making Rotterdam warmer, how this affects the health of its inhabitants, and what can be done about it*, TU Delft.

### 6.7.6

#### Use

- Downloads: e.g. 26,000 downloads of the book edited by Portugali, J., Meyer, H., Stolk, E. & Tan, E. (Eds) (2012) *Complexity Theories of Cities Have Come of Age*, Springer:
- Participation: e.g. 70,000 visitors to the Sixth International Architecture Biennale Rotterdam 2014: Urban by Nature, at nine exhibitions and 52 conferences and lectures.
- Personal citations: e.g. 2612 citations since 2011 to multiple articles by S. Zlatanova, 3D Geoinformation Group.
- Book citations: e.g. 1161 citations for Cullingworth B., Nadin, V. et al., (various editions to 2015) *Town and Country Planning in the UK*, Routledge (Nadin has 1082 citations since 2011).

### 6.7.7

#### Recognition

##### Major grants

- 5D data modelling Vidi (2010–17); Design and implementation of a 3D GII for integrated 3D environmental modelling (2015–20);
- Dabrowski: Urban Studies Foundation Postdoctoral Research Fellowship (2013–16).
- Simplification of digital terrain models using feature-based 3D methods (2013–17);
- Smart 3D Indoor models to support crisis management (2015–20).
- Stoter: ERC Starters Grant 'Urban Modelling in Higher Dimensions' (€1.5 million);

##### Membership of national research council review panels

- NWO–MaGW Veni (2013: Zonneveld)
- NWO–MaGW Vidi (2010: Zonneveld)
- NWO–STW Vidi (2015: Stoter)
- Flanders standing FWO W&T9 panel (2004–12: Meyer; since 2012: Zonneveld)
- FNR Luxembourg; standing panel (2010–14, Nadin)

##### Editorship of academic journals indexed in Scopus

- European Journal of Spatial Development (Zonneveld).
- International Journal of 3-D Information Modelling: IJ3DIM (Zlatanova)
- Journal of Design Research (Klaasen & Stolk);

- Planning Practice & Research (Nadin)
- Regional Studies, Regional Science/Early Careers Section (Dabrowski);
- Research in Urbanism Series (RiUS) (Van der Hoeven & Nijhuis)

#### Honorary positions and awards

- Bekkering: honorary member, Board of the International Forum of Urbanism (since 2014)
- Nadin: Overseas famous teacher project of Ministry of Education, China, (2015–20)
- Van der Spek: visiting professor, University of Northumbria, UK (2012–18)
- Van Nes: tenured professor, Bergen University College (since 2015)
- Vanstiphout, Pierre Bayle lifetime achievement award for art criticism

#### Five examples of prominent keynote speeches

- Van Timmeren – Dies Natalis TUD, 2015.
- Van Nes – Space and Crime, China First Space Syntax Congress, School of Architecture, Beijing Jiatong University, 2015.
- Sijmons – Climate Change Adaptation and Landscape Identity, International Landscape Architecture Symposium, Beijing Forestry University, Beijing, 2015.
- Ulf Hackauf – 7<sup>th</sup> international conference of the Association of Architecture Schools of Australasia AASA, Melbourne, 3/10/2013.
- Luiten – Osaka Seminar on Cultural Landscapes. OSAKA, Japan, 2011.

#### Key policy advisor or membership key advisory boards

- Dijkstra, state advisor for Infrastructure and the City (since 2012)
- Luiten, state advisor for Landscape and Water (since 2012)
- Vanstiphout, member of Council for the Environment and Infrastructure (2012–16)
- Meyer, advisor to research group Lisbon Integrated Delta Approach (2010–14)
- Meyer & De Hoog, advisors to Delta-programme Rijnmond–Drechtsteden (2010–14)
- Meyer, advisor to Greater New Orleans Urban Water Plan (2011–14)
- Meyer, advisor to Integrated water-management plan Kaoshiung, Taiwan (2012)
- Luiten and others National Research Agenda Heritage and Space (2013)
- Nadin advisor to National Cheng Kong University Taiwan on planning and reservoirs (2013)

#### Key positions in practice

- Bekkering, deputy chairman of the Board of the Stichting Bureau Architectenregister (Dutch Registration Bureau for Architects, Urbanists, Landscape Architects (2010–11).
- Tillie, vice president World Council on City Data (WCCD) and director of European Office, World Council on City Data.
- Stoter: researcher at the NL Kadaster and Geonovum.
- De Hoog, Van Eesteren–Fluck–van Lohuizen Foundation (chairman since 2009), Bekkering (board member (2010–12) & Meyer (board member since 2012).
- Meyer, board member and chair, International New Town Institute (2006–10).
- Meyer, board member CityPorts Academy established by City of Rotterdam & Port of Rotterdam.
- Pouderoijen, Piccininie, Van Loon, participation in the Dutch Oerol Theatre Festival on Terschelling (2010–15) with about 50,000 visitors. <https://goo.gl/U461WQ>

#### Partner in major design and consultancy offices

- Palmboom: Palmbout Urban Landscapes, <http://palmbout.nl/>
- Vanstiphout: Crimson Architectural Historians, <http://www.crimsonweb.org/>
- Dijkstra: Maxwan Architects, Urbanists <http://maxwan.nl>
- Zandbelt: De Zwarte Hond, <http://www.dezwartehond.nl/>
- Nillesen: Defacto Architecture & Urbanism, <http://www.d.efac.to/>

### Context

At the time of the 2010 assessment the Urbanism programme had decided to consolidate candidate numbers so as to improve completion rates. During that time we have also instigated a more rigorous recruitment process and connected candidates more closely with research themes. We established a moratorium on recruitment with exceptions only for newly appointed professors and vacancies associated with externally funded projects. Completion rates are currently improving. Table 6.5 does not differentiate between part-time and full-time candidates. However, it shows that of 10 candidates starting in 2011 all have either completed within five years, or discontinued. This reflects more rigorous monitoring of progress and potential to complete. In comparison only two of eight candidates starting in 2007 completed in five years. We have a small number of candidates who are still in the programme after a considerable time which is the outcome of our commitment to assist members of staff to gain a PhD diploma and to support other candidates who have in effect been 'suspended' from the programme, for example when starting a family. We are implementing additional measures to make further improvements in completion rates. From 2014 we began to recruit more actively if selectively, with a preference for full-time contract and standard candidates, but also with the aim to increase the number of Dutch candidates who are more likely to be part-time (16 of the 49 PhD candidates in December 2015 were Dutch nationals).

### Selection and admission procedures

The selection and admission procedure has been revised and significantly strengthened during the review period, with the assistance of the Graduate School for Architecture and the Built Environment (GS A+BE). Admission, doctoral training and monitoring are now managed at the Faculty level, although involving considerable programme input. Complete applications are checked centrally and forwarded to the Head of the Urbanism Research Programme and PhD coordinator who consult relevant staff. The department Daily Board (management group) makes the admission decision advised by the prospective promoter. This decision was formerly made by professors. The criteria for admission are:

- 1 the relationship to the urbanism research programme and the current call in relation to research questions and topics on the urbanism website;
- 2 the scientific quality of the research proposal;
- 3 the societal relevance of the research proposal;
- 4 the candidate's curriculum vitae and references;
- 5 writing skills in English or Dutch language and evidence of publication in any language.

The Urbanism Research Leaders Group, made up of representatives from each research theme together with a representative of the PhD candidates, monitors overall PhD progress and makes policy recommendations to the Daily Board. The Programme attracts a very high number of speculative applications from well-qualified students (in excess of 100 per year). We also receive many applications from PhD candidates at other institutions who seek short-term visits. In the recruitment process applicants must clearly contribute to the priorities set out in the research programme. Themes and topics in which there is capacity for supervision are advertised on the Urbanism website. PhD candidates are now organized within the research themes. Although Urbanism does not provide funding for PhD work, we assist excellent applicants with proposals for national and international scholarships.

The Urbanism programme has also played a key part in establishing a double PhD degree programme with South China University of Technology through the Joint Research Centre on Urban Systems and Environment. The first urbanism PhD candidates on this programme are expected in 2016. The European Post-Master in Urbanism (EMU) provides a pre-PhD track for exceptional students who want to move directly into PhD research. The department will continue to make use of this track, which has less risk as we already know the candidates well.

#### Supervision and guidance of PhDs

Appointed PhD candidates are expected to complete their promotion within four years (or pro-rata for internal and external candidates). During this period, progress is supervised by the promoter, sometimes a co-promoter, and a day-to-day supervisor. A PhD mentor also provides support to all candidates on issues related to the PhD process and the relationship between candidates and the supervision team. To ensure that appropriate supervision is available for all candidates, the team of supervisors is appointed by the Daily Board during the approval of the admission of the candidate.

TU Delft provides training for promoters, day-to-day supervisors and mentors, and a number of our staff have completed the training in the review period. Only a professor can promote a PhD candidate and this is becoming a constraint on the number of candidates that can be admitted. It is expected that soon there will be a change to allow suitably qualified associate professors to act as promoters. The policy in Urbanism will be to allow this where the associate professor has a record of successful supervision as a daily supervisor and has completed training.

As explained in the section on the graduate school all candidates are required to present at a first year 'go/no-go' review that are held at least twice a year. All urbanism professors and two external peers are invited to assess the presentation and research report. In later years the supervisory team holds review meetings at individual or team level. In addition in 2016 the Urbanism programme inaugurated an annual PhD review conference in May, inviting all PhD candidates to present their progress to the whole department. The Urbanism Programme with the PhD Council facilitates regular meetings for candidates covering topics such as publication and career prospects in academia and industry. Additionally, the elective courses of the Graduate School include at least two courses for third and fourth year PhDs, to help them in their transition to work in academia or private sector. Of the 33 Urbanism PhD candidates who received their doctorate diploma during the review period, 65 per cent are currently working in the academic sector, 28 per cent work in private consultancy firms, while 6 per cent work for government agencies.

Starting year	ENROLMENT			SUCCESS RATE								Total graduated		Not yet finished		Discontinued	
	Gender			Finished													
	Male	Female	Total	≤ 4Y	≤ 5Y	≤ 6Y	≤ 7Y										
2006	0	3	3	0	0%	0	0%	0	0%	1	33%	1	33%	1	33%	1	33%
2007	3	5	8	0	0%	2	25%	4	50%	5	63%	5	63%	1	13%	2	25%
2008	3	4	7	0	0%	0	0%	2	29%	3	43%	3	43%	3	43%	1	14%
2009	3	10	13	1	8%	2	15%	2	15%	3	23%	3	23%	8	62%	2	15%
2010	2	3	5	0	0%	1	20%	1	20%	1	20%	1	0%	4	0%	0	0%
2011	5	0	5	1	20%	2	40%	2	40%	2	40%	2	40%	0	0%	3	60%
<b>Total</b>	<b>16</b>	<b>25</b>	<b>41</b>	<b>2</b>	<b>5%</b>	<b>7</b>	<b>17%</b>	<b>11</b>	<b>27%</b>	<b>15</b>	<b>37%</b>	<b>15</b>	<b>37%</b>	<b>17</b>	<b>41%</b>	<b>9</b>	<b>22%</b>

TABLE 6.5 Length of PhD candidacies and success rate of the PhD programme

## Self-reflection

Urbanism is now without doubt a research-led department that gives equal attention to academic and social partners. The weaknesses identified in the 2010 assessment have been largely overcome, but have been replaced with new challenges, notably concerning the effective management and steering of a more successful research programme. The Urbanism programme continues to perform particularly well in 'relevance to society' with extensive and effective interrelations with many stakeholders. We have also good progress on research quality with a substantial improvement on outputs in the last six years. Viability is strong despite a competitive research environment.

### Research quality

For the main indicator of quality, academic publication, the programme has achieved striking increases in both quantity and quality of peer-reviewed papers, indicating real strength-in-depth in specialisms and crosscutting themes. There has been a very substantial increase in external research grant income including successful proposals to the national research organisation (NWO), EU 7<sup>th</sup> Framework Programme, Horizon 2020, the EU Joint Programming Initiative, the European Research Council, and others. Actions on PhD candidate selection and monitoring have improved completion rates, and a number of PhD dissertations have proved to be very popular downloads.

Urbanism's high reputation for research quality is confirmed by the decisions of international research organisations to host major prestigious events at TU Delft, including the Regional Studies Association, the Association of European Schools of Planning, and the Annual Geo-information conference. These and other indicators demonstrate a step change in research quality since the 2010 assessment. Future progress will be made as set out in our strategy.

### Relevance to society

Urbanism is making an outstanding contribution to critical challenges in the Netherlands and abroad. We are working in concert with government, the private sector and civil society actors to shape understanding and policy-making at all levels from Delft Municipality to the EU institutions. The sponsorship of chairs of Design and Politics and Van Eesteren play a particularly important role in connecting Urbanism to government and citizens. The extensive outreach programme of Urbanism of curatorships, conferences, seminars and publications are targeting end-users nationally and internationally, including for example, two curatorships at the 2014 Venice Biennale. Professors are assisting with setting research agendas steering research funding through advisory posts in government and research programmes, and key positions in practice. The extent and depth of engagement and outreach with society in many forms continue the core strengths of the Urbanism Programme. For the future we will be continuing to work closely with local organisations including local municipalities, and in international knowledge networks that bring academic and social actors together.

### Viability

There is no doubt that the significance of 'urbanism' in government has fallen in Europe in the wake of neoliberal politics and austerity policies. Nevertheless, the demand for urbanism research and education remains strong in the Netherlands and more especially abroad. We expect demand to continue but with shifting attention to new challenges, such as the risks arising from climate change and conflicts arising from competition for scarce territorial resources. We will also seize new opportunities arising from the potential of innovative technologies and the demand for more adaptable planning models. The Urbanism Programme is very well placed to respond to new research needs in cooperation with partners.

## SWOT analysis

### STRENGTHS

- Distinctive combination of design, planning and technology disciplines in the 'Dutch model'.
- Deep experience and capability in international research collaboration.
- Well-established collaboration between academics and practitioners.
- Critical mass of research staff willing to collaborate across disciplines.
- Wide and balanced output of publications – academic, professional and popular.
- Rapidly growing portfolio of major externally funded research projects.
- Continuing demand from high-quality applicants for master's and doctoral studies.
- Excellent accommodation.

### WEAKNESSES

- Few women in senior positions.
- Relatively large number of themes vs the cohesion of the overall urbanism programme.
- Lack of clarity about research of truly international excellence.
- Not all staff experienced yet in peer-reviewed publication and writing research proposals.
- Continuing, if reducing, backlog of PhD candidates.
- Limited capacity for supervising PhD candidates.
- Limited supervisor–PhD candidate collaboration on publications.
- Emerging demands and gaps in research project management skills and support services.
- Accommodation constraints as programme expands.

### OPPORTUNITIES

- Global trends in urbanisation demand knowledge and expertise in urbanism.
- Potential for developing underpinning cross-cutting theory on urbanism.
- Continuing research calls at national, EU and global levels on urbanisation.
- Wide network of national and international partners that bring opportunities to urbanism.
- Strong strategic alliances in the Netherlands and internationally.
- Collaboration with other departments and faculties including OTB.

### THREATS

- Neoliberal policies reducing the demand for research on urban design, urban landscape and planning.
- Reduction in funding sources and increasing competition for funds.
- Potential for fragmentation of overall programme and direction.
- Possible fragmentation of effort as researchers pursue limited funding sources.
- Few opportunities for staff progression in TU Delft and possible loss of younger capable researchers.
- Difficulty of recruiting senior staff in urbanism who meet our expectations in terms of research and practice experience.
- Staff with similar expertise and interests dispersed across different departments.

# IMBE

## Innovations in Management in the Built Environment

Programme leaders:

Hans Wamelink (2010-2015)

Hans de Jonge (2010-2015)

172 Ellen van Bueren (2016 -)

SKG Praktijkcongres with Hans de Jonge and  
Friso de Zeeuw sitting in the first row



# 7 Innovations in Management in the Built Environment

## 7.1 Scope

The programme stimulates and evaluates innovation in management in the built environment by supporting decision making and interaction between all stakeholders and actors involved in the initiation, design, construction, and development or redevelopment of the built environment. Innovations in Management in the Built Environment (IMBE) promotes an integrated view of management processes in the built environment that covers:

- all stages of the lifecycle (initiative, development, realisation and use), stressing continuity and adaptability;
- the different aspects and actors involved (clients, users, designers, engineers, policymakers, developers, contractors, etc.), towards the integration of actions, information and products;
- the relevant scale and abstraction levels (from urban planning and portfolio management to construction logistics and workplace management) in a coherent background to human actions and activities.

The aim of this programme is to develop scientific insights and new solutions on the basis of a wealth of knowledge and tools drawn from a wide spectrum of disciplines. These include public administration, strategic management, economics, law, mathematics, sociology and psychology, in addition to design and engineering. IMBE also addresses a social necessity: the built environment is a major though diffuse area of large investment that has yet to achieve its potential in terms of spatial, functional and technical quality, cost effectiveness and sustainability, as indicated by current vacancy rates in real estate, failure rates in construction, high cost relative to performance, etc. This makes it necessary to incorporate the interests, ambitions and constraints of the various stakeholders, and to unite products and processes of development and redevelopment towards new multidisciplinary approaches.

To achieve this, IMBE analyses:

- performance requirements, goals and constraints; ways of adding value through real estate; successful and sustainable real-estate strategies (product-oriented research);
- the planning, briefing, design, construction, management and redevelopment of the built environment (process-oriented research).

Research questions derived from the above feed the study of innovative decision-making solutions for the management in the built environment at all stages of the lifecycle. Such solutions:

- contribute to the best possible alignment of the supply of relatively static real estate and dynamic market demand for up-to-date buildings, infrastructure and public space;
- promote and facilitate cooperation, innovation and integration in the planning, design and construction of buildings and urban areas.

IMBE	2010		2011		2012		2013		2014		2015	
	Nr.	FTE										
Scientific staff	31	9,8	29	9,4	29	8,9	25	7,9	25	7,8	27	8,6
Researchers	10	5,1	12	4,5	10	4,5	14	6,1	14	5,7	14	5,0
PhD candidates	13		12		14		16		14		10	
<b>Total research staff</b>	<b>54</b>	<b>14,8</b>	<b>53</b>	<b>13,9</b>	<b>53</b>	<b>13,4</b>	<b>55</b>	<b>14,0</b>	<b>53</b>	<b>13,5</b>	<b>51</b>	<b>13,6</b>
Visiting fellows	28		20		17		23		22		19	
<b>Total staff</b>	<b>82</b>	<b>14,8</b>	<b>73</b>	<b>13,9</b>	<b>70</b>	<b>13,4</b>	<b>78</b>	<b>14,0</b>	<b>75</b>	<b>13,5</b>	<b>70</b>	<b>13,6</b>

TABLE 7.1 Research staff (composition of the research unit)

IMBE	2010	2011	2012	2013	2014	2015
Refereed articles	0	3	6	7	11	26
Non-refereed articles	6	9	3	0	0	0
Book	11	10	9	7	4	1
Book chapters	26	22	22	11	10	9
PhD theses	6	3	2	1	3	0
Conference papers	15	27	11	15	30	28
Professional publications	48	63	26	20	24	33
Publications aimed at the general public	1	3	6	6	7	5
<b>Other Research Output:</b>						
Book reviews	2	1	0	0	1	1
Appearances on radio or television	0	0	4	5	7	8
Internal reports, lectures, posters, datasets	14	19	12	31	28	37
External reports	6	12	8	17	18	7
Editorships of books	6	7	5	4	3	6
Editorships of journals	0	1	0	2	1	2
<b>Total other Research Output</b>	<b>28</b>	<b>40</b>	<b>29</b>	<b>59</b>	<b>58</b>	<b>61</b>
<b>Total publications</b>	<b>141</b>	<b>180</b>	<b>114</b>	<b>126</b>	<b>147</b>	<b>163</b>

TABLE 7.2 Main categories of research output

IMBE	2010		2011		2012		2013		2014		2015	
	K€	%										
Direct funding	1.090	50%	1.082	46%	923	54%	735	43%	775	43%	840	50%
Research grants	-	0%	-	0%	-	0%	-	0%	128	7%	63	4%
Contract research	697	32%	830	36%	606	36%	251	15%	202	11%	75	4%
Own contribution	-	0%	101	4%	-	0%	-1	0%	-61	-3%	-36	-2%
Other	383	18%	320	14%	174	10%	705	42%	776	43%	747	44%
<b>Total funding</b>	<b>2.171</b>	<b>100%</b>	<b>2.333</b>	<b>100%</b>	<b>1.703</b>	<b>100%</b>	<b>1.691</b>	<b>100%</b>	<b>1.820</b>	<b>100%</b>	<b>1.689</b>	<b>100%</b>
Personnel costs	-1.725	94%	-1.653	93%	-1.534	95%	-1.224	96%	-1.356	91%	-1.370	96%
Other costs	-101	6%	-115	7%	-89	5%	-50	4%	-130	9%	-62	4%
<b>Total expenditure</b>	<b>-1.826</b>	<b>100%</b>	<b>-1.768</b>	<b>100%</b>	<b>-1.622</b>	<b>100%</b>	<b>-1.274</b>	<b>100%</b>	<b>-1.486</b>	<b>100%</b>	<b>-1.432</b>	<b>100%</b>
<b>Result</b>	<b>345</b>		<b>565</b>		<b>81</b>		<b>417</b>		<b>334</b>		<b>257</b>	

TABLE 7.3 Funding (research unit's financing structure)

## Strategy

IMBE aims to continue being a highly qualified multidisciplinary research group by continuously reflecting on the research programme and its results. Internally, this calls for measures that improve synergy: colloquia, working groups and working papers. The working group on Circular Economy is indicative of such measures. Externally, IMBE has been strengthening its scientific profile and contacts by increasing the number of journal papers in its output, while continuing its presence at scientific conferences and on the boards of international organisations like ERES, Corenet and CIB. Similarly, contacts with practice through seminars, professional publications and digital media remain a priority both in terms of utilisation of research results (valorisation) and for the identification of emerging societal and professional issues. The latter also involves participation in joint bodies that formulate research priorities and develop national or regional research plans, for example AMS (Amsterdam Institute for Advanced Metropolitan Solutions), as well as joint ventures with public and private partners to develop platforms and communities that promote the research goals of IMBE, such as the Foundation for Knowledge of Urban Area Development (SKG) and the Foundation for Public Procurement (Opdrachtgeversforum), both of which are discussed below.

The strengthening of IMBE's scientific profile has already borne its first fruits in the form of research grants from national grant organisations (NWO, STW, AMS) and H2020 European grants (as research partner) and an increase in the number of foreign PhD candidates. Further improvement of funding performance is a key element in the strategy of IMBE. It entails the consolidation of research activities into a compact number of multidisciplinary topics, which will allow us to respond to emerging societal needs that require integrated approaches. Two topics form focal areas of IMBE research:

- 1 adaptive reuse of the existing built environment, from the scale of building materials to the urban scale, including attention to reuse and recycling towards a circular built environment;
- 2 integration of processes and information on building products, buildings and areas to support inclusive decision making that actively connects relevant actors, disciplines and spatial dimensions (object, stock, area and portfolio). This includes the development of theoretical and methodological underpinnings of management practices for the built environment, as in 'the project design school' approach currently under development for design and construction management.

Both topics are intertwined with contemporary societal challenges, such as the transition to a circular economy (CE), namely the transition to renewable energy and resources in the built environment, utilising our lifecycle understanding of products and processes, including the use of big data and building information modelling (BIM) to identify, evaluate and control opportunities in existing and emerging AECO (architecture, engineering, construction and operation) practices.

Addressing societal needs involves extending the scientific basis of IMBE, in particular through alliances with research groups from other areas, such as social sciences that study the same phenomena and engineering sciences that offer technological solutions. These alliances improve the quality of our data, analyses and management approaches, and create more opportunities for research grants both nationally and internationally. In 2010–15, we worked on national alliances through interuniversity thematic collaborations in the fields of urban solutions (AMS), urban big data (LDE BOLD Cities) and sustainability (LDE Centre for Sustainability). These fields directly support the first of our core topics and indirectly the second one. These collaborations have already resulted in two grants, which serve as stepping stones towards further development.

Existing contacts with practice will also be included in this direction, as indicated by the funding of a chair in the Department of Management in the Built Environment, the home of IMBE, by the Foundation for Public Procurement.

Increasing research funding from European and other international sources requires the careful reconsideration of investments in existing contacts, networks and platforms, and the development of new ones that address current societal and scientific priorities. A prerequisite to such cooperation is a further increase in the number of scientific publications through which we can present our results and our ambitions, as well as substantiate research proposals for large grants. A second prerequisite is gaining experience of the coordination of large research proposals. So far we have been successful as research partners in proposals coordinated by others. Organising proposals from our own point of view is a key skill that needs to be developed. The submission of a Marie Curie proposal, which is to be re-submitted in 2017, is a step in this direction.

#### 7.4

### Targets

In the period 2010–15, the main targets of IMBE were to:

- maintain a high societal impact through strong relations with relevant organisations (clients, professional bodies, companies, etc.);
- improve the focus of the research programme through internal consolidation and integration;
- improve the international exposure and positioning of research themes by means of improved visibility in networks like ERES and CIB;
- increase the number of scientific publications;
- increase the share of national and European grants in research funding (long-term projects);
- increase the number of PhD students.

The results have been encouraging with respect to all targets but one (the number of PhD students), to the degree that we can assert not only that these targets have been reached but also that we can follow the same strategy towards a higher goal: to make IMBE a major international research presence associated with strong connections to innovative practice as well as clear, powerful approaches with sound methodological foundations. Prior to the credit crunch this was roughly the position in the national context, resulting in healthy streams of funding from the AECO industry. The drying-up of these streams, changes in university policy and an increase in our own scientific ambition have led to the definition of an internationally oriented strategy and corresponding targets, which can now be adapted as follows:

Qualitative targets concerning research themes:

- *Adaptive reuse*: consolidation of existing knowledge, especially critical appraisals of Dutch cases, into scientific publications that analyse existing problems and approaches and outline new research subjects (again including PhD topics) with links to:

- CE: principles and methods not yet present in AECO (knowledge and technology transfer);
  - design and construction: connections to AECO practices and business models;
  - methodical underpinnings of integration and collaboration in AECO.
- *Integration and collaboration*: present a theoretical and methodical framework of innovative management in the built environment (consisting of two main parts, provisionally entitled 'alignment theory' and 'project design school') and develop prototypical tools and environments for key processes and products, with emphasis on the inclusive interaction between stakeholders or actors and the overall performance of the built environment, towards decision making and business structures for AECO in the 21<sup>st</sup> century. This target refers firstly to IMBE researchers and aims at the further consolidation of existing knowledge towards a comprehensive and coherent basis for their research: it should stimulate an increase in the number of scientific publications (especially jointly authored) and a closer relation of IMBE products to current scientific and societal challenges. Secondly, this target concerns the wider scientific community: making it aware of what the IMBE approach has to offer involves developing platforms for the dissemination and utilisation of research results, for example through the organisation of international symposia and conferences, and the coordination of grant proposals with an educational character, both for PhD students and for existing practitioners (lifelong learning). Special attention will be paid to the relation of both themes with circular economy: to describe and explain how AECO works, where it connects to CE ideas and how (e.g. by relating urban mining to construction and demolition waste processing) and where improvements are possible in AECO processes and products; develop research proposals (including PhD topics) that address short-term priorities, in particular concerning:
    - the role of public stakeholders such as local authorities as policymakers and problem owners (as with waste);
    - process improvements in AECO, for example through information sharing and use of advanced technologies like robotics.

The research products in the area of CE should be more than scientific and professional publications: they should be platforms that bring together public and private partners ranging from demolition and waste processing firms to institutional owners and local authorities, including AECO professionals like architects and engineers, to undertake proof-of-concept projects funded by national or European grant organisations and implemented in Dutch urban settings. Establishing a critical mass for the contribution of IMBE is a clear priority for continuing research into this topic.

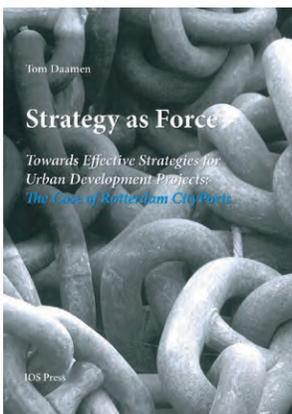
Quantitative and operational targets:

- further increase in the number of scientific publications, showcasing research done in IMBE and its methodology;
- further increase in national and EU grants in research funding, focused on our research themes;
- increase in the number of PhD students through the improved international networks and visibility of IMBE.

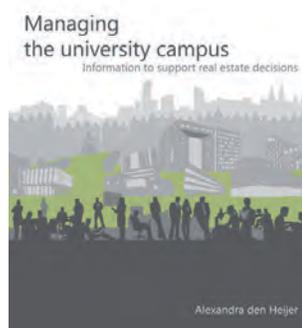
The main environmental change for IMBE in the past six years has been the transition from one source of funding to another: while the strong relation with the AECO industry remains, we have been looking for indirect research funding (national and European grants), as opposed to the previous emphasis on contract research funding. As management presupposes design, engineering and other activities, this also meant closer partnerships with other research programmes in the faculty, which remain ad hoc but are developing along recognisable paths.

These paths need to be expanded beyond the confines of the faculty, because while the built environment is the cause of many societal problems and a primary recipient of technological innovation, neither national nor European research calls address AECO directly. By becoming a conduit of connections between societal problems and technological innovation, we can guide research towards more effective directions that take into account the current organisation of the industry and its potential for improvement. In particular, questions relating to CE can give a new impetus not only to new approaches to designing, constructing and operating buildings, but also to the sustainable evolution of the existing building stock.

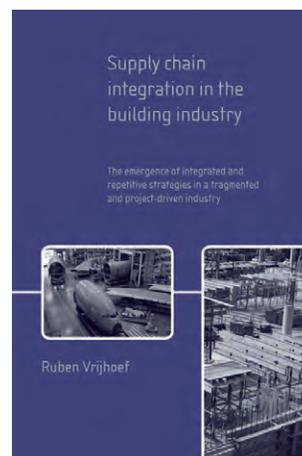
Consequently, IMBE has to sensitise relevant stakeholders, such as real-estate owners and operators, contractors and public-policy makers, as well as communities of users, to the potential of the management methods and tools we offer. Of course, this has little appeal at the level of theory, so IMBE has to address actual problems and help with their solution by applying knowledge from research. To do so, we are connected to existing initiatives, platforms and incubators, such as AMS and the TUD group working on the earthquake issues caused by fracking in the Groningen area. A non-neglectable constraint is that developing expertise and tools for such problems while also working on theoretical and methodological aspects, can be a strain on the human resources of IMBE.



PhD thesis Tom Daamen



PhD thesis Alexandra den Heijer



PhD thesis Ruben Vrijhoef



PhD thesis Esra Bektas



*International conference MISBE2011, 20 June 2011 - 23 June 2011, location: Beurs van Berlage, Amsterdam*

## Performance indicators

ASSESSMENT DIMENSIONS	QUALITY DOMAINS	
	RESEARCH QUALITY	RELEVANCE TO SOCIETY
ACTIVITIES, ORGANISATION, FACILITIES/ASSETS, OUTPUT	<p><b>Activities</b></p> <ul style="list-style-type: none"> <li>• Ambition level and impact of research projects</li> <li>• Organisation of international conferences</li> </ul> <p><b>Organisation</b></p> <ul style="list-style-type: none"> <li>• Multidisciplinary team composition</li> <li>• Participation in academic networks</li> </ul> <p><b>Facilities/assets</b></p> <p>n/a</p> <p><b>Output</b></p> <ul style="list-style-type: none"> <li>• Articles in peer-refereed scientific journals</li> <li>• Academic books</li> <li>• Academic book chapters</li> <li>• PhD theses</li> <li>• Conference papers</li> </ul>	<p><b>Activities</b></p> <p>Editorship of professional journals</p> <ul style="list-style-type: none"> <li>• Role in practice and policymaking</li> <li>• Advisor/election to professional associations</li> </ul> <p><b>Organisation</b></p> <ul style="list-style-type: none"> <li>• Research centres and platforms</li> <li>• Participation in 'golden triangle' networks</li> </ul> <p><b>Facilities/assets</b></p> <ul style="list-style-type: none"> <li>• Valorisation through digital media</li> </ul> <p><b>Output</b></p> <ul style="list-style-type: none"> <li>• Articles in professional journals</li> <li>• Professional books</li> <li>• Media presence</li> </ul>
USE	<ul style="list-style-type: none"> <li>• Citations</li> <li>• H-index</li> </ul>	<ul style="list-style-type: none"> <li>• Attendance at IMBE meetings/conferences/seminars</li> <li>• Visibility and use of websites</li> <li>• Change of public or private policies, regulations, organisations, procedures, etc.</li> </ul>
MARKS OF RECOGNITION	<ul style="list-style-type: none"> <li>• Invitations to important conferences and seminars</li> <li>• Election to academic or academic professional associations</li> </ul>	<ul style="list-style-type: none"> <li>• Prizes and awards</li> <li>• Advisor/election to professional associations</li> </ul>

TABLE 7.4 Selected output indicators

## 7.7

## Results

## 7.7.1

## Activities

The following research projects indicate the ambition level and impact intentions of IMBE research:

**FuturaA: Future Value Chains of Architectural Services:** ([www.future-architect.nl/en](http://www.future-architect.nl/en))

The futurA project, initiated and led by Prof. Hans Wamelink and Dr Leentje Volker, analyses existing revenue and organisational models for the architectural profession and develops new ones that take into account the changing circumstances of the 21<sup>st</sup> century. This four-year project – a collaboration with Radboud University Nijmegen, the BNA (Royal Institute of Dutch Architects) and eight architecture companies – is one of the 23 projects that have been initiated in the creative industry top sector by NWO (Netherlands Organisation for Scientific Research). The aim of the project is to discover changes in the work field of the architect that have been caused by social shifts and the financial crisis and to uncover possible future opportunities.



*fururA-consortium with in the front row dean Karin Laglas (right from the centre), Hans Wamelink (right) and Leentje Volker (left)*

The revenues of architectural firms have drastically declined since the beginning of the economic crisis. For a large part this has simply been caused by a decreasing demand for new buildings, but architects are also struggling to adapt to their shifting roles and new responsibilities.

Earlier research shows that architects are now taking on new roles more often than before. For example, they can also act as system integrators, product developers, process managers or network coordinators. FuturA is defining the future playing field of the architect. It aims to support a new positioning within the professional relationship with clients, contractors and users. Changing revenue and organisational models demand different skills of architects. If one aspires to become a product developer, for example, one has to be capable of conducting market research. And anyone who

wants to become a “starchitect” needs to be able to serve international markets. Today, even traditional architects cannot afford to limit themselves only to designing. Since most architectural firms are fairly limited in size, employees are expected to have basic competences in management, entrepreneurship and writing business plans.

The primary goal of futurA is to design economically profitable and socially sustainable organisational networks for the architectural field. To do so, current and future relationships between client (the traditional buyer), architect (the traditional service provider) and user are analysed. The results contribute to a healthy architectural service sector by identifying manageable revenue and organisational models that are focused on the future service delivery of architects and the necessary competences to deliver those services. Besides recommendations for the education of architectural students, futurA provides new educational products to professionalise existing architectural firms.

The futurA project runs two parallel PhD programmes at TU Delft (Faculty of Architecture and the Built Environment) and Radboud University Nijmegen (Faculty of Business Administration). Together with the two universities, BNA, De Zwarte Hond, EGM architects, IAA Architects, JHK Architects, Rothuizen Architects, Ballast Nedam, Havensteder and the Central Government Real Estate Agency are involved as consortium members. In five ongoing studies, current governance and business models of architectural service delivery are being analysed, and trends and market developments in architecture are being identified. The results will be connected to scenarios to develop new network-based revenue and organisational models

#### REPAiR: REsource Management in Peri-urban Areas: Going Beyond Urban Metabolism

The H2020 Research & Innovation Action project REPAiR will develop and implement a tool to help local and regional authorities reduce waste flows in peri-urban areas. A shift towards a more circular economy is crucial to achieving more sustainable and inclusive growth. The REPAiR project will provide a geodesign decision support environment (GDSE) that will assist local and regional authorities to reduce waste flows by helping them create integrated spatial development strategies that are specific to the place at hand and are transdisciplinary and eco-innovative. The GDSE will be developed and implemented in “living labs” in six metropolitan areas, namely Naples, Ghent, Hamburg, Pecs (Hungary), Lodz (Poland) and Amsterdam.

<http://www.tudelft.nl/en/business/container-zakelijk/circular-economy-project-repair-receives-5-million-from-h2020-programme/>

#### Smart campuses

Dr Alexandra den Heijer, Monique Arkesteijn and Prof. Hans de Jonge have been studying campus management since 1995. From the very first project, the goal of campus management research has been to generate decision-support information for universities in practice and to use the insights to build real estate management (REM) theory. Since 1999, all 14 Dutch universities have been actively involved in REM research and have co-funded a long series of research projects, collectively building up a knowledge base with the campus research team, led by Associate Professor Alexandra den Heijer.

In the period 2010–15, four projects worth a total of over €500,000 were acquired and executed or partially executed for and with Dutch and European campus managers. In 2011, Alexandra den Heijer published her dissertation “Managing the university campus”, which has been an academic bestseller with more than 1500 printed copies and a popular eBook version. This also enlarged the international campus network: more than 100 lectures were delivered to international groups at Delft and abroad.

The following six subjects have been explored in the past five years:

- 1 the campus and the knowledge city, based on case studies in the PhD project "Technology campuses and cities" of Flavia Curvelo Magdaniel and also in close collaboration with the municipality of Delft;
- 2 decision-support tools on campus, with preference-based strategies and smart campus tools as PhD research projects of Monique Arkesteijn and Bart Valks;
- 3 the European campus, with researcher George Tzovlas, resulting in another successful book published in 2014;
- 4 the sustainable campus, which was furthered explored by Naif Alghamdi in his PhD research and by the Climate KIC project "Façade Leasing" with colleagues at Architectural Engineering + Technology;
- 5 the changing academic workplace, with researcher Bentinck, related to workplace research of the Centre of People & Buildings (CfPB) and Van der Voordt;
- 6 Campus NL, based on benchmark studies of all 14 Dutch campuses and more than 60 university projects that have been collected over the past decade.

<http://managingtheuniversitycampus.wordpress.com>

#### MISBE2011: Management and Innovation for a sustainable Built Environment

This well-attended international conference was organised by Hans Wamelink, Rob Geraedts and Dr Leentje Volker, under the auspices of Working Commissions W55, W65, W89 and W112 of the International Council for Research and Innovation in Building and Construction (CIB), together with the European Network for Housing Research (ENHR) and the association of European Schools of Planning (AESOP).

<http://misbe2011.fyper.com/>

#### Practice

All professors have strong connections with practice. For example, Prof. Hans de Jonge is CEO of the Brink Groep, a major consultancy and management firm in real estate and construction, and also performs a number of advisory and supervisory roles in the industry. Prof. Friso de Zeeuw is director of new markets for a large developer, and Prof. Monika Chao-Duivis is the managing director of the Institute for Construction Law and a member of the Court of Arbitration for Construction.

#### 7.7.2

##### Organisation

Our integrated knowledge of management in the built environment makes us a highly valued partner in research collaborations with academic, public and private stakeholders, positioning the group strategically in the process of formulating research:

#### Leiden–Delft–Erasmus collaborative centre on BOLD cities

Prof. Ellen van Bueren is a board member of Leiden–Delft–Erasmus collaborative centres on BOLD Cities (on the meaning of big open and linked urban data for citizens and decision-makers) and on Sustainability (with a focus on the circular economy, strategically aligned with EIT Raw Materials).

### AMS

Ellen van Bueren is principal investigator at the Amsterdam Institute for Advanced Metropolitan Solutions (AMS). AMS is a public-private collaboration between TU Delft, Wageningen University Research and the MIT as core academic partners, with TNO (Dutch Applied Research Organisation), Amsterdam Smart City, The Waag Society, City of Boston, KPN, Accenture, Alliander, Cisco, ESA, IBM, Shell and Waternet. Its principal aim is to formulate research on urban governance and management with respect to the urban challenges of sustainability and quality of life, including resource and food security, mobility and logistics, water and waste management, and health and wellbeing.

Research centres and platforms with close ties with IMBE include:

### Center for People and Buildings

The Center for People and Buildings (CfPB) is a foundation that was established in 2001 by the Dutch Government Buildings Agency, TU Delft (Management in the Built Environment department) and ABN AMRO bank. CfPB is a knowledge centre specialising in the relations between people, work and work environments. It collects, develops and provides knowledge about accommodation issues. This knowledge helps organisations make informed decisions regarding new work environments, and with the process that leads to those decisions. IMBE (especially through Dr Theo van der Voordt) has collaborated with CfPB in many projects. Prof. Hans de Jonge is chairman of the foundation's board.

CfPB focusses on the accommodation of organisations like government and other public institutions or companies with complex needs, for example educational facilities and laboratories: it views accommodation as a key issue in the policy and management of an organisation, one that is integral to business operations and critical for satisfaction and performance.

<https://www.cfpb.nl/en/>

### Public Commissioning client forum

The "Opdrachtgeversforum" is a knowledge network on procurement in construction that brings together all major public clients in the Netherlands towards improving the quality of the built environment through better support for the role of clients. Since 2013, it has funded a chair in public procurement commissioning, which is held by Prof. Marleen Hermans.

<http://www.opdrachtgeversforum.nl/>

### SKG

SKG (Stichting Kennis Gebiedsontwikkeling) is a foundation for the development of knowledge on urban area development. It was established in 2006 by various public authorities, including the Ministry of the Environment and Infrastructure, and various private actors involved in area development. Agnes Franzen, who has been director since 2009, has encouraged other public and private stakeholders in urban area development to commit to this knowledge network. SKG funds the practice-oriented chair in Urban Area Development, which is held by Prof. Friso de Zeeuw. The foundation has had a significant influence on Dutch professional practice and public policy by bringing together 20 public and private organisations so as to improve collaboration between them and promote sustainable area development.



SKG: Praktijkcongres gebiedsontwikkeling

In the past three decades, area development (gebiedsontwikkeling) has emerged as a distinct category in Dutch spatial policy and practice, combining language and concepts from urban planning, property development and related professions. Its emergence runs parallel to similar integrative, area-based planning and development efforts that have been observed throughout north-western European practices since the 1990s. The fundamental drivers of these efforts lie in the broad social and economic trends in this part of Europe, such as changing compositions and increasing numbers of households, the advancing IT and service sectors in cities, the revaluation of and growing demand for urban amenities, and the increased internationalisation of and competition between urban regions. These trends have triggered formidable growth in urban residential and office markets, and have led to high demands for all kinds of infrastructure, amenities and public space inside and between Dutch cities.

SKG is active at the interface of science and society. Its mission is to contribute to the development, exchange and dissemination of knowledge of the emerging discipline of integrated area development, by focusing on developing 'good' procurement, by identifying and alleviating institutional barriers, and through co-learning. In addition, it aims to influence the present and future agenda of public and private decision-makers in the built environment. Three classes of activities support the pursuit of this mission:

- the funding of the chair in Urban Area Development at TU Delft, part of the Innovation in the Built Environment research programme. The part-time chair is held by Prof. Friso de Zeeuw, who until May 2016 was director of BPD property development;
- the organisation of workshops, seminars, and online and face-to-face tutorials for practitioners, often in close collaboration with other practitioners ("the GO Academy");
- the dissemination of knowledge and best practices on urban area development by hosting, organising and delivering the content, and managing the website <http://www.gebiedsontwikkeling.nu> ("area development.now"), which attracts an average of 10,000 unique visitors per month.



GO - Gebiedsontwikkeling in beweging



Routekaart Innovatieakkoord Bouw

These activities have made SKG a central platform in the field. Its project on 'Ontslakken' (a concept developed by Prof. Friso de Zeeuw that calls for the removal of institutional barriers that slow down decision-making) have led to the establishment of a taskforce on this issue at the Ministry of the Interior.

<https://www.gebiedsontwikkeling.nu/>

#### Platform Ketensamenwerking in de bouw

The complexity of construction processes has increased substantially in recent years. Specialisation and industrialisation have led to longer chains with more interactions. Together with the Association of Dutch Housing Corporations ([www.aedes.nl](http://www.aedes.nl)) and the Dutch Association of Contractors ([www.bouwendnederland.nl](http://www.bouwendnederland.nl)), IMBE has formed an alliance aimed at helping contractors to implement principles of supply chain integration.

### 7.7.3

#### Facilities/assets

##### Urban Development Management Knowledge Portal

Gebiedsontwikkeling.nu is a website operated by SKG. Launched in November 2010, Gebiedsontwikkeling.nu is an independent platform that acts as a knowledge network for professionals, researchers and students involved in area development. Knowledge exchange between science and practice is central, as is boosting collaboration between public and private partners. Unlocking scientific knowledge leads to concrete suggestions and insight into new strategies. The platform attracts over 10,000 unique visitors per month; its Twitter account has more than 4,500 followers and its LinkedIn-group has 1,350 members.

<https://www.gebiedsontwikkeling.nu/>

## 7.7.4

## Output

Representative examples of IMBE publications are:

- 7 Agnes Franzen, Fred Hobma, Hans de Jonge, Gerard Wigmans (eds). *Management of Urban Development Processes in the Netherlands – Governance, Design, Feasibility*, Amsterdam (Techne Press), 2011, 247 pp. (<http://www.technepress.nl/publications.php?id=51>)
- 8 Den Heijer, A. *Managing the university campus: Information to support real estate decisions*. PhD dissertation. Supervisors: Prof. H Priemus and Dr DJM van der Voordt. Eburon Academic Publishers, Delft, 2011, 432 pages. ISBN 9789059724877.
- 9 Volker, L. (2012). *Procuring Architectural Services: Sensemaking in a Legal Context*. *Construction Management and Economics*, 30(9), 749-759 (<http://www.tandfonline.com/doi/abs/10.1080/01446193.2012.667138>)
- 10 Daamen, T.A., Vries, I. (2013). *Governing the European port-city interface: institutional impacts on spatial project between city and port*, *Journal of Transport Geography*, 27, 2013, pp. 4–13
- 11 Koutamanis, A. (2013). *Computer-mediated briefing for architects*, Hershey, USA: IGI Global (<http://www.igi-global.com/book/computer-mediated-briefing-architects/77391>)
- 12 Wilkinson, S.J., H. Remøy and C. Langston (2014). *Sustainable Building Adaptations*. Oxford, Wiley-Blackwell.
- 13 Squires, Graham, & Heurkens, E. (2015). *International Approaches to Real Estate Development*. Routledge, UK.
- 14 Wamelink, J.W.F., J.L. Heintz (2015). *Innovating for integration: Clients as drivers of industry improvement*. In: F Orstavik, ARJ Dainty, C Abbott (eds.), *Construction innovation*. Wiley-Blackwell, Oxford, UK, 2015, ISBN 9781118655535, pp. 149–164.

## 7.7.5

## Use

Most senior IMBE researchers have an h-index in the area of 3–8 on ResearchGate, while four are at 10–13. Their ResearchGate score are 4–12, with three at 18–28. On Google Scholar, most have an h-index of 5–10 and four are in the area of 11–17; four researchers have i10-indices of 8–15, two go over 20 and one over 30. Publications produced by IMBE researchers have been cited up to 80 times in ResearchGate and Google Scholar, with a few approaching 200–300 citations. The most popular products of the period 2010–15 have been cited 20–40 times in ResearchGate and 40–120 times in Google Scholar.

IMBE events include:

**Annual conference 'Praktijkcongres Gebiedsontwikkeling'**

<https://www.gebiedsontwikkeling.nu/?tag=praktijkcongres-gebiedsontwikkeling-2016>

The aim of this annual national conference on area development practice is to stimulate knowledge dissemination in the area of urban development management. The conferences are organised jointly with SKG and are attended by 400–600 representatives of professional and public organisations.

Influences of IMBE research on public and private parties include:

- Following negotiations that lasted a year, in June 2012, public and private parties signed a covenant on reducing the number of vacant offices in the Netherlands. IMBE made a major contribution to this success through Prof. Hans de Jonge, who chaired the negotiations (<https://www.rijksoverheid.nl/documenten/convenanten/2012/06/27/convenant-aanpak-leegstand-kantoren>).
- The development of the BIM norm of the RGVB (Central Government Real Estate Agency) was supported and evaluated by Dr Alexander Koutamanis. The BIM norm specifies which BIM information products should be delivered by the contractors of public buildings. (<https://www.rijksvastgoedbedrijf.nl/expertise-en-diensten/b/building-information-modelling/inhoud/rvb-bim-norm>)
- The Public Commissioning Maturity Model is a tool that allows public clients to evaluate the internal structure of their organisations and specify further improvements that will allow them to play a more effective role in design and construction projects (<http://www.bk.tudelft.nl/over-faculteit/afdelingen/management-in-the-built-environment/organisatie/leerstoelen/publiek-opdrachtgeverschap-in-de-bouw/onze-co-producten/>).
- The Kompaswijzer is a tool that helps clients select an appropriate project structure and contract type concerning commissioning. (<http://kompaswijzer.nl/>).
- 'Simply Better: deregulating area development' (in Dutch, Ontslakken): a development-oriented approach to legislation, regulations and initiatives reducing complexity and throughput time in procedures concerning urban planning. (<http://ontslakkengemeente.nl/wp-content/uploads/2016/09/Simply-Better-deregulating-area-development-ontslakken.pdf>)

### 7.7.6

#### Recognition

- In 2010 Prof. Hans Wamelink was elected chair of the Expert Board of the Dutch Green Building Council (<https://www.dgbc.nl/content/organisatie>).
- In 2010, Prof. Hans de Jonge was appointed Officer in the Order of Oranje-Nassau.
- In 2012, Dr Leentje Volker was nominated for the Boekman Dissertation Prize in the field of arts, culture and related policies. The prize is organised by the Boekman Foundation in collaboration with the department of Humanities of now. It is awarded every three years.
- Prof. Monika Chao-Duivis was 'Legal Woman of the Year' 2013.
- Monique Arkesteijn was appointed CoreNet Global board member in 2015. CoreNet Global is a non-profit association representing almost 10,000 executives in 50 countries with strategic responsibility for the real estate assets of large corporations. The organisation's mission is to advance the practice of corporate real estate through professional development opportunities, publications, research, conferences, designations and networking in 47 local chapters worldwide (<https://corenetglobal.org/about/tcontent.aspx?ItemNumber=21093&navItemNumber=20841&sso=1>).
- "Designing a preference-based accommodation strategy: a pilot study at Delft University of Technology" by Monique Arkesteijn, Bart Valks, Dr Ruud Binnekamp, Peter Barendse and Prof. Hans de Jonge, published in Journal of Corporate Real Estate 2015 Vol 17 2 E, has been selected by the journal's editorial team as the Outstanding Paper in the 2016 Emerald Literati Network Awards for Excellence.
- In 2015, Marina Bos-de Vos, Dr Leentje Volker and Prof. Hans Wamelink won the Paul Townsend Commemorative Best Paper Award at ARCOM 2015 (Association of Researchers in Construction Management in the UK).

## PhD programme

### Context

The level of applicants for recent PhD positions suggests that Innovation in Management in the Built Environment (IMBE) addresses key issues in AECO in a way that promises a thorough understanding and excellent training, as well as opportunities in today's demanding job market. On the other hand, IMBE subjects and approaches seem to require some experience in practice: some of our PhD candidates do not come straight from university. A corollary is that a number of PhD candidates at IMBE do their research part time, while working in industry or government. As such candidates represent a substantial source of empirical knowledge and a direct channel of valorisation, we try to accommodate their circumstances without lowering the level expected of a PhD dissertation.

### Supervision of PhD candidates internally and guidance of PhDs to the labour market

Long before the introduction of the current Graduate School for Architecture and the Built Environment (GS A+BE) regulations, the MBE department had implemented very similar rules concerning daily supervision by a key researcher in the same area, in addition to the main supervision by a professor, annual evaluations and performance indicators. Consequently, the transition to the new situation whereby all PhD candidates are subject to the rules and conditions of the faculty's Graduate School has been effortless and natural.

### Quality assurance

The combination of daily supervision, main supervision, annual evaluations and – perhaps more significantly – the preference for dissertations comprising papers submitted to scientific journals, supports the early and continuous detection of problems in the quality and direction of PhD candidates, as well as the adequacy and compatibility of supervision.

ENROLMENT	Gender			SUCCESS RATE								Total graduated		Not yet finished		Discontinued	
	Starting year	Male	Female	Total	Finished								Total graduated	Not yet finished	Discontinued		
					≤ 4Y	≤ 5Y	≤ 6Y	≤ 7Y	≤ 4Y	≤ 5Y	≤ 6Y	≤ 7Y					
2006	0	0	0	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
2007	2	1	3	0	0%	0	0%	1	33%	3	100%	3	100%	0	0%	0	0%
2008	3	1	4	1	25%	2	50%	4	100%	4	100%	4	100%	0	0%	0	0%
2009	0	0	0	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
2010	0	1	1	1	100%	1	100%	1	100%	1	100%	1	100%	0	0%	0	0%
2011	1	1	2	0	0%	0	0%	0	0%	0	0%	0	0%	1	50%	1	50%
<b>Total</b>	<b>6</b>	<b>4</b>	<b>10</b>	<b>2</b>	<b>20%</b>	<b>3</b>	<b>30%</b>	<b>6</b>	<b>60%</b>	<b>8</b>	<b>80%</b>	<b>8</b>	<b>80%</b>	<b>1</b>	<b>10%</b>	<b>1</b>	<b>10%</b>

TABLE 7.5 Length of PhD candidacies and success rate of the PhD programme

## Self-reflection

### Research quality

The 2010–15 period was one of transition and adaptation to new constraints. IMBE managed to achieve most of its targets and improved the quality of its scientific output, while sharpening its focus and laying the first promising theoretical and methodological foundations to support its long-term ambitions. The strategy followed in this period was successful, so we intend to continue with it, constantly raising the ambition level towards higher performance and adapting our themes and goals to emerging societal, scientific and technological opportunities and questions.

### Relevance to society

In addition to scientific quality, IMBE has managed to continue to pay attention to society and industry. Through professional publications and especially the knowledge centres, IMBE has connected fundamental to applied research and to valorisation, maintaining existing collaboration platforms and developing new ones. The latter are also related to new societal challenges taken on by IMBE, such as CE. The particular value of IMBE with respect to both knowledge transfer to practice and societal challenges lies in the wide spectrum within which it addresses such matters: not only from the design or technical point of view (product view) but also with respect to the processes that bring together stakeholders and actors towards inclusive, comprehensive solutions that satisfy the needs and requirements of most if not all of those stakeholders and actors. This should be seen as both an opportunity and a challenge for IMBE, the latter especially concerning resource allocation and priorities/foci in research and valorisation.

### Viability

IMBE is a management research programme within a school of architecture. This view from the inside (as opposed to management imposed on domain processes) offers advantages and opportunities, for example for wide collaboration with other AECO disciplines. In these post-credit crunch times, it is becoming increasingly evident that AECO needs to improve its business approaches to facilitate collaboration with clients, users and communities in general, by making the connection between processes and products more transparent, and by paying attention to the importance of the existing building stock (which is expected to constitute a very high percentage of the built environment in the coming decades) – all hallmarks of IMBE research. Such developments make us confident in the scientific and societal relevance of IMBE and its viability in the foreseeable future.



International conference MISBE2011, 20 June 2011 - 23 June 2011, location: Beurs van Berlage, Amsterdam

## SWOT analysis

### STRENGTHS

- Multidisciplinary approach.
- Emphasis on integration (wide scope that includes all aspects, actors and stakeholders).
- Lifecycle approach (emphasis on continuity).
- Research into management issues in correlation with AECO problems and developments, including technological ones.
- Strong connections with and relevance to society and industry: direct valorisation.
- Continuity in research themes and methods.

### WEAKNESSES

- Limited growth in PhD student numbers.
- Limited funding possibilities (multidisciplinary character can be a weakness in disciplinary calls).

### OPPORTUNITIES

- Attention to the city as the central focus of societal problem-solving and research.
- Ongoing changes in the built environment put themes on the agenda that require a multi-disciplinary approach to management issues:
  - Vacancy and reuse of existing building stock
  - Circular economy
  - Integrated development of buildings, urban environments and infrastructures.

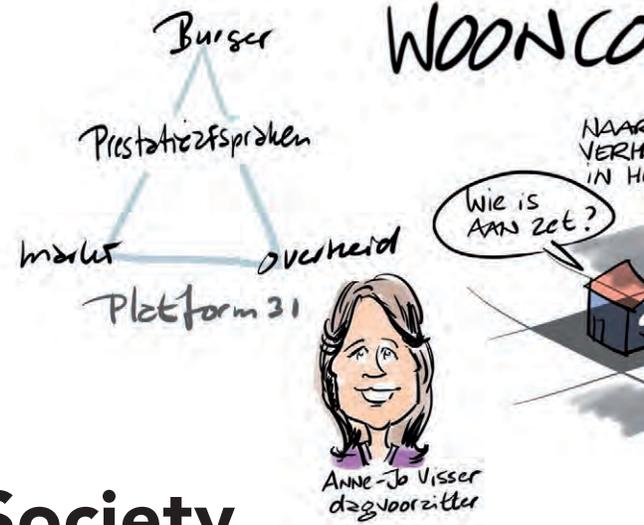
### THREATS

- Limited funding from industry (especially in comparison to before 2010).
- More competition from non-AECO disciplines for funding.

# HCS

## Housing in a Changing Society

Programme leader:  
Marja Elsinga



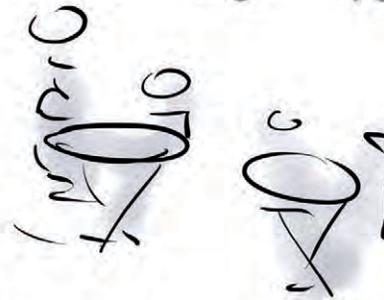
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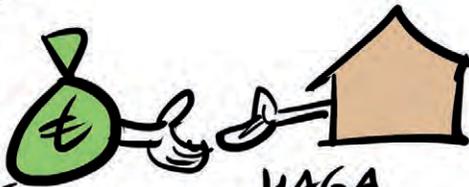


betaalbaarheid

Wij zijn  
hier gekomen  
om te  
blijven!



Erik Beets  
PATRIZIA



HAGA  
Project

STRATEGIE

VIRTUAL  
REALITY

IK ZIE DE  
STIP!



WAT IS DE  
GEZAMELIJKE STIP?  
OP DE HORIZON?

Co. Create  
business model



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EVEN EEN MARATHON

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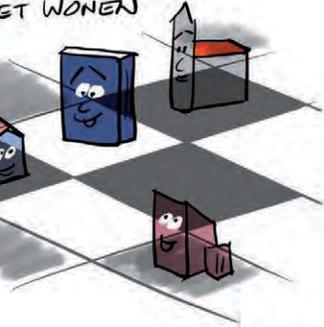


Senior Smart Living  
WOONTREND 18

# CONGRES 2015

3 NOV

DE NIEUWE  
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MET WONEN



TOEKOMST  
UW HUIS EEN ROBOT?



TU Delft PLATFORM3L



De overheid  
in zet?

WANTROUW  
Continuïteit  
EN BEREID U VOOR  
OP HEEL VEEL  
Disruptie



Hugo Priemus

Zeggenschap  
CIVIL SOCIETY

Internet of things

Winners  
Take all  
markere

A.I.  
Netwerken

Digitalisering

- Migraties komen
- Meer zeggenschap
- Het Nieuwe Wonen
- Individualisering
- Veranderend systeem woning/auto
- Bestaande woning voorraad



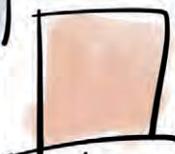
220 wie verkoop ik de

WOONBELEID  
Woonruimte  
Hypotheekgarantie  
Woningcorporaties

Huurder

Collectieve  
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Particuliere  
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Beleggers

LAADPAALRUZIE

EVEN  
MIJN STEP  
OPLADEN!



omming?

TRENDS  
Internet of things  
Deeleconomie  
A.I.  
Big DATA

o KURF. 3/11/2015

# Housing in a Changing Society

## Scope

Adequate housing is of major importance for the quality of life of occupants, for the ecological footprint, for resilient urban areas and in terms of economic assets. The research group Housing in a Changing Society deals with the question of how to achieve sufficient, sustainable and affordable housing in changing societal contexts. The objective of the group is to increase the knowledge of the role of housing in changing societies and to contribute to scientific and societal debates, solutions and education. We do so from four interrelated perspectives:

- **Market Dynamics:** studying the functioning of the housing and house building market by focussing on demand, supply and price and their interdependence (Prof. Peter Boelhouwer);
- **Governance:** focussing on policies for sufficient, affordable and secure housing and on the impacts of those policies on welfare and economic growth (Prof. Marja Elsinga);
- **Organisational Strategies:** developing and evaluating approaches to the management and redevelopment of the housing stock in order to contribute to increasing the socioeconomic and environmental sustainability of housing provision (Prof. Vincent Gruis);
- **Housing Quality:** studying the physical performances of housing – such as energy efficiency, ecological sustainability and indoor climate – and policy instruments that guarantee or improve such performance (Prof. Henk Visscher).

The research group is a unique combination of policy, finance, management and technology dimensions that aligns professional debates and innovations with consumer preferences and behaviour. We demonstrated in 2010–15 that we are able to combine scientific and societal performance in a financially sustainable way.

HCS	2010		2011		2012		2013		2014		2015	
	Nr.	FTE										
Scientific staff	11	3,1	10	3,2	12	3,5	13	3,7	13	3,5	14	4,1
Researchers	21	12,8	19	12,1	16	9,8	13	7,9	16	9,0	14	10,0
PhD candidates	12		10		12		15		16		20	
<b>Total research staff</b>	<b>44</b>	<b>15,9</b>	<b>39</b>	<b>15,3</b>	<b>40</b>	<b>13,3</b>	<b>41</b>	<b>11,6</b>	<b>45</b>	<b>12,5</b>	<b>48</b>	<b>14,1</b>
Visiting fellows	13		17		17		12		15		12	
<b>Total staff</b>	<b>57</b>	<b>15,9</b>	<b>56</b>	<b>15,3</b>	<b>57</b>	<b>13,3</b>	<b>53</b>	<b>11,6</b>	<b>60</b>	<b>12,5</b>	<b>60</b>	<b>14,1</b>

TABLE 8.1 Research staff (composition of the research unit)

HCS	2010	2011	2012	2013	2014	2015
Refereed articles	33	23	33	28	26	26
Non-refereed articles	2	1	1	3	0	0
Book	9	5	1	7	2	0
Book chapters	15	36	30	14	12	8
PhD theses	5	3	1	5	3	2
Conference papers	78	59	47	33	48	32
Professional publications	99	71	60	74	36	27
Publications aimed at the general public	59	36	80	38	55	58
Other Research Output:						
Book reviews	4	2	4	5	1	2
Appearances on radio or television	48	45	107	97	54	48
Internal reports, lectures, posters, datasets	8	8	46	74	112	115
External reports	25	46	35	33	59	46
Editorships of books	8	4	3	0	1	0
Editorships of journals	9	7	13	11	14	14
<b>Total other Research Output</b>	<b>102</b>	<b>112</b>	<b>208</b>	<b>220</b>	<b>241</b>	<b>225</b>
<b>Total publications</b>	<b>402</b>	<b>346</b>	<b>461</b>	<b>422</b>	<b>423</b>	<b>378</b>

TABLE 8.2 Main categories of research output

HCS	2010		2011		2012		2013		2014		2015	
	K€	%										
Direct funding	876	43%	779	47%	673	47%	608	39%	1.282	46%	1.163	46%
Research grants	-	0%	-	0%	-	0%	-	0%	-	0%	-	0%
Contract research	1.088	53%	704	42%	604	42%	786	50%	2.091	75%	1.501	59%
Own contribution	-168	-8%	-28	-2%	-122	-8%	-8	0%	-765	-27%	-375	-15%
Other	260	13%	206	12%	291	20%	187	12%	192	7%	254	10%
<b>Total funding</b>	<b>2.057</b>	<b>100%</b>	<b>1.661</b>	<b>100%</b>	<b>1.446</b>	<b>100%</b>	<b>1.574</b>	<b>100%</b>	<b>2.800</b>	<b>100%</b>	<b>2.542</b>	<b>100%</b>
Personnel costs	-1.135	75%	-983	77%	-925	78%	-810	77%	-1.698	68%	-1.489	79%
Other costs	-387	25%	-292	23%	-258	22%	-243	23%	-786	32%	-391	21%
<b>Total expenditure</b>	<b>-1.521</b>	<b>100%</b>	<b>-1.275</b>	<b>100%</b>	<b>-1.183</b>	<b>100%</b>	<b>-1.053</b>	<b>100%</b>	<b>-2.484</b>	<b>100%</b>	<b>-1.879</b>	<b>100%</b>
Result	536		386		263		520		315		663	

TABLE 8.3 Funding (research unit's financing structure)

## 8.3

**Strategy**

In January 2013, we started the Housing research programme as a joint endeavour of the former groups Housing Systems and Housing Quality of the Faculty of Architecture and the Built Environment. In 2015, the name of the programme was changed to Housing in a Changing Society to reflect the changing connection between housing and societal challenges. In our previous assessments, we were recommended to work on our international profile, international funding and textbooks. The overview of projects, PhD students, keynote lectures and key achievements demonstrates that we took these recommendations on board.

We deal with the housing component of the following societal challenges: energy efficiency, resilient cities, ageing and new concepts of welfare. Society, however, is changing in many ways. Housing markets have changed considerably since the global financial crisis. There is a huge need for a better understanding of the market, such as price, risk and business models. Moreover, the ambition to make Europe energy neutral in 2050 implies that there is also a huge need for innovation and investment in the housing stock. This requires an understanding of the effects of energy efficiency measures and of financial models for investment in rental and owner-occupied housing. Furthermore, the sustainability agenda is shifting from a focus on energy efficiency to also implementing principles of a circular economy. In addition, houses, especially those in cities, will have to be adapted to the higher temperatures and intensified precipitation associated with climate change. In the housing industry, this requires new business models, redesign of the supply chain and product development to go hand in hand. Housing adequacy and affordability are also becoming important issues in Europe. There is a need for new or renewed models, for new ideas on planning against spatial segregation and the provision of affordable housing. Moreover, societies are ageing: people are living longer and remaining in their own houses for longer, which means the houses have to be made age-friendly. Finally, welfare states in Europe are changing and housing appears to play a very important role here, as is demonstrated in the debate on housing asset-based welfare: housing as a pension and a cornerstone of the welfare system.

The strategy of the group is:

- to keep on top of new developments, and to play an agenda-setting role through publications and events;
- to be attractive as a partner or leader in consortia undertaking large projects, to continue the performance in previous projects;
- to be attractive to excellent PhD students and others who succeed in acquiring funding;
- to accommodate diversity and increase the viability of the group.

We combine knowledge from technology, policy sciences, economy, management sciences, sociology, psychology and geography.

## 8.4

**Targets**

The group has many disciplines and is sufficiently flexible to adapt to the changes in society while maintaining four consistent and promising research lines:

- adapting housing quality to future needs and real energy savings;
- adapting housing governance to future needs of affordable and inclusive housing;

- understanding housing markets and contributing to market stability;
- adapting asset management and organisational strategies to future housing needs.

In the coming period, we aim to see at least four PhD candidates graduate each year and to keep the production of articles in peer-reviewed journals at the current level. Moreover, we aim to be visible in the international scientific arena and to deliver insights that have a high societal impact by, for example:

- developing a model for predicting residential energy consumption based on the building's and the occupant's characteristics;
- developing strategies for combining energy renovations with adaptations for lifelong living;
- developing a framework for transferability of new policies and solutions for affordable housing;
- developing knowledge and contributing to the development of housing equity release markets;
- developing a renewed, stable and accurate house price model;
- developing transition strategies for a sustainable housing market;
- introducing circular components into the built environment through innovative maintenance and refurbishment strategies;
- developing strategies for successful collaborative housing.

## 8.5

### Environment

The Faculty of Architecture and the Built Environment is an attractive environment for highly qualified academics from all over the world. Housing fits well with the expertise in the faculty, and we are often approached by students from Architecture and Urban Planning who have an interest in housing. Moreover, many of our PhD students have a background in architecture, urban planning or architectural engineering. The reputation of the faculty is beneficial to ours.

In the environment outside the university, it appears that housing is becoming increasingly important in many ways. Interestingly, worldwide we see the topic of housing handled in different parts of governments; sometimes in a ministry for housing, but more and more as a substantial issue in ministries such as economic affairs, spatial planning, sustainability and social affairs. This illustrates the diverse connections between housing and society. Housing is part of several other policies; governments aim to achieve competitiveness, sustainability and welfare by addressing housing. Housing is a vehicle for governments and NGOs in making societies more sustainable, competitive and equitable.

The research group focusses on a special part of the built environment. Housing is the field not only of many professionals, but also of private households. After all, the interactions between the built environment and household behaviour determine the quality of the built environment and of people's lives. The profile of the group is typically TU Delft: increasing knowledge and using knowledge to solve societal problems and to sustain education. The group operates on the edge of scientific and societal relevance and is particularly proud of projects and products that have both scientific and societal impact, such as research projects (FP6, FP7, H2020), events, keynote speeches, and being members of editorial and expert boards. We therefore selected the following key performance indicators.



*Social housing in Chongqing*

## Performance indicators

ASSESSMENT DIMENSIONS	QUALITY DOMAINS	
	RESEARCH QUALITY	RELEVANCE TO SOCIETY
ACTIVITIES, ORGANISATION, FACILITIES/ASSETS, OUTPUT	<b>Activities</b> <ul style="list-style-type: none"> <li>• Academic events</li> </ul> <b>Organisation</b> <ul style="list-style-type: none"> <li>• Taking part in consortia</li> <li>• Attracting PhD students</li> </ul> <b>Facilities/assets</b> <ul style="list-style-type: none"> <li>• Databases</li> <li>• Boards</li> </ul> <b>Output</b> <ul style="list-style-type: none"> <li>• Academic journal articles</li> <li>• Books</li> </ul>	<b>Activities</b> <ul style="list-style-type: none"> <li>• Events for practitioners</li> </ul> <b>Organisation</b> <ul style="list-style-type: none"> <li>• Taking part in consortia</li> <li>• Contract research</li> </ul> <b>Facilities/assets</b> <ul style="list-style-type: none"> <li>• Hosting centre/office</li> </ul> <b>Output</b> <ul style="list-style-type: none"> <li>• Articles in professional journals</li> </ul>
USE	<ul style="list-style-type: none"> <li>• Citations</li> <li>• Invitations</li> </ul>	<ul style="list-style-type: none"> <li>• Invited speeches</li> <li>• Participation in projects</li> </ul>
MARKS OF RECOGNITION	<ul style="list-style-type: none"> <li>• Selection by excellent researchers</li> <li>• Invited keynote speeches</li> <li>• Editorial boards</li> <li>• Assessment committees</li> <li>• Visiting positions</li> </ul>	<ul style="list-style-type: none"> <li>• Invited keynote speeches</li> <li>• Editorial boards</li> <li>• Committees</li> <li>• Advisory positions</li> </ul>

TABLE 8.4 Selected output indicators

## Results

### The 'Housing in a changing society' approach

Combining knowledge of the professional and the private world

The group deals with the environmental sustainability challenge in housing, building and the existing housing stock and is on top of new ways to achieve sustainable housing. This requires knowledge about the housing stock and technology, transaction costs, management, finance opportunities and consumer preferences. The group is recognised for its knowledge on linking energy use in buildings with behaviour, and is an obvious partner in European funded projects on energy renovation of the housing stock. The PhD project of Oliva Guerra Santin influenced many other researchers in this field and resulted in new PhD projects on this topic within the group. This research also influenced practice and policymakers. The DTF fellowship of Queena Qian brought to the group deep and very useful knowledge of transaction costs for sustainable transitions in the built environment.

Investment in housing contributes considerably to national economies. Moreover, spending on housing, including implicit tax policies, covers large a part of national budgets. Therefore, understanding the market and, more in particular, the risks in the market is of key importance for economic stability. The group is developing advanced price and risk models, as well as models for consumer preferences. Moreover, the group is on top of current developments in the housing and building market. An illustrative example is the 'earthquake project' in Groningen: there was a huge need for knowledge on the effect of earthquakes on the housing market and the group contributed to that with its knowledge of econometric models as well as consumer attitudes.

Housing is for most households the largest part of their monthly expenses and if they are home owners it is often the largest investment in their personal portfolio. The group deals with policies for affordable housing, with the techniques of subsidies schemes, and with models for social housing providers and public–private partnerships. It also deals with the question of what is affordable for households and how it can be measured. Old models and policies for social housing are under pressure and there is an ongoing search for new solutions. New policies and regulations, new technologies to save/produce energy, and new investment and management approaches are needed. This implies improving advanced methods and business models in asset management, as well as understanding and accommodating bottom-up initiatives such as housing and energy cooperatives. An example of research on the latter is the DTF fellowship of Darinka Czischke on collaborative housing approaches.

Moreover, although housing is often considered a wobbly pillar of the welfare state, it is becoming more and more a cornerstone of the welfare system. The group is and was involved in a range of projects for the European Commission exploring the changing relation between housing and welfare and searching for new solutions. The DEMHOW project explored the role of housing as pension, by analysing pension, tax and housing policies as well as household strategies. This resulted in a cum laude PhD defence by Janneke Toussaint. Since 2015, researchers have been participating as housing experts in the welfare-wide RE-InVEST project that aims to contribute a new welfare strategy based on human rights and people's capabilities.

For practitioners, policymakers and academics

The group is based in Delft and has strong relations with Dutch practitioners and policymakers. This helps the group to be based in practice and to apprehend emerging problems in an early phase. In addition, the policymakers and practitioners provide funding for practice-oriented research.

The group is also working in many projects for the European Commission, the DG Research and Innovation, and the DG Employment. Moreover, the group is a member of the European Forum for Living, a foundation of European housing providers that aims to find new housing solutions in ICT, energy efficiency, corporate governance and measuring SROI. The latter is also done in projects for the European Investment Bank and Habitat for Humanity.

Finally, the group is welcoming PhD candidates, many of them from outside Europe. This brings in knowledge of other housing systems, increases global thinking and emphasises the role of institutional differences. This raises the question of the extent to which policies and solutions are transferrable from one context to another. Many of the PhD students study issues in their own countries and have connections to universities in these countries. Thus, we are getting increasingly involved in a worldwide network of housing researchers and policymakers.

Speeching and teaching

The group is known for this combined expertise, which is why members of the group are invited by policymakers to give keynote speeches, to be involved in or chair expert committees, and to comment on developments in professional media as well as in newspapers and on radio and television.

The knowledge is disseminated by teaching undergraduates, graduates and PhD students in the faculties BK, TPM, The Hague School of Applied Sciences, Tongji University and a summer school on Sustainable Housing. The group is also active in teaching practitioners through seminars, TU Delft courses, the NRP Academy and the Amsterdam School of Real Estate.

## 8.7.2

### Activities

The group is active in initiating and organising projects, for example COHERENO and Woningkwaliteit 2020. The group is also active in organising courses and events in order to valorise our knowledge and to better understand the societal problems in our field. The NRP academy and the annual National Housing Conference address professionals. The international conference on comparative housing research ('Approaches and Policy Challenges in a New International Era', 2010) and the international seminar 'Edges of home ownership' (2014) addressed academics. An overview of research projects finished during the years 2010-2015:

BEEM-UP, FP7 – EeB-Energy, 2010-2014

The BEEM-UP project (Building Energy Efficiency for Massive market Uptake) will demonstrate the economic, social and technical feasibility of retrofitting initiatives for drastically reducing the energy consumption in existing buildings, and lay the ground for massive market uptake. BEEM-UP involves key expertise to implement and demonstrate innovative building and energy management approaches with the overall aim to improve energy efficiency in existing buildings and obtain better indoor comfort conditions.

#### COHERENO, Intelligent Energy Europe 2013-2016

The EU project 'Collaboration for housing nearly zero energy renovation', abbreviated to COHERENO, made a valuable contribution to achieving the EU's energy efficiency and climate protection goals. Nine institutions from five European countries were involved in the project. They developed proposals and concepts for promising cross-sector and company business models for high efficiency refurbishment of single-family houses to nearly zero-energy housing. From financing, consulting and planning, right through to implementation – all parties in the construction process are involved. A major goal of COHERENO was to improve the quality of the construction measures by providing specific support to all stakeholders, thus increasing customer confidence. With these two key aspects, nearly zero-energy houses can gain credibility and acceptance.

#### DEMHOW, FP7 SSH, 2007-2011

Demographic change leads to an EU-wide shrinking and ageing of populations, accompanied by EU-wide changes to housing systems. The co-incidence of these two leads to the question of the extent to which home ownership provides a potential cure for some of the consequences of ageing populations. DEMHOW undertook research and other activities in order to investigate how the composition of wealth has changed with respect, in particular, to changes in population, housing systems, state pension arrangements, and financial institutions. It also investigates the attitudes toward the acquisition of housing assets and their use in old age are changing, particularly given equity release products in the eight participating countries.

#### Housing and social exclusion, EC DG Employment, 2009-2010

This project studies the link between welfare policies, housing provision and labour markets. The project consists of a quantitative part, analysing EU-statistics and a qualitative part. The latter implies a number of focus groups held in each of the six countries participating in the project. The group was involved in the management team and responsible for the Dutch contribution.

#### NEUJOBS, FP7 SSH, 2011-2015

NEUJOBS is a research project financed by the European Commission, under the 7<sup>th</sup> Framework Programme. The objective is to analyse future possible developments of the European labour market(s) under the main assumption that European societies are now facing or preparing to face four main transitions that will have a major impact on employment, in particular for some groups in the labour force or sectors of the economy. The group is involved in the housing part of this project and studies the effect of the energy efficiency policies and the links between the housing market and the labour market.

#### Pilot project eviction, EC DG Employment, 2014-2015

This project studies the link between housing evictions and homelessness and is led by Pádraic Kenna, at the School of Law, NUI Galway, Ireland. The project was awarded following a competitive tendering process by the European Commission. Funded by the European Commission, DG Employment, Social Affairs and Inclusion, Europe 2020: Social Policies, Social Inclusion and Poverty Reduction, this pilot project supports the EU poverty reduction and active inclusion strategy through combatting homelessness, reducing housing vulnerability and promoting access to quality and efficient social services as underpinned by the Europe 2020 Strategy and the Social Investment Package. The group is responsible for the Dutch part.

SHELTER, Intelligent Energy Europe, 2010-2013

The social housing sector faces a significant challenge. Housing operators have to implement energy renovations, but have difficulties in implementing them with the professionals on their portfolio. SHELTER starts from the current situation: the lack of coordination of professionals as the main obstacle to reach high efficiency in buildings and the ineffective use of information and tools available. The integrated design approach is applied, thus changing the way different professions work together along the supply chain. In SHELTER this approach is analysed in the frame of the renovation programmes of social housing operators in 5 countries and applied in practice.

SUSLABNWE, Interreg IVB North West Europe, 2012-2015

SusLabNWE is an international infrastructure of living labs that enables innovation processes in which users and other actors actively participate. SusLabNWE provides the context in which they can interact with and report on sustainable innovations in the home environment, while sharing practices with other households and stakeholders. These innovation processes are examined using observational techniques.

TENLAW, FP7 SSH 2009-2015

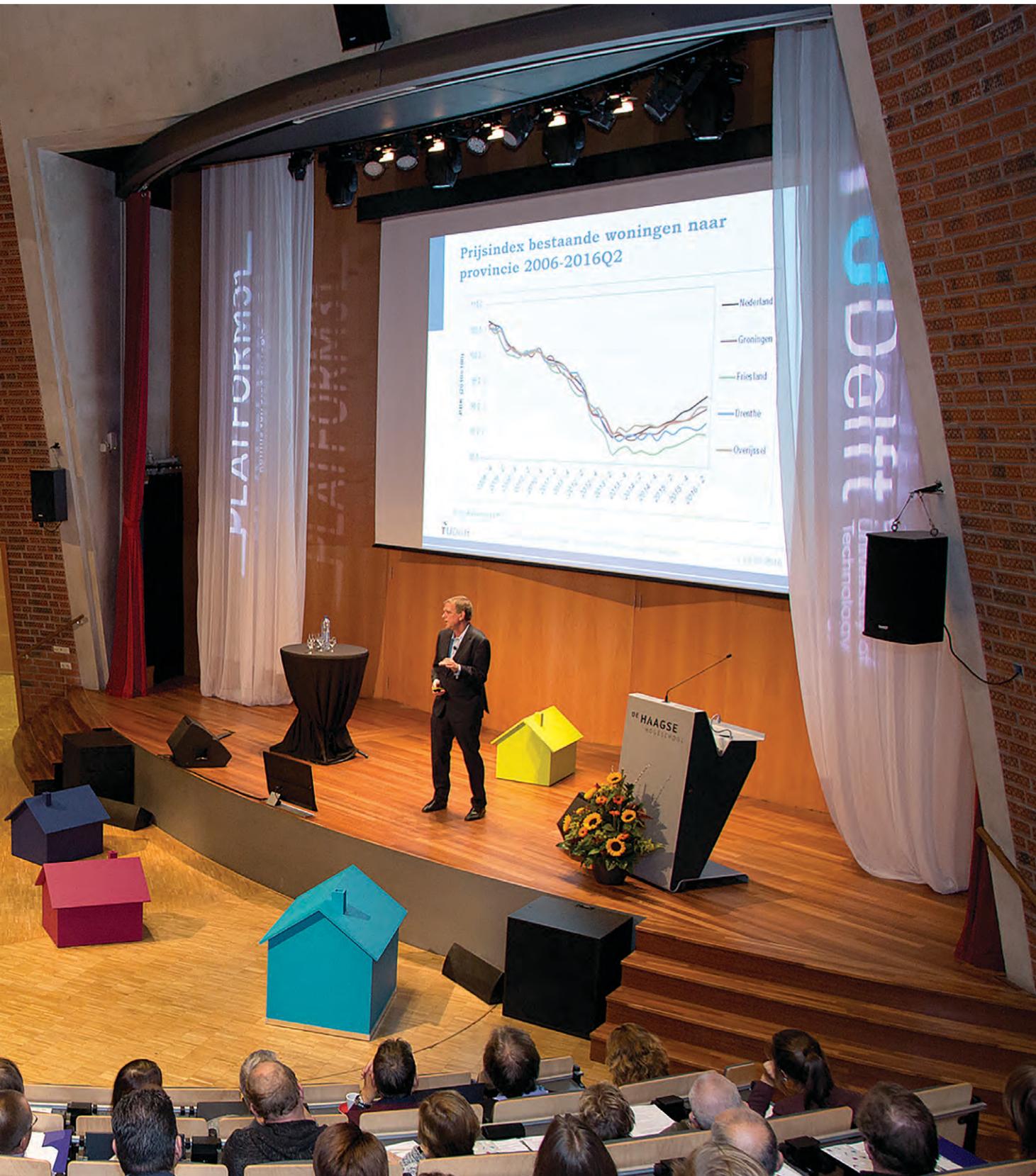
Private tenancy law is existentially affecting the daily lives of European citizens, as about one third of them depend on rental housing. That notwithstanding, it constitutes a nearly blank space in comparative and European law. At the same time, however, different parts of EU law and policy do affect tenancy law significantly, albeit indirectly. Thus, EU social policy against poverty and social exclusion extends to selected issues of housing policy. This project studies tenancy law in Europe from a law and a housing perspective. The group was, together with law experts from URS, involved in the study of Dutch and French tenancy law from a housing perspective.

Membership editorial boards

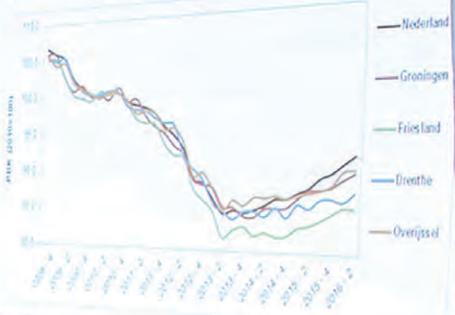
- Boelhouwer, PJ; Board member, Critical Housing Analysis. ISSN 2336-2839
- Boelhouwer, PJ; editor in chief, Journal of Housing and the Built Environment. ISSN 1566-4910
- Boelhouwer, PJ; member management board International Journal of Housing Policy. ISSN 1949-1247
- Bortel, GA van; review editor, International Journal of Housing Policy. ISSN 1949-1247
- Elsinga, M; editor in chief, Tijdschrift voor de Volkshuisvesting. ISSN 1382-4112
- Elsinga, M.; board member, Current Urban Studies, ISSN: 2328-4900
- Gruis, VH; Editor in chief, Real Estate Research Quarterly. ISSN 1877-9700
- Haffner, MEA; editor in chief, European Network for Housing Research Newsletter. ISSN 1014-8027
- Haffner, MEA, G ; board member, Tijdschrift voor de Volkshuisvesting. ISSN 1382-4112
- Hoekstra, JSCM; board member, Journal of Housing and the Built Environment. ISSN 1566-4910
- Hoekstra, JSCM; board member, Urban Studies Research. ISSN 2090-4185
- Itard, LCM; board member, TVVL Magazine. ISSN 0165-5523
- Qian, QK; board member. Journal of Housing and the Built Environment. ISSN 1566-4910,
- Visscher, HJ; board member, International Journal of Law in the Built Environment. ISSN 1756-1450
- Visscher, HJ; board member, Open House International. ISSN 0168-2601



Peter Boelhouwer speaks at the Wooncongres 2016 by Platform 31/OTB



### Prijnsindex bestaande woningen naar provincie 2006-2016Q2



## Organisation

The group participates in many consortia for projects for the European Commission as well as in scientific and professional expertise centres, such as the Flemish Expertise Centre for Housing, the European Forum for Living, VOGON and the Housing Value Expertise Centre. Members of the group play a key role in many of these consortia:

- Partner Steunpunt Wonen, together with Flemish Universities, led by KU Leuven: <https://steunpuntwonen.be/>
- Board member of VOGON (Vereniging Onroerend Goed Onderzoekers Nederland; Dutch Association for Real Estate Researchers) [www.vogon.nl/](http://www.vogon.nl/)
- TKI Urban Energy. Funding network, part of the Dutch 'top sector' policy. The group initiated three projects: Monicair, KIEM, Opschaler: <http://topsectorenergie.nl/urban-energy/>
- Hosting Housing Value Expertise Centre in cooperation with Statistics Netherlands (CBS);
- Partner European Federation for Living (EFL): federation of affordable housing providers and associated members: <http://www.ef-l.eu>. Initiated the IEE project TRIME: <http://www.trime-eu.org/nl/>.



*Impressions Housing Research Day*

### Facilities/assets

The group has several facilities that are beneficial to the group, such as large databases that can be used for PhD and other research projects. Moreover, the membership of the editorial team of Elsevier's International Encyclopaedia of Housing and Home helped to compose a 7-volume Encyclopaedia full of education material. Finally, running the editorial office of the European Network for Housing Research makes the group a key player in this research network.

- SHAERE database: database with Energy Performance Certificates and related data for 2010–15 of 1.5 million dwellings provided by AEDES to the group for research.
- Remote access facility of the national Central Bureau for Statistics (CBS).
- Team Elsevier & International Encyclopaedia of Housing and Home produced an encyclopaedia: <http://www.sciencedirect.com/science/referenceworks/9780080471716>
- The editorial office and the chair of the board of the European Network for Housing Research.

### Output

The group produces a substantial number of journal articles and scientific books (see table). We are particularly proud of publications that set the agenda in energy efficiency and household behaviour (PhD theses of Guerra Santin and Majcen), asset-based welfare (PhD thesis of Toussaint and DEMHOW book), social enterprises (special issue of Housing Studies) and housing preferences (book).

- Doling, John & Marja Elsinga (2013) Demographic change and housing wealth, Springer (final book DEMHOW project: <http://www.springer.com/us/book/9789400743830>).
- Majcen, D., Itard, L.C.M., Visscher, H. (2013) Theoretical vs. actual energy consumption of labelled dwellings in the Netherlands: Discrepancies and policy implications. *Energy Policy* 54, pp. 125-136;
- Special issue of *Housing Studies: Social Enterprise, Hybridity and Housing Organisations* (2012) <http://www.tandfonline.com/toc/chos20/27/4>.
- Jansen, Sylvia J.T, Henny C.C.H. Coolen & Roland W. Goetgeluk (2011). *The Measurement and Analysis of Housing Preference and Choice*, Springer.

#### PhD-theses (selection)

- Joris Hoekstra (2010), *Divergence in European welfare and housing systems*
- Paul de Vries (2010), *Measuring and explaining house price developments*
- Olivia Guerra Santin (2010), *Actual energy consumption in dwellings*
- Janneke Toussaint (2011) cum laude, *Housing wealth in retirement strategies; towards understanding and new hypotheses*
- Sonja van Dam (2013), *Smart Energy Management for Households*
- Christian Lennartz (2013), *Competition between social and private rental housing*
- Erwin Mlecnik (2013), *Innovation development for highly energy efficient housing*
- Darinka Czischke (2014), *Social housing organisations in England and the Netherlands: between state, market and community*
- Martin Roders (2015), *Partnering for climate change adaptations by Dutch housing associations*
- Salcedo Rahola, Tadeo Baldiri (2015), *Integrated project delivery methods for energy renovation of social housing*

## 8.7.6

## Use

The output of the group is used in many ways. First, the scientific way: Guerra Santin's thesis was highly cited and PhD students following that track, like Majcen (cum laude PhD defence in 2016), also appeared to be very successful. Second, members of the group are considered experts in relevance-to-society debates and have therefore been invited to join expert teams by, for example, Parliamentary Enquiry Committees and to appear before hearings in Parliament on the issues of house prices and housing associations. Finally, several members of the group are regularly invited by Dutch radio and television programmes to comment on housing issues.

- The paper: Guerra Santin, O., Itard, L.C.M. & Visscher, H.J. (2009). *The effect of occupancy and building characteristics on energy use for space and water heating in Dutch residential stock*. Energy and buildings, 41(11), 1223-1232; was widely cited (May 2016): Scopus 157, Google Scholar 312 citations.
- Two articles written by members of our group are among the top 20 most cited articles of the International Journal of Housing Policy: <http://www.tandfonline.com/action/showMostCitedArticles?journalCode=reuj20>
- Invitations from the Parliamentary enquiry committee on Housing Associations to perform a background study and a literature study, and to attend hearings in Parliament: <https://www.tweedekamer.nl/kamerleden/commissies/pew> and ;
- RTLZ Huizenindex (quarterly television programme of RTLZ that presents the results of the OTB housing market monitor) ([www.rtlnieuws.nl/economie/home/rtl-z-huizenindex-herstel-zet-deur](http://www.rtlnieuws.nl/economie/home/rtl-z-huizenindex-herstel-zet-deur)).
- Members of the group appear in the media more than the members of any other group at TU Delft.
- Citations of our academic work (see table below).

STAFF MEMBER	CITATIONS		H-INDEX	
	Google Scholar	Scopus	Google Scholar	Scopus
Peter Boelhouwer	1189	296	19	11
Marja Elsinga	1381	280	22	8
Vincent Gruis	672	115	14	7
Marietta Haffner	1262	195	20	8
Joris Hoekstra	964	278	15	9
Laure Itard	1444	598	19	12
Henk Visscher	1068	322	15	8

TABLE 8.5 Citations and H-index of selected staff members

## 8.7.7

## Recognition

The group is widely recognised for its scientific performance and societal contribution:

- The Housing group hosted many visiting researchers and was selected by two excellent academics as the place to continue their very successful academic careers in housing research: Darinka Czischke and Queena Kun Qian. This was facilitated through the TU Delft fellowship programme.
- The Housing group is an obvious partner in European funded projects (H2020, FP7, IEE, Interreg, DG Employment) and was invited to participate in a long series of projects.

- Invitations to take part in PhD examinations: Hong Kong Polytechnic, University of Pretoria, Aalborg University, Nottingham Trent, University of Lille, University of Geneva, University of Ghent, KTH Stockholm, KU Leuven, Montfort University, University of Murcia, Urban Institute Moscow.
- Invited to chair Vanenburg Bestuurdersoverleg Woningcorporaties for high level debate on the future of Dutch housing associations: <http://www.bestuurdersdebat.nl/>
- 233 invited lectures in the Netherlands.

PhD thesis, cum laude

Janneke Toussaint (2011) cum laude, Housing wealth in retirement strategies; towards understanding and new hypotheses

Keynote speeches, invited lectures: international (selected)

- Bortel, GA van; *Rethinking Grand Design: towards 'slow' neighbourhood regeneration?* Presentation held on 10 August 2015 in Helsinki during conference on Neighbourhood regeneration.
- Elsinga, M; *The road to tenure neutral housing policies*. Naples, September 3; 2012. Key note presentation World Urban Forum
- Elsinga, M; *Rethinking housing systems*. Tarragona, Spain, June 20; 2013. Key note conference European Network for Housing Research
- Gruis, V; *The Dutch Model of Social Rented Housing*, October, 6, 2014; Barcelona, Conference of La Taula del Tercer Sector (Catalonian association of third sector organisations).
- Haffner, MEA; *How do the Dutch and German systems provide secure occupancy?* Melbourne, October 10; 2012. AHURI Event: Secure Occupancy in Rental Housing. An International Comparison
- Hoekstra, JSCM; *Social housing in the Netherlands. The development of the Dutch social housing model*. Barcelona, June 6; 2013. Keynote speech, 2<sup>nd</sup> multinational knowledge brokerage event in the area of Sustainable Housing.
- Mlecnik, E; *Gebouwen bijna energieneutraal renoveren*. Brussel, België, January 19; 2015. Debat Belgische Federale Raad voor Duurzame Ontwikkeling 'Krijgt u het er ook warm van? Hoe aanzetten tot energiezuinig verwarmen?'
- Visscher, HJ; *Energy saving in the housing stock: Goals, progress and challenges*. Paris, France, November 25; 2014. Invited Keynote lecture at the 'Universite Europe 2014' Federation des ESH
- Visscher, HJ; *Building regulations and energy reduction in Europe and the Dutch experience*. Lisboa, Portugal, July 2; 2015. Invited lecture for LNEC (Laboratório Nacional de Engenharia Civil)

Visiting positions

- Marja Elsinga, visiting professor, East China Normal University (ECNU) in Shanghai, China (2014)
- Marja Elsinga, visiting professor, Tongji University in Shanghai, China (since 2015)
- Marietta Haffner, visiting fellow, Cambridge Centre for Housing and Planning Research, Department of Land Economy, Cambridge University (since 2012)
- Marietta Haffner, honorary principal research fellow, Centre for Urban Research, School of Global, Urban, and Social Studies, AHURI at RMIT University, Melbourne (since 2010)
- Marietta Haffner, visiting fellow, Curtin University, Perth, Australia (2012-2013),)
- Joris Hoekstra, visiting lecturer, University of the Free State, Centre for Development Support, Bloemfontein, South Africa (2014).



PhD research by Sonja van Dam: Smart Energy Management for Households.

Displayed above: the 'Wattcher' energy monitor, a 'Plugwise' energy management device and two multifunctional home energy management systems.

## PhD programme

### Context, supervision and quality assurance

In the last five years, we have extended our knowledge of housing problems and solutions in Asian, African and Latin American contexts. We have also attracted many PhD students with research projects that closely match our research ambitions.

We aim to assure quality by:

- Attracting the right candidates by increasing the visibility of our research ambitions through actively promoting them via our website, contact persons, positions as visiting professors and our planned Sustainable Housing summer school.
- Increasing knowledge of the transferability of policies and solutions from one institutional context to another by building on our long tradition of comparative housing research. This facilitates PhD candidates looking for inspiration in Europe to find solutions for problems in their home countries.

### Selection and admission procedures

The strategy to recruit new, talented PhD candidates consists of:

- Acquiring externally funded projects, formulating a research description for a PhD embedded in the project and advertising PhD positions internationally.
- Encouraging prospective candidates to apply for PhD scholarships, supervising them while they are writing their research proposal, and conducting a Skype interview and a face-to-face interview.

### Supervision and guidance to the labour market

PhD candidates always have at least one supervisor and one day-to-day supervisor/mentor. Policies on the supervision and mentoring of PhDs have been formulated at the Graduate School for Architecture and the Built Environment (GS A+BE) and in greater detail at the research group level. All senior staff members have followed a course on supervising and mentoring, which is now subject to peer-review sessions several times a year. Most of the senior staff have good connections in both the academic and the professional housing world. They use their networks to support the PhD candidates in finding a job.

ENROLMENT	Gender			SUCCESS RATE								Total graduated		Not yet finished		Discontinued	
	Starting year	Male	Female	Total	Finished				Total graduated	Not yet finished	Discontinued	Discontinued					
					≤ 4Y	≤ 5Y	≤ 6Y	≤ 7Y									
2006	1	1	2	0	0%	2	100%	2	100%	2	100%	0	0%	0	0%		
2007	0	1	1	1	100%	1	100%	1	100%	1	100%	0	0%	0	0%		
2008	1	1	2	0	0%	1	50%	1	50%	1	50%	1	50%	0	0%		
2009	0	1	1	0	0%	0	0%	0	0%	0	0%	1	100%	0	0%		
2010	2	0	2	0	0%	1	50%	2	100%	2	100%	0	0%	0	0%		
2011	0	3	3	0	0%	1	33%	1	33%	1	33%	2	67%	0	0%		
<b>Total</b>	<b>4</b>	<b>7</b>	<b>11</b>	<b>1</b>	<b>25%</b>	<b>6</b>	<b>55%</b>	<b>7</b>	<b>64%</b>	<b>7</b>	<b>64%</b>	<b>4</b>	<b>36%</b>	<b>0</b>	<b>0%</b>		

TABLE 8.6 Length of PhD candidacies and success rate of the PhD programme

## Self-reflection

### Quality

The research group aims to achieve high quality in academic as well as in societal standards. The group demonstrated by publishing in academic journal, being invited for committees, editorial boards and visiting positions that the quality of the group is widely recognised.

### Relevance

According to the midterm review of November 2013: the group is *“really excellent and leading at ‘housing’ research”*. The main comment during the midterm review was the label of housing research which may be too narrow and has little chances on getting funded. The recommendation was to link housing to wider societal topics and funding opportunities. We took this on board, not only by changing the name of the program into Housing in a Changing Society, but also by participation in events and projects that put housing in the context of energy efficiency, resilient cities, ageing and new concepts of welfare. We are aware that constant openness and creativity is of key importance to stay a key player in the field of housing research.

### Viability

The group proved to have a steady performance in attracting funding and PhD-students. Our viability is built on the quality and relevance of our research as well as on the creativity, flexibility and team spirit in the research group.



*Summerschool Sustainable Housing*

## SWOT analysis

### STRENGTHS

Housing in a Changing Society is an internationally leading research programme. The multidisciplinary approach, the combination of scientific and societal ambitions, the size and the long-standing existence of the programme make it unique and recognised in many parts of the world.

The group is well known for its expertise, and several members of the group are on the boards of scientific journals, members of expert panels, and appear in Dutch and international media. The group has a strong network and is often invited to join consortia, develop new products and policies, and contribute to high-level debates.

### WEAKNESSES

The multidisciplinary approach results in a focus on multidisciplinary teams working on scientific and applied research in the field of housing. Since there is no single emphasis on housing in scientific councils or at the European Commission, there is no straightforward way to get projects funded. It takes broad orientations and creativity to get funding. The composition of the group makes it difficult to appoint new tenured staff.

### OPPORTUNITIES

Housing was recently added to the EU Urban Agenda as a specific topic. The programme has good potential to contribute to the Agenda.

The programme attracts PhD candidates with projects that match our research ambitions. We plan to be more proactive in attracting the right people by, for example, starting a Sustainable Housing summer school and participating in a MOOC on Planning for Sustainable Cities.

The group is well embedded in the faculty and could benefit even more from cooperation with research programmes such as URS, IMBE and GBI and with design and technology programmes in other faculties.

### THREATS

It remains a challenge to find adequate funding for our research. It is particularly a challenge to find projects that accommodate 4-year PhD projects. This requires the research group to be creative and alert to debates outside but relevant to housing.



# Urban and Regional Studies

Programme leader:

**Willem Korthals Altes**

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**Patricia Mokhtarian (left) and Kees Maat (right) at the  
World Symposium on Transport and Land Use (WSTLUR)  
TU Delft, Aula Conference Centre, 24–27 June 2014**



# Urban and Regional Studies

## Scope

The Urban and Regional Studies programme investigates the interrelationships between everyday social and spatial patterns, and the governance and growing complexity of neighbourhoods, cities and regions.

The programme seeks to understand regions, cities and city life, and particularly focuses on how governance and planning can influence and contribute to cities and regions becoming more competitive, sustainable and liveable. We aim to contribute to fundamental discussions about current and future changes in the politics and practices of territorial governance, urban and neighbourhood change, governance of land development, and urban systems and transport, as well as their implications at various scale levels. The programme has a growing emphasis on studying participatory approaches. The research of this programme provides insights into the interactions between authorities and market players as well as between institutions and people in a day-to-day living environment. The programme operates from a strong international position and reputation and contributes to a variety of networks and collaborations. The scope of its results include the acquisition of significant grants, such as ERC, NWO, FP7 and Marie Curie grants, over 200 mostly well-cited papers in international peer-reviewed journals, influential books, impact on policymaking, and research outcomes featuring in leading newspapers. We aim to study this field from the following four perspectives, which have been conceptualised as sub-programmes of the Urban and Regional Studies programme:

- Governance of Land Development (led by Professor Willem Korthals Altes) is about the interaction between planning, property rights and property markets, the governance of the relationship between the private interests of landowners and common societal goals;
- Territorial Governance (led by Dr Dominic Stead) studies the policy, politics and administration of territory and how cooperation and collaboration both between different parts and levels of government and between governmental and non-governmental actors are being shaped;
- Urban and Neighbourhood Change (led by Professor Maarten van Ham) investigates neighbourhoods and cities as changing social sites and as sites of governance and civic action, including the effects of neighbourhoods on residents and how residents affect neighbourhood stratification;
- Urban Systems and Transport (led by Dr Kees Maat) studies how the built environment interacts with spatial and transport behaviour, how this influences urban performance, and how these interactions can contribute to more competitive, sustainable and liveable cities.

During the assessment period, a fifth topic – Urban Systems and Dynamics – was developed. In January 2016, the topic was conceptualised as a sub-programme (led by Dr Evert Meijers). The topic's key focus is on how relationships and flows between cities develop, and how these affect the fate and fortune of cities, their inhabitants and the firms they host. This knowledge base on spatial structure, dynamics and performance is translated into metropolitan planning strategies.

URS	2010		2011		2012		2013		2014		2015	
	Nr.	FTE										
Scientific staff	8	2,3	11	2,8	9	3,0	12	3,8	11	3,8	11	3,4
Researchers	20	12,2	22	11,0	19	10,6	18	10,3	16	8,1	14	7,6
PhD candidates	2		5		6		9		12		14	
<b>Total research staff</b>	<b>30</b>	<b>14,4</b>	<b>38</b>	<b>13,8</b>	<b>34</b>	<b>13,6</b>	<b>39</b>	<b>14,0</b>	<b>39</b>	<b>11,9</b>	<b>39</b>	<b>11,1</b>
Visiting fellows	6		7		15		12		20		22	
<b>Total staff</b>	<b>36</b>	<b>14,4</b>	<b>45</b>	<b>13,8</b>	<b>49</b>	<b>13,6</b>	<b>51</b>	<b>14,0</b>	<b>59</b>	<b>11,9</b>	<b>61</b>	<b>11,1</b>

TABLE 9.1 Research staff (composition of the research unit)

URS	2010	2011	2012	2013	2014	2015
Refereed articles	33	29	29	35	35	52
Non-refereed articles	2	2	0	2	0	0
Book	14	7	6	1	1	3
Book chapters	25	23	36	22	20	15
PhD theses	3	2	0	2	0	2
Conference papers	38	42	66	43	39	21
Professional publications	29	28	31	23	27	28
Publications aimed at the general public	4	2	8	10	4	18
<b>Other Research Output:</b>						
Book reviews	2	4	7	6	2	5
Appearances on radio or television	3	6	9	9	3	27
Internal reports, lectures, posters, datasets	9	0	29	18	49	60
External reports	7	24	33	17	31	21
Editorships of books	3	2	2	4	0	3
Editorships of journals	7	7	13	7	7	12
<b>Total other Research Output</b>	<b>31</b>	<b>43</b>	<b>93</b>	<b>61</b>	<b>92</b>	<b>128</b>
<b>Total publications</b>	<b>179</b>	<b>178</b>	<b>269</b>	<b>199</b>	<b>218</b>	<b>267</b>

TABLE 9.2 Main categories of research output

URS	2010		2011		2012		2013		2014		2015	
	K€	%										
Direct funding	1.118	54%	1.172	46%	1.258	48%	1.300	45%	1.196	46%	824	48%
Research grants	149	7%	97	4%	169	6%	259	9%	304	12%	124	7%
Contract research	1.291	62%	1.286	51%	1.524	58%	1.502	52%	1.584	61%	1.046	61%
Own contribution	-566	-27%	-97	-4%	-301	-11%	-211	-7%	-511	-20%	-341	-20%
Other	81	4%	76	3%	-32	-1%	21	1%	22	1%	49	3%
<b>Total funding</b>	<b>2.073</b>	<b>100%</b>	<b>2.534</b>	<b>100%</b>	<b>2.618</b>	<b>100%</b>	<b>2.872</b>	<b>100%</b>	<b>2.596</b>	<b>100%</b>	<b>1.701</b>	<b>100%</b>
Personnel costs	-1.200	63%	-1.236	65%	-1.393	63%	-1.487	66%	-1.507	65%	-1.142	79%
Other costs	-711	37%	-672	35%	-806	37%	-757	34%	-813	35%	-308	21%
<b>Total expenditure</b>	<b>-1.911</b>	<b>100%</b>	<b>-1.908</b>	<b>100%</b>	<b>-2.199</b>	<b>100%</b>	<b>-2.244</b>	<b>100%</b>	<b>-2.320</b>	<b>100%</b>	<b>-1.450</b>	<b>100%</b>
<b>Result</b>	<b>162</b>		<b>627</b>		<b>419</b>		<b>628</b>		<b>276</b>		<b>251</b>	

TABLE 9.3 Funding (research unit's financing structure)

## Strategy

The Urban and Regional Studies research programme was formed in January 2014 by the merger of three programmes that had previously operated independently:

- Neighbourhood Change and Housing (formerly Urban Renewal and Housing) has been developed into the sub-programme Urban and Neighbourhood Change.
- Urban and Regional Development has been remodelled to become the sub-programmes Urban Systems and Transport and Territorial Governance.
- The Governance of Geoinformation and Land Development has been divided between the Urban and Regional Studies programme (sub-programme Governance of Land Development) and the Geoinformation Technology and Governance programme.

All three previous research programmes had been assessed positively. The outcomes of the research assessment were used in developing research programmes for the individual programmes for the period 2009–14 and, after the OTB merged with the Faculty of Architecture to become the Faculty of Architecture and the Built Environment, in developing the joint programme Urban and Regional Studies 2014–18.

In response to the outcomes of the 2008 research assessment, Urban and Regional Development formulated the ambition to become an international leader, which involved 'working harder to get our papers published in highly rated journals' and improving relevance and viability by addressing issues that matter to society, while at the same time being innovative and of long-term academic interest. The programme Neighbourhood Change and Housing (formerly Urban Renewal and Housing) appointed a new chair (Van Ham), who has contributed to redrafting the programme towards its current focus on neighbourhoods and cities as changing social sites and as sites of governance and civic action. Although Governance of Geoinformation and Land Development was assessed as being excellent in quality, productivity and relevance, and very good in viability, it has been split up based on the logic of the new ordering of larger research programmes, namely Housing in a Changing Society, Geoinformation Technology and Governance, and Urban and Regional Studies. In this context, the governance of land development seems to be best positioned in Urban and Regional Studies. The merger of the programmes can be seen in the context of the recommendation by the assessment committee (from 2008) to improve cross-fertilisation and forge links between the programmes.

The backbone of the programme's content is the 2014–18 research programme, in which the following research topics have been reformulated:

- the authorities as land developers, new land development legislation, the Europeanisation of the governance of land development, the legal complexities of modern land use, innovative and participatory land policy instruments, and bridging internal and external effectiveness towards a legitimate governance of land development;
- metagovernance, devolution, regionalisation and soft space planning, Europeanisation and territorial impact assessment, policy integration of areas and projects, developing and testing cross-national methods to compare, assess and understand territorial governance and the transferability of policies, concepts, procedures and instruments;
- neighbourhoods as sites of governance and civic action, neighbourhood change and stratification, based on socioeconomic position, ethnic concentration and neighbourhood reputation and the relationship between socioeconomic inequality, poverty and neighbourhoods;
- the relationship between the built environment and travel behaviour within the greater framework of time, linking academic research and planning practice through real-world experiments, and dynamics in the field of transport modes, such as the transition to electric cars and the accommodation of urban freight transport.

The programme's staff are capable of moving towards new research questions that are topping the agenda. We aim to acquire new talented PhD students to improve the balance between tenured and non-tenured staff.

The programme is seeking a greater understanding of competitive, sustainable and liveable cities and regions, territories and neighbourhoods. This is highly relevant especially as it addresses these aspects in relation to governance and planning. The results of its research provide insights into the interactions between authorities and market players, as well as between institutions and people in a day-to-day living environment. It has become clear that there are certain elements between which it is possible to formulate links, because there are joint interests in those elements. One of these elements is governance and the growing emphasis on participatory approaches. We aim to contribute to fundamental discussions about current and future changes in the politics and practices of territorial governance, urban and neighbourhood change, the governance of land development and urban systems and transport, as well as their implications at various scale levels. We aim to become an international centre of excellence in these fields. We also aim to consolidate and extend our international academic reputation, continue to focus on the publication of our work in international peer-reviewed journals, and increase our presence in international consortia. We want to contribute to solving some of the contemporary issues in our cities and regions and we aim to generate knowledge of the preconditions and supporting contexts for and barriers to urban regeneration and transformation, that is, the development of competitive, sustainable and liveable cities. Based on this, we also want to contribute to policy discourses in these fields. As neoliberal approaches tend to dominate, we especially focus on the issue of the inclusiveness of spatial strategies and interventions, in terms of both actors and sustainability and competitiveness effects.

## 9.4

**Targets**

We formulated the following more operational targets during the midterm review.

- The publication of influential papers in international peer-reviewed academic journals.
- Combining research with a direct application in a practical context with scientific reflection on the issues involved.
- Maintaining a proper balance between our position as an important national player and involvement in international networks.
- Delivering several PhDs a year within the programme.
- Participation in international research networks.
- More scientific debate and joint projects between sub-programmes.
- Building further relationships within the Faculty of Architecture and the Built Environment.

These targets are still of relevance today. For example, we have published many influential papers in international academic peer-reviewed journals, and we intend to continue doing so, and we expect that the growth in the number of PhD students from three in 2010 to 14 in 2015 will result in more PhD graduates. We also expect that building relationships within the faculty can also be a way to strengthen the links between research and education.

## 9.5

**Environment**

At the start of the assessment period, the research groups were in the OTB Research Institute for the Built Environment. The incorporation of the research programme in the Faculty of Architecture and the Built Environment (A+BE) and the move to the A+BE building represent an important development in the research environment. This was an outcome of the re-evaluation agenda 'Towards a sustained worldclass position', which the Board of TU Delft enacted in June 2010 based on the idea that a merger would boost the faculty's research portfolio. However, it also entailed a financial cut for both organisations. The merger provides opportunities to have links to education not only at the Faculty of Technology Policy and Management (TPM) – the group is heavily involved in education in the track Built Environment & Spatial Development in the BSc and MSc programmes on System Engineering, Policy Analysis and Management (SEPAM) at TPM – but also at A+BE, which may strengthen the links between research and education.

Researchers in the programme have strong international positions and reputations. This is evidenced by a large number of invited talks in Europe and beyond; a large number of invitations to participate in international or European research proposals; invited and financed stays as guests at other universities; a substantial and increasing number of citations of their work in scientific journals; a series of edited books with established scientific editors and the editing of theme issues of established scientific journals; and successful bidding to host or co-host international scientific conferences and seminars. The programme contributes to a variety of networks and collaborations. International networks in which researchers of the programme participate and execute coordination tasks are the Association of European Schools of Planning (AESOP), European Network of Housing Research (ENHR), International Academic Association on Planning Law and Property Rights (PLPR), Regional Studies Association (RSA), Network on European Communications and Transport Activity Research (NECTAR) and the World Society for Transport and Land Use Research (WSTLUR).

## Performance indicators

ASSESSMENT DIMENSIONS	QUALITY DOMAINS	
	RESEARCH QUALITY	RELEVANCE TO SOCIETY
ACTIVITIES, ORGANISATION, FACILITIES/ASSETS, OUTPUT	<p><b>Activities</b></p> <ul style="list-style-type: none"> <li>• International-funded research projects (FP7/H2020/ERC)</li> <li>• Nationally-funded projects (NWO/STW)</li> </ul> <p><b>Organisation</b></p> <ul style="list-style-type: none"> <li>• Involvement in scientific event or conference organisation activities</li> </ul> <p><b>Facilities/assets</b></p> <p>n/a</p> <p><b>Output</b></p> <ul style="list-style-type: none"> <li>• Books</li> <li>• Refereed journal articles</li> <li>• Refereed journal articles in targeted journals</li> <li>• Scientific book chapters</li> <li>• Editorships</li> <li>• PhD-theses</li> </ul>	<p><b>Activities</b></p> <ul style="list-style-type: none"> <li>• National research projects/programmes for professionals</li> <li>• International research projects (INTERREG/IEE/ESPON)</li> <li>• Media appearances: television, radio, internet</li> </ul> <p><b>Organisation</b></p> <ul style="list-style-type: none"> <li>• Role in practice and policy making</li> </ul> <p><b>Facilities/assets</b></p> <p>n/a</p> <p><b>Output</b></p> <ul style="list-style-type: none"> <li>• Professional publications</li> <li>• Editorships of professional journals</li> </ul>
USE	<ul style="list-style-type: none"> <li>• Number of citations in WoS, Scopus and G-Scholar between 2010 and 2015</li> <li>• Downloads of books and/or book chapters</li> <li>• Co-operation with other researchers</li> <li>• Participation in consortia of EU (FP7/H2020) and national (NWO/STW) projects</li> </ul>	<ul style="list-style-type: none"> <li>• Use of scientific and professional publications in practice</li> <li>• Co-operation with societal groups an impact to general public</li> </ul>
MARKS OF RECOGNITION	<ul style="list-style-type: none"> <li>• H-index of researchers defined by WoS, Scopus and G-Scholar</li> <li>• Total number of citations in WoS, Scopus and G-Scholar</li> <li>• Personal grants (ERC, VENI, VIDI, VICI)</li> <li>• Prizes and awards</li> <li>• Acquisition of research grants based on peer review (FP7/H2020) and NWO/STW)</li> <li>• Participation in EU-consortia</li> <li>• Invitations for keynote speeches</li> </ul>	<ul style="list-style-type: none"> <li>• Marks of recognition of scientific publications by societal groups and governance organisations</li> <li>• Income contract research</li> <li>• Collaboration with stakeholders</li> <li>• Long-term cooperation with government and industry</li> <li>• Invited Public lectures and debates and honorary positions and role in professional associations</li> </ul>

TABLE 9.4 Selected output indicators

## 9.7

## Results

An important number of the targets of the programme relate to traditional scientific performance indicators of research, that is, the publication of high-quality research in high-quality journals and work that is cited extensively. The publication of influential papers in international peer-reviewed academic journals is one of the targets formulated, so it is relevant to consider whether papers are published in the right journals to achieve this impact. Although peer-reviewed journal papers are of increasing importance in the field of urban and regional studies, so too are other outputs including books, PhD theses and articles in publications for a professional audience. These links with a professional audience are important for achieving targets on combining research with a direct application in a practical context. It is about scientific reflection on the issues involved and the maintaining of a proper balance between our position as an important national player and involvement in international networks.

Acquiring research funding is also a sign of quality, as reviewers are asked to assess the excellence of proposed projects. This is especially the case with personal grants. Many projects, however, reflect not only scientific excellence but also the emphasis on societal challenges, and acquiring projects may be also a sign of societal relevance. These projects not only affect the scientific debate, but may also have an impact on urban and regional governance practices. Many of these projects also involve operating in international networks.

## 9.7.1

## Societal relevance

Research in the Urban and Regional Studies programme is relevant to society. Personal grants to Professor Maarten van Ham and Dr Evert Meijers not only the scientific excellence of the programme, but also the valorisation potential resulting from its societal relevance.

The ERC Consolidator Grant (€2 million) has been awarded to Professor Maarten van Ham (who previously received a Marie Curie Career Integration Grant NBHCHOICE (€100,000)) for research on socio-spatial inequality, deprived neighbourhoods and neighbourhood effects ([www.deprivedhoods.eu](http://www.deprivedhoods.eu)). The project began in August 2014 with 10 researchers based in four countries (Estonia, Sweden, the Netherlands, United Kingdom) who track neighbourhood sorting over the life course, neighbourhood change and neighbourhood effects, according to a single theoretical and analytical framework. The project is the first integrated, multi-country research project on neighbourhood effects to use unique geo-referenced longitudinal data from four countries. Through its integrated and international approach, the project fundamentally advances understanding of the ways in which individual outcomes interact with the neighbourhood, which will ultimately lead to more targeted and effective policy measures.

The research project has already resulted in the publication of 25 journal articles, book chapters and working papers. Its topics of inequality and urban poverty are of high societal relevance. This is evidenced by the attention generated by the book *Socio-Economic Segregation in European Capital Cities* that was published by Routledge in August 2015. The book has already had a significant impact on policy and practice and has attracted wide international media attention. The book shows that a widening gap between rich and poor people is leading to segregation in more and more European cities. The rich and the poor are living at increasing distance from each other, which can negatively affect the social stability of cities. The book provides rigorous comparative

evidence on socioeconomic segregation from 13 European cities: Madrid, Milan, Tallinn, London, Stockholm, Vienna, Athens, Amsterdam, Budapest, Riga, Vilnius, Prague and Oslo. The book's website ([www.segregationeurope.eu](http://www.segregationeurope.eu)), which has a summary animation, has been viewed more than 14,000 times. The findings have been covered by media in the US, the UK, Sweden, Estonia, the Netherlands, Spain, Austria, Germany, Norway and Belgium, and have led to interviews published in high-profile newspapers including the Washington Post, The Guardian, El Pais, Die Zeit, and NRC Handelsblad. The book has also featured on radio and TV in the Netherlands, Sweden, Estonia and Spain, and in/on a range of magazines and websites for professionals and practitioners. The finding that socioeconomic segregation is increasing has led to questions in parliament in the Netherlands and Spain, national discussions in Sweden and Estonia, and high-profile attention from the OECD and the European Commission. The book has resulted in numerous invitations to make presentations and give keynote speeches. The results have also found their way into reports by the OECD and the EU on the state of cities. They have also been used to feed into the national election programmes of the major political parties in the Netherlands.

Dr Evert Meijers received two successive personal NWO grants. Both were granted under the Innovative Research Incentives Scheme, the most prestigious type of grants for *"talented, creative researchers engaged in innovative research"*. The first, a Veni project funded from 2008 to 2011 (€215,000), focused on agglomeration effects in urban networks and compared polycentric and monocentric metropolitan areas. The Veni project resulted in several well-cited scientific publications. Dr Meijers' second award, a Vidi project funded from 2015 to 2019 (€800,000), focuses on the spatial dimension of agglomeration economies. The Vidi grant funds a new research group comprising two PhD students and a postdoctoral researcher. Both Veni and Vidi projects are of high societal relevance and the topics are related to the NAPOLEON project (Networks, Agglomeration and Polycentric Metropolitan areas: New perspectives for improved economic performance), funded under the NWO/Platform31 Knowledge for Strong Cities programme. The NAPOLEON project was one of nine projects funded under the NWO/Platform31 Knowledge for Strong Cities programme (Frame) that were awarded to members of the Urban and Regional Studies programme.

#### Projects in NWO/Platform31 Knowledge for Strong Cities programme (funded by NWO/NICIS/Ministry and other practice partners)

- Knowledge development experiment community enterprises. Practice partner: Landelijk Samenwerkingsverband Aandachtswijken (LSA) (external funding to URS €120,000).
- 'Please do it yourself'. On social support, professional counselling and long-term upward social mobility in a neighbourhood-based approach. Practice partners: Borough of Hoogvliet, Vestia Hoogvliet, Woonbron Hoogvliet, Platform Corpovenista (external funding to URS €202,000).
- Spillover Effects from Urban Restructuring. Practice partners: local authorities of The Hague, Rotterdam, Breda, Groningen and Ede, and the housing associations Woonstad Rotterdam, Haag Wonen and Lefier (external funding to URS €64,000)
- The Power of Beautiful Public Spaces. Practice partners: local authorities of Amsterdam, Rotterdam, Utrecht (external funding to URS €89,000).
- Branding and Life Styles. Practice partners: local authorities of The Hague, Leeuwarden, Maastricht, Rotterdam, housing association Vestia and ERA Contour (external funding to URS €102,000).
- Neighbourhood Decline and Collective Efficacy Practice partners: local authorities of Amsterdam, Rotterdam, Dordrecht.
- At Home in the City. Practice partners: local authorities of Utrecht and Zaanstad (external funding to URS €100,000).

- Best Persons. Academic partner: Tilburg University. Practice partners: local authorities of Leeuwarden, Zwolle, Den Haag, Utrecht, Amsterdam (external funding to URS €40,000).
- How can gentrification contribute to trust? Practice partners: local authorities of Amsterdam and Enschede.
- Networks, Agglomeration and Polycentric Metropolitan areas: New perspectives for improved economic performance. Academic partners Erasmus University Rotterdam and University Utrecht. Practice partners: local authorities of Amsterdam, Den Haag, Eindhoven, Rotterdam, Utrecht, and Region Groningen–Assen (external funding to URS €140,000).

The relationship between urban development and transport is another key theme in the Urban and Regional Studies programme in which scientific interest and societal relevance have been successfully integrated. The programme received two postdoc grants from NWO's The Sustainable Accessibility of the Randstad programme, which has been sponsored by the Ministry of Infrastructure and the Environment. The first of these two projects focused on transit-oriented development (TOD) in the southern part of the Randstad (€139,000). The second focused on an international comparison of TOD in North America and Europe (€50,000). Furthermore, a grant under the NWO's Doctoral Grant for Teachers programme, which is aimed at getting teachers to directly apply the knowledge and research experience they acquire during their PhD study for the benefit of educational practice, has been awarded to investigate the temporal relationships between travel behaviour and the built environment.

Outcomes of a project on urban planning and transport infrastructure provision in the Randstad have been presented, financed by the OECD's International Transport Forum, at a closed roundtable at the Chinese Ministry of Transport. In the field of electric mobility, the group participated in an NWO project on Energy Transitions that investigated the early adopters of electrical vehicles (€24,000), and in the field of the sustainable accessibility of the Randstad, it participated in an NWO project on the large-scale introduction of electric transport (€182,000). E-mobility was also the topic of an Interreg project in the North Sea Region (€180,000), while transport innovations in a regional context was the subject of research in the FP7 project on Mapping European Transport regional Research & Innovation Capacities (METRIC) (€88,000) and the Interreg project TWINHUB project examining new rail routings using Rotterdam and Antwerp as a dual hub (€399,000). Several projects related to transport infrastructure and urban development have been funded, including a project on bicycle parking in Delft (€63,000) during the redevelopment of the station area, and a project (commissioned by the City of Amsterdam: funding €80,000) on potential land value gains and property development proceeds of the tunnelling of main road infrastructure through the South Axis business district in Amsterdam.

Another key theme in the Urban and Regional Studies programme is the governance of cities and regions, including attention to legal issues. The group's reputation has resulted in participation in various large collaborative projects such as the FP7 project Tenancy Law and Housing Policy in Multilevel Europe (Tenlaw) (contribution to TU Delft: €385,000), which involved an analysis of housing law in France, Belgium and the Netherlands and activities to promote cross-national cooperation. Legal norms were also a central topic in the NWO-funded CONTEXT project (€135,000) investigating how such norms are embedded in different local contexts in urban peripheries.

In another project, TANGO (Territorial Approaches for New Governance), funded under the ESPON Programme, research was carried out into the ways in which territorial governance is organised across Europe and the mechanisms that are used to promote

coordination between sectoral policies and cooperation between different levels of public government (€167,000). Other recent ESPON projects carried out by members of the Urban and Regional Studies programme include ARTS (Assessment of Regional and Territorial Sensitivity; €38,000), EATIA (on territorial impact analysis; €38,000) and RISE (Regional Integrated Strategies in Europe; €63,000).

The Urban and Regional Studies group has also recently been involved in projects for the Ministry of Infrastructure and the Environment concerning international examples of urban land readjustment (€73,000) and the feasibility of introducing such an instrument in the national context (€49,000). The group has applied its multidisciplinary expertise in studies for local auditing committees and council inquiries, such as research for the auditing committee towards land acquisitions by provinces Gelderland and Overijssel (€45,000) and research to support a council inquiry into land policy in the City of Enschede (€59,000). In December 2015, a new project on advanced decision support for smart governance (SmartGov) (€255,000) was awarded under the ERA-NET CO-FUND Smart Cities and Communities call.

The close relation to practice is evidenced by various committee memberships, including Herman de Wolff's membership of the Wijntjes committee on the Amsterdam land development reallocation fund, and Professor Willem Korthals Altes's membership of the City of Amsterdam's committees on land value and land values of leasehold land.

Sustainability and urban resilience are key themes in the research carried out in the Urban and Regional Studies programme. Activities related to this topic include the FP7 Sustainable Urban Metabolism in Europe (SUME) project, which examined the impacts of existing urban forms on resource use and estimated the future potential to transform urban building and spatial structures (€312,000), and the Planning for Energy Efficient Cities (PLEEC) project (carried out together with two other research programmes in the Faculty – Housing in a Changing Society, and Urbanism; €154,000), which focused on the ways in which urban planning and development can promote energy efficiency. Two other projects closely related to the theme of sustainability and urban resilience are CASUAL (Co-creating attractive and sustainable urban areas), financed by JPI Urban Europe (€226,000), which investigates how to promote sustainable living and consumption patterns by including citizen and consumer perspectives in the governance of urban areas, and the SUPER-CITIES project (Sustainable Land Use Policies for Resilient Cities) funded under the EU URBANET programme (€42,000). The latter project resulted in a book published by Springer. To date, the book has been downloaded more than 24,000 times. Finally, as part of Rockefeller Foundation's 100 Resilient Cities project, members of the programme have been involved in research commissioned to examine the transfer of knowledge between cities.

Over the last few years, a new line of research on active citizenship and local entrepreneurship has been developed in the Urban and Regional Studies programme. Its main focus is on social enterprises, neighbourhood development and creative development in cities and makes a good fit with the emphasis on participatory approaches in the research programme. The three-year project on Knowledge development Experiment community enterprises in the Knowledge for Strong Cities programme has monitored bottom-up, new community enterprises in the Netherlands as part of a national experiment based on long-standing British experiences with community enterprises being formed in the context of welfare state retrenchment, austerity regimes and a growing emphasis on active citizenship and self-organisation. In total, 14 case studies were monitored and the results were analysed in a theoretical framework of community enterprise. The project resulted in two journal

articles, a forthcoming book, and substantial dissemination among policymakers, practitioners and citizens.

Members of the Urban and Regional Studies programme have been active as co-initiators and researchers of a much broader FP7 project on Governing Urban Diversity: Creating Social Cohesion, Social Mobility and Economic Performance in Today's Hyperdiversified Cities (DIVERCITIES) (external contribution to URS: €509,000), in which research took place in the Jane and Finch neighbourhood in Toronto (Canada). Social innovation and local enterprises were central to the project. Local entrepreneurship is very much central to the Interreg NSR project on Creative City Challenges (€143,000) and its continuation project CREALAB (€25,000) and the Interreg Europe INcompass project (Regional Policy Improvement for Financially Sustainable Creative Incubator Units) (€183,000). Local entrepreneurship was also a central theme of a handbook on neighbourhood economic development, commissioned by the Netherlands Ministry of Economic Affairs and edited by members of the Urban and Regional Studies programme in cooperation with the company SEINPOST (contribution to URS €59,000).

Knowledge exchange between academia and practice is an important part of the Urban and Regional Studies programme. Between 2009 and 2012, members of the programme participated in Platform Corpovenista, an intensive knowledge exchange network involving academic and practitioner partners (including 14 social housing providers). Platform Corpovenista funded state-of-the-art scientific research with a strong focus on practice. Local authorities, housing associations and other stakeholders were closely involved in the design, execution and dissemination of the research. Members of the Urban and Regional Studies programme carried out research and coordinated knowledge exchange (receiving over €200,000 in external funding for various contracts).

Closely related to Platform Corpovenista, various members of the Urban and Regional Studies programme contributed to national discussions on the liveability of neighbourhoods, including the development of the Leefbaarometer tool for the Ministry of the Interior and Kingdom Relations ([www.leefbaarometer.nl](http://www.leefbaarometer.nl)). The tool is being widely used by local and national governments in the Netherlands. Professor Maarten van Ham has been invited to parliamentary hearings to discuss the tool and has had discussions with the Housing minister on this issue. In addition, members of the Urban and Regional Studies programme have developed strategic "knowledge and research agendas" on Polycentric Metropolitan Areas and Sustainable Urban Mobility for the European Metropolitan Network Institute, which reflect and bridge the knowledge needs of European cities and regions and the state of the art in scholarly research on these subjects. Scientific debate between the subprogrammes has been promoted by organising OTB colloquium sessions, participating in joint projects and co-supervising PhD students. Relationships within the faculty have developed in various ways, including through education, joint projects and the secondment of Dominic Stead to Urbanism.

## List of refereed journals in which U&RS published (indexed in WoS/ESCI and others):

### REFEREED JOURNAL ARTICLES (WOS, ESCI)

- Annals of the Association of American Geographers
- Antipode
- Applied Spatial Analysis and Policy
- Building Research and Information
- Cities
- Comparative Population Studies
- Creativity and Innovation Management
- Demography
- Deviant Behavior
- DISP
- Energy Policy
- Environment and Planning A
- Environment and Planning B: Planning and Design
- Environmental Policy and Governance
- European Journal of Population
- European Planning Studies
- Geografisk Tidsskrift-Danish Journal of Geography
- Geografiska Annaler. Series B. Human Geography
- Habitat International
- Housing Policy Debate
- Housing Studies
- Journal of Urban Affairs
- Journal of Urban Design (ESCI)
- Journal of Urban Planning and Development
- Journal of Youth and Adolescence
- Land Use Policy
- International Journal of Sustainable Development and World Ecology
- International Journal of Urban and Regional Research
- Journal of Baltic Studies
- Journal of Cleaner Production
- Journal of Economic Geography
- Journal of Enterprising Communities (ESCI)
- Journal of Ethnic and Migration Studies
- Journal of Housing and the Built Environment
- Journal of International Migration and Integration
- Journal of Planning Education and Research
- Journal of Planning Literature
- Journal of Quantitative Criminology
- Journal of Research in Crime and Delinquency
- Journal of Technology Transfer
- Journal of Transport Geography
- Landscape and Urban Planning
- Maritime Economics & Logistics
- Municipal Engineer
- Open House International
- Papers in Regional Science
- PLoS One
- Population, Space and Place
- Progress in Human Geography
- Regional Studies
- Research in Transportation Economics
- Research Policy
- Social Science Research
- Sociological Review

- Sustainability
- Technological Forecasting and Social Change
- Technology Analysis & Strategic Management
- Tijdschrift voor Economische en Sociale Geografie
- Transactions of the Institute of British Geographers
- Transport Policy
- Transport Reviews
- Transportation
- Transportation Research
- Part A: Policy & Practice Transportation Research
- Part D: Transport & Environment Transportation Research
- Part E: Logistics and Transportation Review
- Transportation Research Record
- Urban Studies
- Voluntas

### OTHER REFEREED ACADEMIC JOURNALS

- Arhitektura, Raziskave
- B en M: tijdschrift voor beleid, politiek en maatschappij
- Built Environment
- City
- Cityscape
- Environmental Innovation and Societal Transitions
- Etudes Foncières
- European Journal of Spatial Development
- Geographia Polonica
- Geography Research Forum
- Housing, Theory and Society
- International Journal of Housing Policy
- International Journal of Knowledge-Based Development
- International Journal of Law in the Built Environment
- International Planning Studies
- Journal of Ethnic and Migration Studies
- Journal of Legal Affairs and Dispute Resolution in Engineering and Construction
- Journal of Urban Design
- Journal of Urban Regeneration and Renewal
- Planning Practice and Research
- Planning Theory & Practice
- PropertyNL Research Quarterly
- Ruimte & Maatschappij
- Stadsgeschiedenis
- Studia i Materialy Towarzystwa Naukowego Nieruchomosci
- Territorio
- Territorium
- The Asian Journal of Shipping and Logistics
- Tijdschrift Vervoerswetenschap
- Tijdschrift voor Bouwrecht
- Town Planning Review
- Urban Design and Planning
- Urban Planning International (Guoji Chengshi)
- Urban Research & Practice
- Urban Studies Research
- Urban Transport of China (Chengshi Jiatong)
- WPNR



Regional Studies Association Annual Conference, TU Delft Aula Conference Centre, 13–16 May 2012.

### 9.7.2

#### Activities

##### Editorships (special issues)

- Stead, D. (2011) *Differential Europe: Domestic Actors and Their Role in Shaping Spatial Planning Systems*, *disP* 186 – 3/
- Stead, D., De Vries, J., Tasan-Kok, M.T. (2015) Special Issue: *Planning Cultures and Histories: Influences on the Evolution of Planning Systems and Spatial Development Patterns*, *European Planning Studies*, 23(11)
- Burger, M.J., Meijers, E.J. & van Oort, F.G. (2014) *Spatial Dynamics of Regional Cities: New Perspectives*, *Regional Studies*, 48(12)
- Kleinhans R., van Ham M. & Evans-Cowley J. (2015) *Using Social Media and Mobile Technologies to Foster Engagement and Self-Organization in Participatory Urban Planning and Neighbourhood Governance*. *Planning Practice & Research* 30(3).
- Kleinhans, R. & Kearns, A. (2013) *Neighbourhood Restructuring and Residential Relocation: Towards a Balanced Perspective on Relocation Processes and Outcomes*. *Housing Studies* 28(2).

### 9.7.3

#### Organisation

##### Involvement in scientific events or conference organisation activities

- Regional Studies Association Annual Conference, Delft, 13–16 May 2012.
- World Symposium on Transport and Land Use (WSTLUR), Delft, 24–27 June 2014.
- ESRC Seminar 'Entrepreneurial Neighbourhoods', 9–10 September 2015, Delft University of Technology.
- Using ICT, Social Media and Mobile Technologies to Foster Self-Organisation in Urban and Neighbourhood Governance, 16–17 May 2013, Delft University of Technology.
- Workshop 'Urban Systems 2.0', Delft University of Technology, September 2010; part of a series of workshops (others were organised in Rotterdam and Washington DC) organised by the research network on 'Regional Urban Systems and their Performance', under the umbrella of the Regional Studies Association (RSA).

## Selected books

- Ham, M van, D Manley, N Bailey, L Simpson, D Maclennan; *Neighbourhood effects research: new perspectives*. Springer, Dordrecht, 2012, ISBN 9789400723085.
- Tasan-Kok, MT, G Baeten; *Contradictions of Neoliberal Planning: Cities, Policies, and Politics*. Springer, Dordrecht, 2012, ISBN 9789048189236.
- Geerlings, H, Y Shiftan, D Stead (eds. 2012); *Transition towards sustainable mobility: the role of instruments, individuals and institutions*, Ashgate, Farnham.
- Eraydin, A, MT Tasan-Kok; *Resilience thinking in urban planning*. Springer, Dordrecht, 2013, ISBN 9789400754751.
- Mason C. Reuschke D., Syrett S. & van Ham M. (eds) (2015) *Entrepreneurship in cities: neighbourhoods, households and homes*. Edward Elgar: Cheltenham.

## Selected peer-reviewed journal publications

- Heinen, E, GP van Wee, K Maat (2010) *Commuting by bicycle: an overview of the literature*. Transport Reviews, 30, pp. 59–96.
- Meijers, EJ, JSCM Hoekstra, M Leijten, E Louw, M Spaans (2012) *Connecting the periphery: distributive effects of new infrastructures*. Journal of Transport Geography, 22, pp. 187–198.
- Stead, D (2013) *Convergence, divergence or constancy of spatial planning? Connecting theoretical concepts with empirical evidence from Europe*. Journal of Planning Literature, 28, pp. 19–31.
- Van der Veen, M & Korthals Altes, WK (2012). *Contracts and learning in complex urban projects*. International Journal of Urban and Regional Research, 36(5), pp. 1053–1075.
- van Ham M., Hedman L., Manley D., Coulter R. & Östh J. (2014) *Intergenerational transmission of neighbourhood poverty. An analysis of neighbourhood histories of individuals* Transactions of the Institute of British Geographers 39, pp. 402–417.

## Selected PhD theses

- Eijk, G van (2010) *Unequal networks: spatial segregation, relationships and inequality in the city*. (Cum laude)
- Bohte, W (2010) *Residential self-selection and travel: The relationship between travel-related attitudes, built environment characteristics and travel behaviour*.
- Doff, W (2010) *Puzzling neighbourhood effects. Spatial selection, ethnic concentration and neighbourhood impacts*.
- Heinen, E (2011) *Bicycle commuting*.
- Wassenberg, FAG (2013) *Large housing estates: ideas, rise, fall and recovery. The Bijlmermeer and beyond*.

## Books, reports, professional journal articles/book chapters

A handbook on neighbourhood economics was written in co-operation with SEINPOST. (Pijlman, L, R van den Hazel, M Vaessen, J Nicasio, M Fokkema, E Borgmeijer, P Draaijer, W Nieuwenhuis, E Radstake, WK Korthals Altes, E Louw, HW de Wolff, M van der Sluis - van Meijeren, CMM Adriaanse, AL Ouwehand, A Romein, JJ Trip, JSCM Hoekstra); Handboek wijkeconomie. Ministerie van Economische Zaken, Den Haag, 2010, 196 pp.

- Kang, V, Park, H (eds.) (2015) *Beyond Seunsangga: 16 ideas to go beyond big plans*. Seoul, South Korea: SPACE Books, an imprint of CNB media.
- Asperen, PCM van (2015) *Pro-poor land tools: Effectiveness within peri-urban areas in Namibia, Zambia and Botswana*. GIM International: the worldwide magazine for geomatics, 29 (March), 26–28.
- Zillmer, S; Lüer, C.; Toptsidou, M.; Krzymuski, M.; Dallhammer, E.; Kintisch, M.; Schuh, B.; Celotti, P.; Colin, A.; Preku, A.; Brignani, N.; Waterhout, B.; Zonneveld, W. &

Stead, D. (2015). *European Grouping of Territorial Cooperation as an instrument for promotion and improvement of territorial cooperation in Europe – Analytical Study*. Study for the European Parliament, Directorate General for Internal Policies Policy. European Parliament, Brussels.

- Oort, F. van, Meijers, E., Thissen, M., Hoogerbrugge, M., Burger, M. (2015) *De concurrentiepositie van Nederlandse steden: Van agglomeratiekracht naar netwerkkracht*, Platform31, Den Haag, 153 pp.

## 9.7.5

## Use

Number of downloads of books and book chapters (best 5; incomplete because only Springer provides these figures);

- *Resilience Thinking in Urban Planning* (eds: Ayda Eraydin, Tuna Taşan-Kok) 24,000 downloads.
- *Neighbourhood Effects Research: New Perspectives* (eds: van Ham, M., Manley, D., Bailey, N., Simpson, L., Maclennan, D.) 16,360 downloads.
- *Contradictions of Neoliberal Planning: Cities, Policies, and Politics* (eds: Tasan-Kok, Tuna, Baeten, Guy ) 11,250 downloads.
- *Understanding Neighbourhood Dynamics: New Insights for Neighbourhood Effects Research* (eds: van Ham, M., Manley, D., Bailey, N., Simpson, L., Maclennan, D.) 9,556 downloads.
- *Neighbourhood Effects or Neighbourhood Based Problems? A Policy Context* (eds: Manley, D., van Ham, M., Bailey, N., Simpson, L., Maclennan, D.) 8,961 downloads.

STAFF MEMBER	CITATIONS TOTAL			CITATIONS 2010-2015			H-INDEX		
	Scholar	Scopus	WoS	Scholar	Scopus	WoS	Scholar	Scopus	WoS
Faludi	8897	1560	575	3375	752	264	44	21	13
Korthals Altes	857	355	164	515	245	119	17	11	8
Maat	2081	901	672	1399	652	509	22	14	12
Meijers	2363	463	308	1640	357	227	23	11	10
Stead	2877	998	330	1756	695	240	27	18	8
Van Ham	3493	1067	719	2488	807	511	35	21	17

TABLE 9.5 Citations and H-index of selected staff members



Maarten van Ham delivering his inaugural address, 12 December 2012.

**Invitations to give keynote speeches**

- Faludi, AKF; European planning – the third way. Aveiro, 5 July 2013. Keynote speech Aveiro's 2<sup>nd</sup> Conference on Urban and Regional Planning.
- Ham, M van; Segregation, neighbourhood effects and area based policies. Helsinki, Finland, 29 October 2013. Keynote speech at the Finnish seminar of the Development Programme for Residential Areas, Department for the Built Environment, Ministry of the Environment.
- Meijers, EJ; Cities borrowing size through networks: a regional perspective on urban regeneration. Seoul, South Korea, 13 November 2014. Keynote lecture at International Symposium on Urban Regeneration to celebrate the 30<sup>th</sup> Anniversary of Dept. of Urban Planning and Design.
- Tasan-Kok, MT; Urban redevelopment for the “public interest”? Athens, Greece, 27 May 2014. Keynote speech and live stream: Rethink Athens: Urban challenges, invited by the Onassis Cultural Centre.
- Stead, D; Instruments for addressing climate change in the transport sector: an exploration of policy favouritism. Valletta, Malta, 13 April 2015. Keynote lecture at the International Conference on Climate Change Targets and Urban Transport Policy

**Invited lectures and debates for audiences of the public and policy makers**

- Ham, M. van (2015) Presentation on Socio-Economic Segregation in European Capital Cities at the OECD, Regional Development Policy Division, Public Governance and Territorial Development, 3 November 2015, Paris.
- Korthals Altes, W.K. (2015) Keynote lecture at the NVR theme afternoon on Land, Money and Municipalities, Organised by the Royal Dutch Association of Stewards, 12 June 2015, Dalfsen.
- Stead, D. (2014). Spatial Planning: Key Instrument for Development and Effective Governance. Invited presentation at the first meeting of the UNECE Task Group on Urban Planning, 15 December 2014, Geneva.
- Kleinhans, R (2015) Keynote lecture at the Mixed Housing (Gemengd Wonen) conference of the Amsterdamse Federatie van Woningcorporaties (Amsterdam Federation of Housing Corporations), Amsterdam, 3 December 2015. Title of presentation: 'Mengen, verkopen, de weg kwijtraken' ('Mix, sell, lose the way'). See online conference magazine.
- Ham, M van (2012); Housing and neighbourhood renewal policy. Discussion with members of the Netherlands Parliament (Tweede Kamer) on housing and neighbourhood renewal policy. Printed by: Netherlands Parliament (Tweede Kamer), Den Haag, 29 March 2012.

### Context, supervision and quality assurance

TU Delft Graduate School provides specific guidelines on the supervision and quality assurance of PhD candidates. The Graduate School for Architecture and the Built Environment (GS A+BE) also requires candidates to complete the doctoral education in addition to research that leads to a thesis. Thesis propositions must be approved by a committee in accordance with the guidelines formulated in the TU Delft Doctoral Regulations, and be defended in public proceedings.

Quality assurance takes place during the intake of new PhD students (see selection and admission procedures below). In addition, after about 1 year a formal 'go/no-go' decision meeting is scheduled by the Graduate School. At this meeting, a peer of the supervisor from another department and an independent chair of the meeting advise the supervisor whether his or her student should proceed with the PhD study. In addition to day-to-day supervision, annual progress meetings are held. A further important moment is the approval of the thesis. Here, the university has strict procedural guidelines, including a plagiarism scan of the work before the supervisor is allowed to approve the thesis, and a PhD committee that includes at least four independent members.

### Participation in research schools

The programme is involved in NETHUR (Netherlands Graduate School of Urban and Regional Studies); Korthals Altes is a member of its board. PhD students follow courses and are active in seminars in this research school, which provides opportunities to attain an economy of scale in providing focused education to PhD students in Urban and Regional Studies.

### Selection and admission procedures

Our research programme and our experienced team of supervisors continue to attract PhD students. Our programme is especially attractive because of the combination of basic and applied research, which means that the work that PhD students do often has direct relevance for society. Working within larger national or international projects is also attractive to students as it allows them to extend their networks. Most PhD students in our programme prepare their PhD thesis based on refereed journal articles. The supervisors are experienced researchers who have published ample papers in peer-reviewed journals. In some cases, and especially where professionals are working on a PhD project, the PhD thesis is prepared as a monograph.

All four sub-programmes take PhD students. The PhD students present some of their topics separately during the mid-term review. Current topics include: Causes and effects of segregation; Co-designing scenarios: success factors for strategic decision-making in a complex reality; Everyday encounters in urban public space; Family conditions; Long-term transport and land use interaction; Longitudinal travel behaviour; Flexibility, accountability and financial results in land development; Relationships between urbanisation, public transport structure and travel behaviour; Strategies of persons seeking housing; The image of the new city: social production and construction of a post-World War 2 urban area.

Most PhD positions (employed) are externally funded by NWO or FP7. Other PhD students (contract PhD candidates) have their own funding in the form of scholarships. We also have several professionals working on PhDs to further their professional careers. PhD students are provided with their own desk and desktop computer in an office in which no more than two researchers work at the same time. They can make use of a

landline telephone and they have their own private storage facilities and bookshelves. PhD students are allocated a personal budget to enable them to attend national and international conferences, publish their PhD thesis in the form of a book (many PhDs are published in the Sustainable Urban Areas series of IOS press) and pay for English language proofing by a native speaker.

The Graduate School for Architecture and the Built Environment has defined criteria for the selection and admission of PhD students. These criteria involve the availability of supervision capacity; the scientific quality and societal relevance of the research proposal; the quality of the curriculum vitae and the fulfilment of the requirement to have a master's degree that is equivalent to a Dutch MSc degree; the financial capacity to cover the costs of living in Delft, which may be covered by a PhD scholarship; and language proficiency. More specifically, PhD students' proposals must fit with the research programme of Urban and Regional Studies 2014–18. If students apply with proposals that appear to be more fitting to another research programme, we advise them to resubmit their proposal to the other programme.

#### Supervision of PhD candidates internally and guidance of PhDs to the labour market

We follow the guidelines of the Graduate School for Architecture and the Built Environment concerning the supervision of postgraduate students. Our research group includes a team of experienced PhD supervisors. In addition, a PhD mentor can be consulted if there are any issues related to supervision. We also contribute to the Urbanism research programme by supervising a number of PhD students at the faculty's Urbanism department.

The research group participates in two interuniversity graduate schools. The most important participation is with the Netherlands Graduate School of Urban and Regional Research (NETHUR); Willem Korthals Altes was a member of the NETHUR board throughout the assessment period. Of secondary importance is the participation in *Ius Commune*, especially in its Property Law programme, of legal researchers in the Governance of Land Development sub-programme.

Starting year	ENROLMENT			SUCCESS RATE													
	Gender			Finished								Total graduated		Not yet finished		Discontinued	
	Male	Female	Total	≤ 4Y	≤ 5Y	≤ 6Y	≤ 7Y										
2006	0	0	0	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
2007	0	1	1	1	100%	1	100%	1	100%	1	100%	1	100%	0	0%	0	0%
2008	0	0	0	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
2009	0	1	1	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	1	100%
2010	0	0	0	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
2011	1	2	3	1	100%	1	100%	1	100%	1	100%	1	33%	2	67%	0	0%
<b>Total</b>	<b>1</b>	<b>4</b>	<b>5</b>	<b>2</b>	<b>40%</b>	<b>2</b>	<b>40%</b>	<b>2</b>	<b>40%</b>	<b>2</b>	<b>40%</b>	<b>2</b>	<b>40%</b>	<b>2</b>	<b>40%</b>	<b>1</b>	<b>20%</b>

TABLE 9.6 Length of PhD candidacies and success rate of the PhD programme

### Research quality

An extensive list of high-quality research publications and of research funds awarded in recognition of excellence (e.g. the ERC consolidator grant; Vidi) evidences the strength of this programme and the quality of its research. In relation to the excellence of research staff, the programme is highly viable and the context of the Faculty of Architecture and the Built Environment provides excellent opportunities for future research activities. In recent years, we have attracted more and more PhD students (financed by a variety of sources, including the ERC Consolidator Grant, Vidi grants and individual grants for the PhD students), which will also result in new research outcomes in addition to research by postdocs (which are financed by research funds) and senior staff.

### Relevance to society

By their very nature, urban and regional studies are highly relevant to society, and the research priorities of the programme are informed by societal relevance. This societal relevance is also communicated to societal actors in a variety of ways. The societal relevance of this programme stems not only from the societal relevance of research inspired by curiosity, but also from the fact that it addresses issues of governance in the urban and regional domain. The link between research and society is formed in different ways. One of these ways is inside projects, in which impact plays an important role in the way a project is formulated. Within the projects, such as in FP7, Interreg or Espon, societal relevance is assessed before the project is selected. Performing these projects is thus a way that gives shape to societal relevance. In addition, there are many projects carried out for societal actors in which research insights or skills are used to study societal questions directly. The programme also has many professional publications that help to connect the domains of scientific and societal relevance.

### Viability, using a SWOT analysis

Overall, this consolidated programme has resulted in a more coherent study of the research field, enabling us to contribute even more to society and the academic community. Thanks to its high quality research staff, many of whom have an international reputation, the programme participates in many national and international research consortia and projects, and has a consistently high level of research income and research output, with papers in international peer-reviewed journals and publications. The group is highly experienced in knowledge-exchange activities.

## SWOT analysis

### STRENGTHS

The programme has a strong international position and reputation and contributes to a variety of networks and collaborations. Urban and Regional Studies has attracted several major and prestigious grants, including a European Research Council Grant, NWO Veni and Vidi grants, two large FP7 grants, two Marie Curie grants and 12 other large grants. Urban and Regional Studies researchers have published influential books and 213 papers in peer-reviewed journals. This research has had a high academic impact, as evidenced by large numbers of citations. Urban and Regional Studies research has influenced policymaking and practice in several European countries and at the level of the OECD and the European Union. The programme has a growing number of PhD students and visiting fellows and its research has featured in leading newspapers in Europe and the USA.

### OPPORTUNITIES

The organisational merger of OTB and the Faculty of Architecture offers many new opportunities for collaboration, sharing and disseminating knowledge, acquiring new, talented PhD students and collecting research data. The recent economic crisis has raised the societal awareness of the need for new ways of governance in the field of urban and regional studies, which has resulted in new funding opportunities especially in relation to issues of urban inequality and urban functional relationships. In addition, the increasing availability of large longitudinal datasets offers new research opportunities. Research funds, including European funding, are providing opportunities for research and collaboration.

### WEAKNESSES

Relative to the number of permanent staff, the programme has had few PhD students. This might be because the sub-programmes Territorial Governance and Urban Systems & Transport are led not by professors but by associate professors, who are not yet allowed to supervise PhD students independently. A relatively large proportion of permanent staff are funded by projects. Acquiring this funding is proving difficult for some sub-programmes. Because of this, acquiring funding for existing staff has, from a financial management perspective, a higher priority than acquiring funding for new PhD students or postdocs. Although researchers in the programme are not troubled by this financial management perspective (and recently many new PhD students have been appointed based on the ERC and Vidi grants), there are no quick and easy solutions to the problem.

### THREATS

As part of the research budgets must be acquired through external funding, external developments relating to research funding can develop into threats to the financing of existing staff or PhD students and postdocs. Although large research projects can provide long-term certainty about funding if they are acquired, it can take a long time before these funds are acquired and there is a big chance that good project proposals will not be funded, resulting in relatively long periods of underfunding. This threat can be countered by the timely writing of project proposals.

# GEO-TG

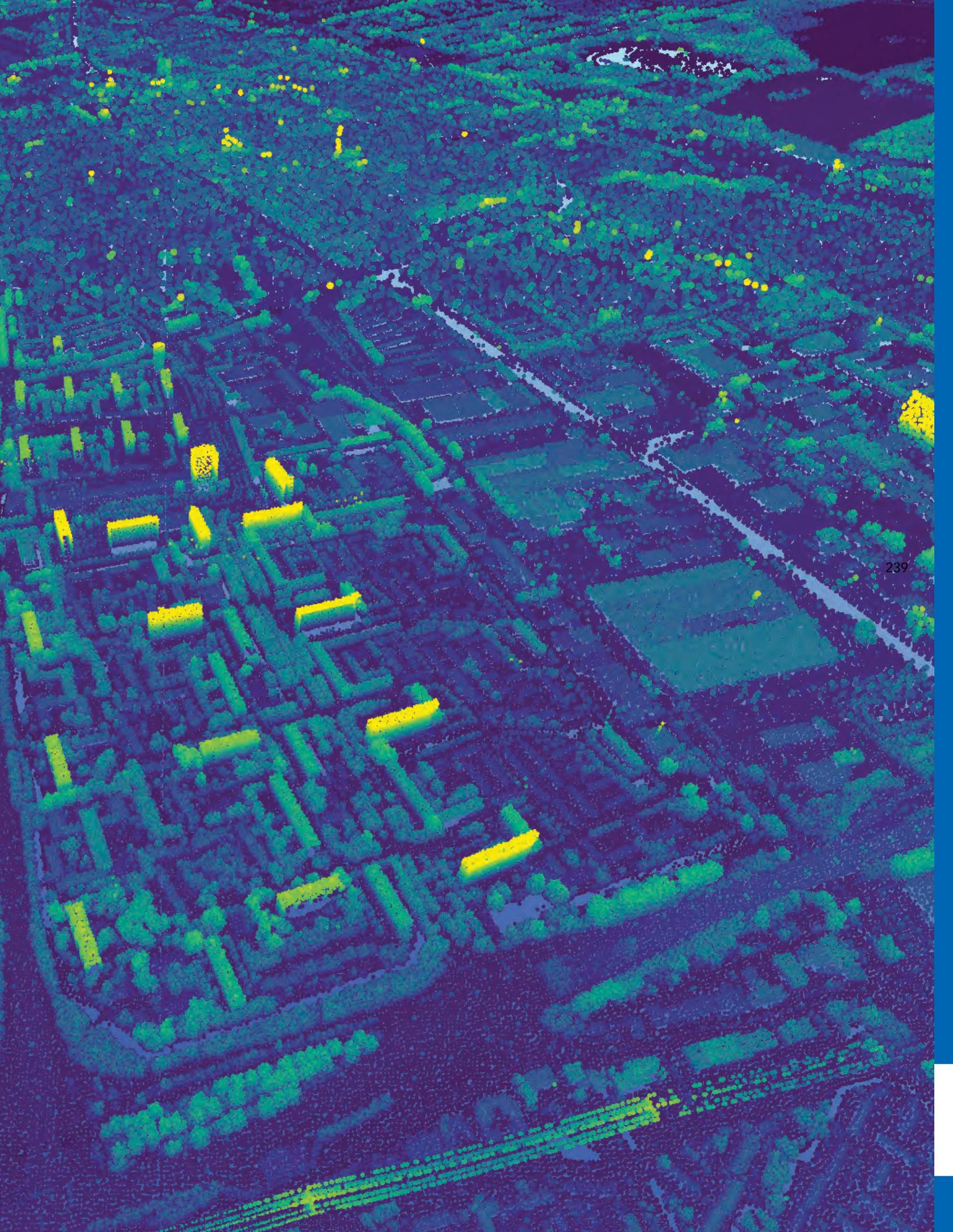
## Geo-information Technology and Governance

Programme leader:

**Peter van Oosterom**

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Massive point cloud: City of Delft



# Geo-information Technology and Governance

## Scope

Geo-information Technology and Governance is setting the stage for a paradigm shift towards vario-scale geo-information, it investigates open data policies, contributes to standardizing land administration (ISO 19152, including 3D Cadastre), and handles big spatial data (such as huge point clouds or real-time sensor data), etc. It has created an organizational setting for these activities by means of the establishment of the Knowledge Centre Open Data (since May 2012), the Wuhan-TU Delft Joint Research Centre (since November 2012), and STW partnership programme Maps4Society (since June 2013).

This research programme investigates how both technology and governance aspects of the geo-information infrastructure (GII) can be further strengthened in order to solve complex social, industrial and management problems in the built environment. Geo-information technology (GIS technology or geo-ICT) and geo-information governance are part of the more general discipline of geo-information science. To realise an efficient GII, both the technology and the governance aspects and their interrelations need to be studied. Therefore, the research within this programme develops both concepts and tools to facilitate the sharing, exchange, integration, updating and reuse of information sources within the GII. The information is not limited to traditional 2D maps, but increasingly involves extra dimensions (height, time, scale): 3D, 4D, ... nD. Datasets are rapidly increasing in complexity and size due to various developments, such as point cloud data acquisition methods, positioning systems, sensor web technology and volunteered geographic information (VGI), and are fed by social media, smartphones, smart cars, etc. When reusing information, the governance aspects – including the legal issues (privacy, licenses and legislation promoting the reuse of public sector information) and organisational issues (such as business models, role of government, businesses and citizens in information supply and use) – play an important role. The societal aim is to investigate, apply and test open data policies in order to underpin their success, maximise the benefit for society and provide sustainable information management for the increasingly complex built environment. The GII, based on big open linked data (BOLD) technology and governance principles, will enable better real-time spatial decision making. The GII serves numerous application domains, such as urban planning and design, climate change studies, disaster management, infrastructure planning and management, transport, and water management. Two specific applications are given more attention and have become central to our research programme: real-time geo-information (decision support, for example in crisis management) and land administration (including land registry, cadastral mapping and surveying). These applications serve as a source of inspiration for challenging research topics, and also provide a realistic setting for the assessment of our latest research results.

GEO-TG	2010		2011		2012		2013		2014		2015	
	Nr.	FTE										
Scientific staff	10	2,7	9	2,5	9	2,9	10	2,9	10	3,0	7	1,8
Researchers	5	2,3	7	2,9	6	2,6	5	3,0	7	3,2	5	2,9
PhD candidates	9		8		7		5		5		5	
<b>Total research staff</b>	<b>24</b>	<b>5,0</b>	<b>24</b>	<b>5,5</b>	<b>22</b>	<b>5,5</b>	<b>20</b>	<b>5,9</b>	<b>22</b>	<b>6,1</b>	<b>17</b>	<b>4,7</b>
Visiting fellows	4		4		8		13		13		4	
<b>Total staff</b>	<b>28</b>	<b>5,0</b>	<b>28</b>	<b>5,5</b>	<b>30</b>	<b>5,5</b>	<b>33</b>	<b>5,9</b>	<b>35</b>	<b>6,1</b>	<b>21</b>	<b>4,7</b>

TABLE 10.1 Research staff (composition of the research unit)

GEO-TG	2010	2011	2012	2013	2014	2015
Refereed articles	16	14	6	18	11	10
Non-refereed articles	0	0	0	1	0	0
Book	3	4	3	1	1	0
Book chapters	16	12	14	25	8	0
PhD theses	0	3	2	1	1	1
Conference papers	41	43	40	30	23	16
Professional publications	37	32	35	39	35	23
Publications aimed at the general public	1	3	6	0	4	2
<b>Other Research Output:</b>						
Book reviews	1	0	0	0	1	2
Appearances on radio or television	0	0	1	0	1	0
Internal reports, lectures, posters, datasets	5	4	16	4	42	25
External reports	10	10	14	9	24	7
Editorships of books	4	1	6	6	3	6
Editorships of journals	1	1	1	2	1	2
<b>Total other Research Output</b>	<b>21</b>	<b>16</b>	<b>38</b>	<b>21</b>	<b>72</b>	<b>42</b>
<b>Total publications</b>	<b>135</b>	<b>127</b>	<b>144</b>	<b>136</b>	<b>155</b>	<b>94</b>

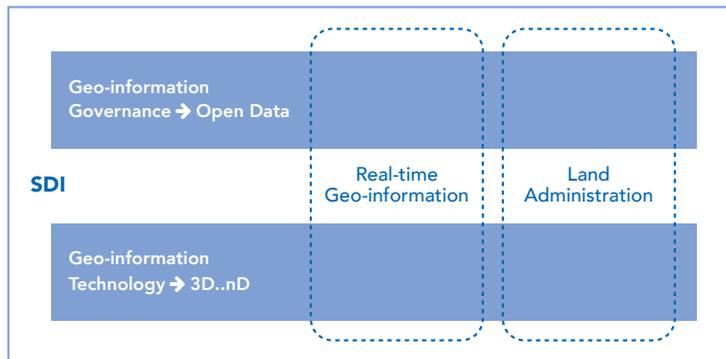
TABLE 10.2 Main categories of research output

GEO-TG	2010		2011		2012		2013		2014		2015	
	K€	%	K€	%	K€	%	K€	%	K€	%	K€	%
Direct funding	571	47%	627	46%	622	45%	765	47%	754	46%	463	52%
Research grants	3	0%	168	12%	280	20%	466	29%	508	31%	146	16%
Contract research	537	44%	568	42%	474	34%	519	32%	627	39%	313	35%
Own contribution	-217	-18%	-49	-4%	-85	-6%	-162	-10%	-311	-19%	-153	-17%
Other	324	27%	48	4%	89	6%	25	2%	49	3%	125	14%
<b>Total funding</b>	<b>1.217</b>	<b>100%</b>	<b>1.362</b>	<b>100%</b>	<b>1.380</b>	<b>100%</b>	<b>1.614</b>	<b>100%</b>	<b>1.626</b>	<b>100%</b>	<b>894</b>	<b>100%</b>
Personnel costs	-625	65%	-673	66%	-795	73%	-896	68%	-909	64%	-604	81%
Other costs	-335	35%	-354	34%	-297	27%	-413	32%	-505	36%	-144	19%
<b>Total expenditure</b>	<b>-960</b>	<b>100%</b>	<b>-1.026</b>	<b>100%</b>	<b>-1.092</b>	<b>100%</b>	<b>-1.308</b>	<b>100%</b>	<b>-1.414</b>	<b>100%</b>	<b>-748</b>	<b>100%</b>
<b>Result</b>	<b>257</b>		<b>336</b>		<b>288</b>		<b>306</b>		<b>212</b>		<b>146</b>	

TABLE 10.3 Funding (research unit's financing structure)

## Strategy

The aim is to strengthen the two scientific pillars of the Geo-TG programme that underpin the GII, and to further develop foundational knowledge by focusing on geo-information technology (with a special focus on nD modelling) and geo-information governance (with a special focus on open data). The knowledge is applied to and assessed within the context of our key application domains, namely real-time geo-information (as used in decision support during crisis management) and land administration.



Structure of the Geo-information Technology and Governance programme

Our approach is characterised by the tight integration of education and research, internationalisation (Joint Research Centre, Wuhan, China), participation in standardisation bodies (ISO, OGC, NEN), making developed software available as open source, leading working groups at the national level (NCG) and global level (FIG, GSDI Association and ISPRS), and close cooperation with industry and government (via GDMC & Knowledge Center Open Data).

The two main research topics – nD modelling and open data – will enable us to become world leaders and influence the global research agenda. The STW Maps4Society cooperation programme (M4S) was initiated by us, and of the six funded large projects, three of them belonged to the Geo-TG programme. We aim to improve the use of Big Open Linked (geo) Data, and pay special attention to massive point clouds (either due to scanning scenes or to tracking moving objects). Point clouds should become 'first-class citizens' in our methods and systems for representing spatio-temporal phenomena, in addition to the two well-established alternatives: object (vector) or coverage (raster) representations. For open data, we aim at increasing the impact by studying the open data ecosystem, including the role of law in facilitating the use and reuse of open data, and at assessing the performance of the open data ecosystem, including the effectiveness of governance, with a particular focus on the role of the different stakeholders in the open data ecosystem.

Realising the proper balance between permanent and temporary staff (implying a more or less stable permanent staff, and a growth in temporary staff) is an important target. It is therefore the intention to attract each year three new PhD students (on average, two in technology and one in governance) and also to have three PhD students graduate each year, which is an increase compared to the number of graduates in recent years. We also intend to attract talented young postdocs from elsewhere (e.g. in the context of JRC-SI Wuhan–Delft).

## Targets

The targets in the past period were to create and support key registers (an essential part of GII), which are made publicly available as open data, by carrying out research. Our research and education in the field are closely integrated and our student numbers are growing and we are attracting more talent. Through our research, we have enabled the government's role in efficiently obtaining and distributing data, which is now partly fulfilled by private sector organisations and by citizens (crowdsourcing). Five years ago, we launched the 'day fresh map' target, in an era of 2- and 4-year update cycles of base maps. Today, the 'day fresh map' is close to becoming a reality as a result of the streamlined GII, in which society collaborates and joins forces.

The targets for the coming decade include even better, more advanced and pervasive use of geo-information in our daily lives, in governmental services and in private sector businesses. Due to various developments, including sensor and mobile data, there will be even larger amounts of data, including real-time and big open linked data (BOLD). In the near future, BOLD will allow us to describe and understand what is happening where and when, who is involved and why it is happening, and act upon that information. BOLD will include not only base maps, but also all types of sensor data, most often with a spatial component: water quality data, local air quality data, traffic flows, data on the health of individual people and data on robots in buildings (smart fridges, smart energy supply, etc.). It is a huge challenge to effectively transform these enormous amounts of sensor data into meaningful information that can be used effectively on a real-time basis.

Geo-information traditionally stops at the front door. However, we spend most of our time indoors. This requires integrated information covering both the outdoors and indoors, and coincides with the shift from creating new buildings to managing existing buildings, based on building information models (BIMs). We therefore need to conduct more fundamental research, and the Dutch geo-information research community has identified the following priorities:

- move from static to dynamic data (including real-time);
- support multi-scale and vario-scale spatio-temporal representations;
- integrate the outdoor and indoor spatial information;
- design tools and the governance frameworks to enable open data.

The greatest benefits can be achieved by applying these innovations in new domains, for example healthcare, energy, water, spatial planning, transport and construction.

## Environment

The current programme Geo-TG has its roots in two old research programmes (GIS Technology and Geo-information & Land Development). Today, its staff are still based in these two sections. In 2014, OTB (the Research Institute for the Built Environment) became a department of the Faculty of Architecture and the Built Environment. The number of MSc students doing Geomatics (TU Delft), GIMA (Geo Information Management and Applications; UU, WUR, UT and TU Delft) or the National GI Minor (VU, UU, WUR, UT and TU Delft) has been growing:

- MSc in Geomatics: 2010: 7; 2015: 19; 2016: 29;
- MSc in GIMA: 2010: 19; 2015: 37; 2016: 40;
- GI minor: 2012 (first year): 23; 2015: 36; 2016: 45.

The monopoly of government organisations on the supply of geo-information is slowly ending. Particularly in the field of dynamic data, the millions of observations obtained from smartphones now complement the measurements from the dozens of public data-gathering networks. To make the best use of the information available to our society while showing respect for fundamental rights such as privacy, agreements must be reached between government bodies, private companies and citizens on how to organise our future information infrastructure.

The new NWO/SURF organisation in the Netherlands – NLeSc (Netherlands eScience Center) – has proved to be very relevant for the geo-information technology part of the programme.

INSPIRE is a continuous activity that is important for both parts of the programme, and the European Galileo satellite navigation system and the Copernicus earth observation system are striking developments. For open data, the European Commission's Digital agenda for Europe 2011 (COM 2011, 882) and Digital single market 2015 are important.

Our environment in the future will include Big Open Linked (geo) Data (BOLD), which is becoming increasingly important (sensor technology, social media, etc.). The same holds for massive point clouds. The importance of open data is recognised by government at all levels (UN, EU, NL, provinces, municipalities, etc.), but this recognition might lead to a conflict of interest with other goals (such as data protection or safeguarding the privacy of citizens). Another challenge is how to manage BOLD (how to optimise organisational and legal interoperability) and the impact on the information position and the authority of government data in the explosion of 'competing' data. The integration of indoor–outdoor (geo-information, navigation, etc.) will be of growing importance. The internationalisation is growing (e.g. via our JRC Wuhan–Delft, partnership and the MoU with the Chinese National Mapping Authority (NASG), and UN–GGIM), as is our influx of PhD and MSc students.

Moreover, big commercial players, such as Google, Microsoft and Oracle, also pioneer important international developments (and we have various types of collaboration with these players). At the global level, the standards of the Open Geospatial Consortium and ISO are promoting the interoperability of location-based information (from a technical standpoint). Anticipating international developments in a timely manner and influencing them, combined with actively participating in international knowledge networks (UN–GGIM, JRC Wuhan–Delft, GSDI, ISPRS, FIG, etc.), will help us to stay at the forefront of the research developments.

## 10.6

### Performance indicators

Given the nature of the Geo-TG programme, we have selected the above performance indicators. The academic prestige and quality of the funded and conducted scientific projects together with the academic impact and agenda-setting nature of the conferences organised are good indicators. On the societal side, projects and events (with and for government and industry) are also important indicators, but here also the design and execution of SDI, database and data policy benchmarks is listed as an indicator. Looking at the category 'organisation', structural collaborations with partner universities on the scientific side and established knowledge centres and working groups on the societal side are relevant indicators. Given the technology level and SDI orientation of the Geo-TG programme, the indicators for facilities/assets include computing hardware and web services, as well as access to young talents, such as

master's students. For the indicators of the category 'output', contributions to standards and obtaining patents has been added to more traditional indicators, such as the various types of publications. The scientific use can be measured by citations and the attractiveness to international visitors. The societal use can be verified by checking the use/implementation of methodologies and research results. Further, the use of the knowledge generated can be measured by developed open source code and the potential direct use in master's education. Finally, in the category 'recognition', the indicators are quite obvious, on both the scientific and the societal side: prizes, grants, keynote speeches, editorial boards/programme committees, awards and repeated selection for projects ('customer satisfaction'), etc.

ASSESSMENT DIMENSIONS	QUALITY DOMAINS	
	RESEARCH QUALITY	RELEVANCE TO SOCIETY
ACTIVITIES, ORGANISATION, FACILITIES/ASSETS, OUTPUT	<p><b>Activities</b></p> <ul style="list-style-type: none"> <li>• Projects</li> <li>• Conferences</li> </ul> <p><b>Organisation</b></p> <ul style="list-style-type: none"> <li>• Joint research centres</li> </ul> <p><b>Facilities/assets</b></p> <ul style="list-style-type: none"> <li>• Computing hardware facilities Master's students</li> </ul> <p><b>Output</b></p> <ul style="list-style-type: none"> <li>• Academic journal articles</li> <li>• Books</li> <li>• Special issue journals</li> </ul>	<p><b>Activities</b></p> <ul style="list-style-type: none"> <li>• Projects</li> <li>• Benchmarks</li> <li>• Events</li> </ul> <p><b>Organisation</b></p> <ul style="list-style-type: none"> <li>• Working groups</li> <li>• Knowledge centres</li> </ul> <p><b>Facilities/assets</b></p> <ul style="list-style-type: none"> <li>• Web services</li> </ul> <p><b>Output</b></p> <ul style="list-style-type: none"> <li>• Professional articles</li> <li>• Patents</li> <li>• Standards</li> </ul>
USE	<ul style="list-style-type: none"> <li>• Citations</li> <li>• International visitors</li> </ul>	<ul style="list-style-type: none"> <li>• Methodologies, results used/implemented</li> <li>• Open source software</li> <li>• Master's education</li> </ul>
MARKS OF RECOGNITION	<ul style="list-style-type: none"> <li>• Prizes</li> <li>• Grants</li> <li>• Keynote speeches</li> <li>• Editorial boards</li> <li>• Programme committees</li> </ul>	<ul style="list-style-type: none"> <li>• Awards</li> <li>• Repeated selections</li> </ul>

TABLE 10.4 Selected performance indicators

In this first paragraph we highlight some exemplary research result: JRC Wuhan–Delft, Open Data Knowledge Centre, and vario-scale geo-information research (patent/projects).

#### JRC Wuhan–Delft

The Wuhan University–Delft University of Technology Joint Research Centre (JRC) on Spatial Information was officially established in November 2012, after 15 years of more or less ad hoc collaborations by the various geo-information groups at TU Delft (both at Architecture and the Built Environment and Civil Engineering and Geosciences). The executive board of TU Delft decided to set up the JRCs (of which Wuhan–Delft is one) to achieve the following five objectives:

- 1 expand and develop academic relations in emerging knowledge economies;
- 2 attract talent from abroad;
- 3 submit proposals to or enter into alliances with funds abroad;
- 4 gain access to state-of-the-art laboratories and new research environments;
- 5 serve as a trailblazer for Dutch business and industry.

Given the extensive track record of collaboration, Wuhan is our natural partner. It is the world's largest university in spatial information (geodesy, geomatics, remote sensing, geo-informatics) with an academic staff of more than 350 and very big student numbers: BSc 3000, MSc 1000 and PhD 500. Also, the quality is world leading, as reflected in scientific journal publications and the key positions held by its staff in international organisations. Further, Wuhan University is the home of the State Key Laboratory of Information Engineering in Surveying Mapping and Remote Sensing (LIESMARS), the first and the best one in China in this field. The first assessment of the JRC was conducted with a very positive outcome on 11 March 2016 by the assessment committee.



Second JRC Wuhan–Delft Workshop, 19–20 August 2014, Delft. In the center: prof Deren Li (member of both Chinese Academy of Sciences and also of Chinese Academy of Engineering, and chair of the JRC Wuhan–Delft Advisory Board) and prof Karel Luyben (Rector Magnificus of the TU Delft).

The results during the first phase of the JRC included:

- increased staff/PhD/MSc student exchanges;
- a variety of research proposals created and submitted, and some awarded;
- jointly developed open source software;
- first double degree PhD students started;
- a large number of co-authored scientific publications.

Further, the plans for the second phase include:

- aiming at higher numbers of co-supervised PhD students;
- attracting more research funding on both sides using JRC strengths;
- conducting even more joint research and possible joint Master's education/training;
- involving more faculties (at TU Delft also Electrical Engineering, Mathematics and Computer Science and Technology, Policy and Management);
- organising the next advisory board meetings.

Some very important opportunities of the JRC are the recognition of the JRC status of Wuhan–Delft for the next three years (2016–18) by the National Chinese Ministry of Education, and the anticipated changes to the Dutch Educational Law (WHW) that will enhance international collaborations and create better opportunities for double degree MSc programmes, also with non-EU partners. The assessment committee recognised the achievements and appreciated the ambitious future plans of the JRC and stated *"We are both satisfied with the work and achievements in the past three years. We are also very optimistic and positive for the future development of JRC"*.

#### Open Data Knowledge Centre

In May 2012, TU Delft Faculty of Architecture and the Built Environment founded the Open Data Knowledge Centre in close cooperation with TNO. The Centre researches the institutional, legal and organisational aspects of the sharing, exchange, use and reuse of geographical data, specifically open data. Its mission is to support the optimal use and reuse of geographical data, at both the national and the international level. This covers the questions how current barriers may best be overcome and which frameworks should be developed to optimise the use and sharing of geographic data by governments, knowledge institutes, companies and citizens.



Start conference Open Data Knowledge Centre (Kenniscentrum Open Data) 23 January 2014, BK City, Room A, TU Delft. Speaking is the Chairman Steering Committee, Mart van Bracht (General Director of TNO Energy).

In January 2014, eight parties signed a memorandum of understanding with the Knowledge Centre: Ministry of Infrastructure and Environment; Kadaster; TNO, Dutch Bureau of Statistics; National Institute for Public Health and the Environment (RIVM); Royal Dutch Meteo Service; City of Rotterdam; and Rijkswaterstaat. These parties expressed their support by cooperating with the Knowledge Centre in research and by hiring TU Delft's expertise to answer pressing knowledge questions at the partners' organisations.

The Knowledge Centre delivered 20 research reports including studies on open data user needs, strategies for open data infrastructures, and data protection in relation to open data. The Centre developed an open data ecosystem assessment methodology, developed open data decision trees, advised on policy issues on open geographic data, helped to design new policy implementation strategies, researched and explored open data licences in a global context, and developed a training programme on geographic data governance for the United Nations. Furthermore, it has been active in a large number of research projects, including small-scale contract research for partners and research that is more fundamental. Three PhD research projects are under way:

- 1 Safeguarding Personal Data in an Open Data World (SPOW);
- 2 Reuse of public sector information;
- 3 Stress-Test for Infrastructures of Geographic Information (STIG).

Moreover, the Centre represented academia in the Dutch national open data breakthrough team. In 2020, the Knowledge Centre should be the national and international central point of access for research, education and knowledge on open (geo)data, with a bias towards legal-administrative issues surrounding open data. Due to technological developments, such as big data, the Internet of Things and the 'datafication' of society, it is expected that the research emphasis will move from a focus on solely open data towards more emphasis on the governance of general data, including open data.

#### Vario-scale geo-information

Spatial zoom and thematic navigation are indispensable functionalities for digital web and mobile maps. Therefore, our recent map generalisation research has introduced the first truly smooth vario-scale structures, which support continuous or smooth zooming. In the implementation, the vario-scale representation of 2D geo-information can be stored as a single 3D (2D+scale) data structure. TU Delft (Peter van Oosterom and Martijn Meijers) obtained a patent on this solution with scale as an additional dimension in the representation. Getting rid of the fixed and redundant map scales is a paradigm shift in geo-information representation, processing and visualisation:

- Van Oosterom, Peter, and Martijn Meijers. *Method and System for Generating Maps in an N-dimensional Space*. Technische Universiteit Delft, assignee. Patent WO 2012144893 A2. 26 Oct. 2012. <https://patents.google.com/patent/WO2012144893A2/en>.

A truly smooth vario-scale structure for geographic information has the property that a small step in the scale dimension leads to a small change in the representation of geographic features that are represented on the map. Furthermore, mixed-scale visualisations can be derived with more or less generalised features shown in one map in which the objects are consistent with each other. In addition, with the vario-scale approach there is no or minimal geometric data redundancy and there is no temporal delay between the availability of datasets at different map scales (as is the case with more traditional approaches). The theoretical framework for vario-scale representations

is used to develop technology (in the ongoing STW project vario-scale geo-information): the topological Generalised Area Partitioning (tGAP) and the related 3D Space-Scale Cube (SSC) data structures. Our vario-scale tools are (and will be) used in various projects such as the European Location Framework (EU FP7 project, 2013-2016) and the Open Project awarded in 2015 by Shenzhen Research Center of Digital City Engineering). It is interesting to note that the 'scale as dimension' approach is useful not only for modelling traditional (vector data) maps as in the above examples, but also for alternative representations, such as those based on point clouds. The earlier mentioned massive point cloud viewer, the largest 3D web-viewer in the world, is also based on the "scale as additional dimension approach", with 14 scale levels for AHN2 data.



3D Space-Scale Cube intersected at 3 levels (map scales)



Diagonal intersection of the 3D Space-Scale Cube resulting in mixed scale map: more detail when intersection plane is low, and gradually less detail when plane is higher

## 10.7.2

## Activities

- Launch conference 'Open Data Knowledge Center', January 2014 and "Open data and beyond" projects I & II with NGinfra /Alliander .
- High profile projects: top sector CERISE-SG , EU European Location Framework (ELF) , Massive Point Clouds for eSciences (NLeSc) , Next Generation Infrastructure programme, ICT Breakthrough Project Open Geodata, Open Technology Programme (STW): Vario-scale geo-information.
- International events (e.g. FIG LADM + 3D Cadastre), including proceedings and special issue journals (CEUS, LUP).
- FIG 3D Cadastres WG (2010–14, 2015–18 terms) – chair Peter van Oosterom and OGC DWG Point cloud (co-chair – Peter van Oosterom).

## 10.7.3

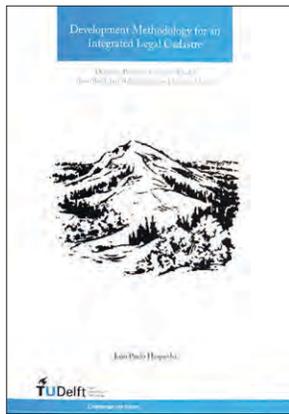
## Organisation

- Successful merging of the old research programmes GIS Technology and part of Geo-information and Land Development in a new programme Geo-information Technology & Governance (as from 2015 publishing a combined newsletter in GIS Magazine – in Dutch).
- JRC Wuhan University – TU Delft (among other things, a successful mid-term evaluation by the Board of JRC), Peter van Oosterom director JRC on behalf of TU Delft; MoU with NASG (Chinese Mapping Agency), advisory board member of the JRC.
- Long term cooperation with government and industry (e.g. RWS, Geonovum, Kadaster, TNO, Bentley, Oracle).
- National STW Maps4Society research programme (and project) – initiated by Peter van Oosterom (and three projects funded within the research programme).
- Establishment of Open Data Knowledge Centre (Kenniscentrum Open Data) with support of eight partners and continuous activities within the GDMC, established in 2000 (Geo-Database Management Centre).

## 10.7.4

## Facilities/assets

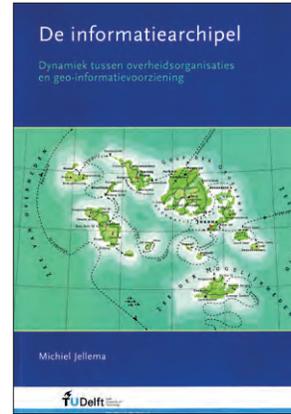
- Our MSc students contribute during their graduation to our research (this holds for the MSc Geomatics and MSc GIMA (MSc Geographical Information and Applications).
- The cooperation with the partners from geo-information practice, both government and industry, resulted in sufficient resources: datasets, software and, if needed, equipment (e.g. CycloMedia or Fugro data acquisition tools). We are often allowed to access these resources free of charge.
- We have a medium-sized server for database and web-service testing, namely an HP DL380 (with operating system Linux Red hat v6) with the following specifications: CPU 2 x 8 cores (32 threads), 128 Gb main memory, 5 Tb RAID 5 (22 \* 300 GB disks, 15k) and 88 Tb RAID 6, (26 \* 4 Tb disks, 7.2K).
- We have access to hardware tools specific to geo-information: GPS receivers for outdoor positioning, Wi-Fi scanners for tracing moving objects, drones for spatial data acquisition, etc.
- AHN2 3D web-viewer: interactive online point cloud dataset from the NL eScience Project Massive Point Clouds (with largest 3D web-viewer in the world).



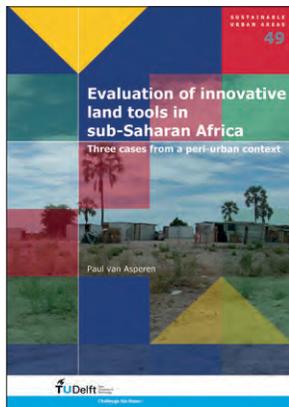
PhD thesis Joao Paulo Hespanha



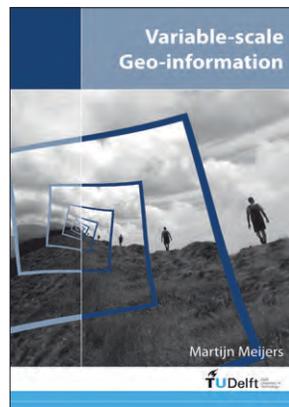
PhD thesis Henk Koerten



PhD thesis Michiel Jellema



PhD thesis Paul van Asperen



PhD thesis Martijn Meijers



PhD thesis Zhiyong Wang

## 10.7.5

### Output

- Lemmens, M.J.P.M., *Geo-information, Technologies, Applications and the Environment*, Textbook, Springer, 2011 (with many downloads of chapters; in total 34,400 by July 2016).
- ISO 19152:2010 standard: Land Administration Domain Model (LADM).
- Patents: in 2012, the patent 'Method and system for generating maps in an  $n$ -dimensional space' was granted to Peter van Oosterom and Martijn Meijers No. OCNL 2006630 and in 2013, US patent 107051-0029 on "Indoor Localization based on Ultrasound Sensors" was obtained together with Bentley.

### Scientific journal papers

- Peter van Oosterom and Christiaan Lemmen (2015), *The Land Administration Domain Model (LADM): Motivation, standardisation, application and further development*. In: Land Use Policy, 49, 2015, pp. 527-534.
- Peter van Oosterom, Oscar Martinez-Rubi, Milena Ivanova, Mike Horhammer, Daniel Geringer, Siva Ravada, Theo Tijssen, Martin Kodde and Romulo Gonçaves (2015), *Massive point cloud data management: Design, implementation and execution of a point cloud benchmark*. In: Computers & Graphics, Volume 49, 2015, pp. 92-125.

- Peter van Oosterom and Martijn Meijers (2014), *Vario-scale data structures supporting smooth zoom and progressive transfer of 2D and 3D data*. In: International Journal of Geographical Information Science, Volume 28, 3, 2014, pp. 455-478.
- Peter van Oosterom (2013), *Research and development in 3D cadastres*. In: *Computers, Environment and Urban Systems*, Volume 40, 2013, 6 p.
- Loenen, B. van & Grothe, M. (2014), *INSPIRE Empowers Re-Use of Public Sector Information*. Int. Journal of Spatial Data Infrastructures Research, 9, pp. 86-106.
- Grus, Ł., W. Castelein, J. Crompvoets, T. Overduin, B. van Loenen, A. van Groenestijn, A. Rajabifard, A. Bregt (2011), *An assessment view to evaluate whether Spatial Data Infrastructures meet their goals*, *Computers, Environment and Urban Systems* 35(3): 217-22.
- Welle Donker F., van Loenen B., Zevenbergen J. (2010), *Geo shared licences: a base for better access to public sector geoinformation for value-added resellers in Europe*, *Environment and Planning B: Planning and Design* 37(2): 326 – 343.

### 10.7.6

#### Use

- Licenses for data 'geo gedeeld licencing' framework developed, with over 1000 datasets incorporated according to these licences (see Nationaal Geo Register).
- Uptake of research results by Netherlands government via Geonovum (see 2015 report 'Locatie informatie op z'n plaats', Bastiaan van Loenen and Marc de Vries) including the Geonovum investigation into the impact of the new EU data protection regulation on geo-information. Also see the SDI assessment methodology developed by TU Delft/Leuven and applied in the monitoring of the SDI programme of NL (Gideon 2008–13).
- Use of our research in commercial software; our GDMC partners have included some of our results in their products; e.g. Oracle Spatial (2D topology, 3D geometry, point cloud functionality), Safe Soft's FME (geometry validation tools), etc.
- Increasing availability and use of our Open Source Software and our source code available on GitHub, Google Code or Bitbucket: pointcloud benchmark, Massive-PotreeConverter, ahn-pointcloud-viewer, DynamicPCDMS (dynamic point cloud data management system), SFCLib (space filling curve library: nD Morton and Hilbert codes), tri (2D constrained Delaunay triangulation), grassfire (straight skeleton by means of kinetic triangulation), voxelGen (voxels for big data analytics), pprepair, prepair (cleaning geometry), val3dity (Validating 3D geometry), Python gems, and more.
- International research visitors: 24 researchers used and further developed our research results during their visit to Delft.
- Citations of publications: number of citations in WoS, Scopus and Google Scholar 2010–15 (selected researchers, data per 13 July 2016 below)

STAFF MEMBER	CITATIONS TOTAL			CITATIONS 2010-2015			H-INDEX		
	Scholar	Scopus	WoS	Scholar	Scopus	WoS	Scholar	Scopus	WoS
Loenen, Van	559	36	6	338	22	5	11	4	1
Meijers	461	53	43	360	43	30	12	4	4
Oosterom, Van	5327	668	337	2506	308	231	36	16	11
Ploeger	593	106	66	426	40	56	13	6	5
Stoter	2829	530	318	1771	420	260	28	14	10
Verbree	627	68	82	231	43	41	12	4	4
Zlatanova	4104	590	346	2498	435	260	32	13	11

TABLE 10.5 Citations and H-index of selected staff members



Geospatial World Leadership Awards: Delft University of Technology: Geospatial Research Institute of the Year 2015

### 10.7.7

#### Recognition

- International cooperation; e.g. Rosreestr (Russian Federation), UTM/JUPEM (Malaysia), Sol/Technion (Israel), Shenzhen (China), Oracle Spatial (USA).
- European/GIS/guest editor (CEUS, Computers & Geosciences, LUP), chair programme committees (FIG 3D Cadastres 2011, 2012, 2014, FIG LADM workshop 2013).
- Six keynote speeches at international conferences.
- Jantien Stoter became professor of 3D Geo-information in 2013.
- Awards: Geospatial Research Institute of the Year award 2015, KNAW/NCG Tienstra awards (Bastiaan van Loenen 2010; Chrit Lemmen 2012). Note: Chrit Lemmen received the award for his PhD research thesis which he defended at TU Delft while employed at the Netherlands Kadaster.

### Context

Whenever we have PhD (AIO) staff member vacancies, we usually receive applications from about 50 candidates, most of whom have the required background and talent. A shortlist of the six most promising candidates is drawn up and the top three are invited to attend an interview, after which the best candidate is given the position. In addition, we receive a significant number of spontaneous requests for a PhD position (typically 50 per year), both with and without own funding/scholarship. After careful selection and based on funding possibilities, on average one new PhD student per year starts as a result of making such a spontaneous request. One aspect we should like to see improved is our attractiveness to Dutch PhD students, as we should like to have more of them. Most of the Dutch geo-information graduates opt for positions within industry or government (good job opportunities). The involved supervisors are leading researchers in their fields and act as magnets to young new talent. In addition, the positive experiences of our current and recently graduated PhD candidates also contribute to making Geo-TG an attractive geo-information research centre. Finally, a GISt lunch seminar is held every month, which enables and stimulates academic debate. The format of the lunch seminar is that at least one geo-information topic is presented, which almost always leads to a lively and constructive discussion.

In addition, the Knowledge Centre Open Data organises lunch seminars with partners (twice a year), and together with Marijn Janssen, professor of ICT & Governance, and Dr Anneke Zuiderwijk-van Eijk of the Faculty of Technology, Policy and Management, section of Information & Communication Technology, have quarterly sessions to share research experiences.

The various categories of PhD candidates have their own funding sources. The funding is often obtained from NWO/STW. Some PhD candidates are awarded scholarships by various foreign funding organisations (China is the most important one).

### Participation in research schools

The Graduate School A+BE programme includes a tracking system and PhD mentors, who meet the PhD candidates frequently. The education of PhD students is realised via the Graduate School A+BE.

Within the framework of the Wuhan–Delft Joint Research Centre, the emphasis is on a double degree PhD (joint supervision/education). PhD students participating in an STW (NWO) funded project have regular user committee meetings as a context.

### Selection and admission procedures

The three most important categories of PhD students are:

- *Category 1:* PhD candidates employed by TU Delft (for a limited part of their time, they also teach at TU Delft);
- *Category 2:* PhD candidates with their own financial resources (e.g. a scholarship) working on their PhD thesis (these are not official employees of TU Delft);
- *Category 3:* External PhD candidates (often with jobs within another organisations).

The admission procedures are:

*Category 1:* announce the vacancy; contact our network; make a first selection on the basis of applications; invite the best candidates for interviews (if appropriate, invite the best candidate to work with the section as a guest for one week); take final decision.

*Category 2:* those who are interested make contact. If their background/topic is relevant, the candidate is asked for more information, and vice versa (providing information about our research programme). The candidate is requested to submit a short research proposal (half an A4 sheet) followed by a Skype meeting (as they are very often from abroad). If the documents, research plan and the Skype meeting are assessed positively, the candidate is sent an invitation letter to support the scholarship application. In parallel, the candidate has to work on a more detailed version of a PhD plan (to prepare for a PhD at Delft). In the case of doubt, the candidate is also invited to come to Delft for a week as a guest and to participate in the work of the section. After confirmation of the scholarship award and the creation of a more detailed plan (and a possible visit), the final decision is taken.

*Category 3:* the PhD research topic is typically related to the applicant's job elsewhere. Those who are interested make contact, and it is first explored whether the topic is suitable for PhD research. If so, the next step is to make a PhD plan taking into account the situation of the PhD candidate (written in iterations). If the PhD plan is of sufficient quality and the proposed timeframe is realistic, the real research can start.

For all categories, the Graduate School A+BE applies certain criteria related to, for example, diplomas.

#### Supervision of PhD candidates internally and guidance of PhDs to the labour market

The supervision of PhD candidates is usually performed by a small team consisting of a day-to-day supervisor (who holds a PhD degree) and a professor (supervisor); in some cases (e.g. in the case of collaboration with an external party), a third person is part of the supervision team. PhD students who started during the last two years have been included in the programme of the A+BE graduate school. However, PhD students who started earlier are following a very similar programme, as in our group we have a long-standing tradition of systematic supervision, which is clearly described in the individual PhD plan of every student. These plans are published, each with its own ISBN number, in our report series (ISSN series number 1569-0245). There are regular progress meetings (every 2 or 3 weeks, in addition to ad hoc meetings), which are all documented in concise 1- or 2-page progress reports divided into three parts: 1) results since the last meeting, 2) deviations from planned activities since the last meeting and 3) the most important goals to be achieved before the next meeting. At the end of the first year, there is reflection on all results and a formal assessment resulting in the 'go/no-go' decision concerning last three years of the PhD research.

ENROLMENT	Gender			SUCCESS RATE								Total gradu-		Not yet		Discontinued	
	Starting year	Male	Female	Total	Finished								ated	finished			
					≤ 4Y	≤ 5Y	≤ 6Y	≤ 7Y									
2006	0	1	1	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	1	100%
2007	1	0	1	1	100%	1	100%	1	100%	1	100%	1	100%	0	0%	0	0%
2008	1	0	1	1	100%	1	100%	1	100%	1	100%	1	100%	0	0%	0	0%
2009	0	2	2	0	0%	0	0%	0	0%	0	0%	0	0%	1	50%	1	50%
2010	2	0	2	0	0%	1	50%	1	50%	1	50%	1	50%	1	50%	0	0%
2011	1	1	2	0	0%	0	0%	0	0%	0	0%	0	0%	1	50%	1	50%
<b>Total</b>	<b>5</b>	<b>4</b>	<b>9</b>	<b>2</b>	<b>22%</b>	<b>3</b>	<b>33%</b>	<b>3</b>	<b>33%</b>	<b>3</b>	<b>33%</b>	<b>3</b>	<b>33%</b>	<b>3</b>	<b>33%</b>	<b>3</b>	<b>33%</b>

TABLE 10.6 Length of PhD candidacies and success rate of the PhD programme

## Self-reflection

The current programme is based on our history including the previous assessment(s). The report 'Assessment of Urban and Regional Research in the Netherlands, 2000-2006' states 'It would recommend that the institute continues to encourage cross-fertilization and interconnection between programmes'. The merging of GI technology with GI governance into one programme has been very fruitful and resulted in more collaboration between the involved researches via joint projects. Despite the very good to excellent scores (GISt programme: 4.25 out of 5, GiLD programme: 4.75 out of 5), the previous assessment committee made some suggestions for further improvements:

- the productivity of this group however can be improved;
- the group does not have the resources to support a wide-ranging service function;
- the group itself is aware of the need to develop and attract new young and eager researchers.

We responded with:

- a significant increase from an average of 3.6 refereed articles per year to an average of 9.0 refereed articles per year during the current assessment;
- the group still does not have these resources, but we initiated projects to enable new GI-services; e.g. with the TU Delft Library the Maps4Science and Maps4Society programme proposals and the NL eScience research proposal 'Massive Point Clouds' resulting in the operational functionality to provide all staff, students and public 3D interactive access to AHN2 height data: 640.000.000.000 of 2-3 cm precise points;
- the warning was recognised. We were able to make some strategic reinforcements; for example the recent appoints of new permanent staff members: Martijn Meijers and Frederika Welle Donker).

### Research quality

We are proud of our research on key topics such as nD geo-information and open data in various application areas (e.g. land administration, real-time GIS), in which we are agenda-setting globally. We have a large share of publications in scientific journals with a high impact factor, for example Land Use Policy (with, in 2015, a 5-year impact factor of 3.253). We also initiated the STW Maps4Society research programme, received funding for various previous research proposals (NWO Vidi, STW OTP, NLeSc, EU ELF) and teamed up in the Joint Research Centre with the worlds' largest university in our field: Wuhan University. A growing number of our master's students (Geomatics and GIMA) are contributing to our research through their thesis projects. We have received prestigious national scientific awards (KNAW/NCG Tienstra awards: Bastiaan van Loenen, 2010, and Chrit Lemmen, 2012) and prestigious international scientific awards (Geospatial Research Institute of the Year award 2015).

### Relevance to society

We are also proud of our long-lasting and growing partnerships with various organisations, both via our centres (KC-OD, GDMC) and through multi-year agreements with individual organisations (RWS, Geonovum, Kadaster, TNO). These are a source of inspiration for research challenges, as well as an ideal setting for assessing our research results. The collaboration is not limited to the national level: we collaborate with NASG/China, JUPEM/Malaysia, Sol/Technion (Israel) and Oracle Spatial (USA). We have had (and still have) a significant impact on national and international standardisation (e.g. ISO 19152:2012) and have obtained two patents (vario-scale and indoor positioning). We are leading in various professional organisations and have organised successful events (FIG LADM + 3D Cadastre), including conferences. The successful merging of the previous research programmes GISt and part of GiLD in a new programme Geo-TG makes us the one-stop-shop for GI research and advice.

**STRENGTHS**

The position within Architecture and the Built Environment provides a dedicated research context for use-based scientific research. The merging of two old programmes into the new Geo-TG programme was successful, and within Architecture and the Built Environment there are several research groups with which cooperation works very well. The programmes' multidisciplinary approach provides excellent opportunities for this kind of research, as societal problems related to geo-information technology and governance are the concern of more than one discipline. The group publishes an increasing number of articles in international peer-reviewed journals, and has many national and international contacts. The group has a healthy mix of funding sources, including several NWO/STW/EU-financed projects, and multi-year cooperation agreements with the Dutch geo-information practice (Rijkswaterstaat, Geonovum, Kadaster).

**OPPORTUNITIES**

The combination of our geo-information expertise and the application knowledge present within A+BE/OTB provides great opportunities for cooperation and sharing and disseminating knowledge and new ways to collect research data (fitting within one of the dean's three spearheads: Automation). Further, an increasing number of data types have a spatial component, which extends the scope of our research to a richer pallet of data than before. This allows us to test and apply our GI principles and concepts to these new data, and vice versa. Moreover, the integration of inside–outside geo-information and specifically the growing importance of linking BIM and GIS provide opportunities. The MSc in Geomatics has been repositioned and moved to Architecture; this also provides good opportunities for research. Together with the growing number of MSc GIMA students, this results in more and more MSc thesis research projects being conducted within our research programme. The Wuhan–Delft Joint Research Centre on Spatial Information provides an excellent opportunity for research collaboration and shared PhD supervision.

**WEAKNESSES**

The field the programme addresses is rather broad, which makes it a challenge to cover all aspects of the programme at the level we desire (i.e. an internationally leading position). The Governance of Geo-information sub-programme lacks a professor at the moment. The staff members involved in the programme originate from two sections, and although there is good collaboration at the individual level, collaboration at the group level could be improved. The number of staff members with a PhD degree should be higher. The average age of staff members with permanent positions is relative high; a better mix of ages would be healthier. Further, there is some fragmentation of the geodesy/geo-information researchers within TU Delft: our colleagues work at the Faculty of CEG (GRS: remote sensing, physical geodesy, GNSS), the Faculty of AE (bathymetry) and the Faculty of A+BE/Urbanism (3D geo-info). This may result in less profiling, compared to for example the Faculty of ITC at the University of Twente, where all geo-disciplines are within a single faculty. The same applies to the topic of open data: it is studied within our programme (at Bk) and also at TPM with a professor/chair in ICT & Governance.

**THREATS**

The growing student numbers demand more time and energy from the same number of staff. This requires the careful balancing of teaching and research tasks. Government funding is not sufficient to cover the cost of the permanent staff and most calls for research proposals only provide funding for temporary staff (PhDs/postdocs). Other groups are also facing this challenge and need to look for other sources, such as research grants and contract research commissioned by public authorities and private parties. This results in stiffer competition for the scarce funds that are still available.

AHN	Actueel Hoogtebestand Nederland [ <a href="http://www.ahn.nl/index.html">www.ahn.nl/index.html</a> ]
BIMs	Building Information Models
BOLD	Big Open Linked Data
CERISE-SG	Combineren van Energie- en Ruimtelijke Informatie Standaarden als Enabler – Smart Grids: Alignment of the information infrastructure architecture of utility companies with related architectures: enlarging circles (for smart grids) [ <a href="http://www.cerise-project.nl/index.php?lang=en">www.cerise-project.nl/index.php?lang=en</a> ]
CEUS	Computers, Environment and Urban Systems [ <a href="http://www.journals.elsevier.com/computers-environment-and-urban-systems/">www.journals.elsevier.com/computers-environment-and-urban-systems/</a> ]
COM 2011, 882	COM(2011) 882 - Open data - An engine for innovation, growth and transparent governance [ <a href="http://www.europarl.europa.eu/RegData/docs_autres_institutions/commission_europeenne/com/2011/0882/COM_COM(2011)0882_EN.pdf">www.europarl.europa.eu/RegData/docs_autres_institutions/commission_europeenne/com/2011/0882/COM_COM(2011)0882_EN.pdf</a> ]
ELF	European Location Framework [ <a href="http://www.elfproject.eu/content/overview">www.elfproject.eu/content/overview</a> ]
FIG	International Federation of Surveyors [ <a href="http://www.fig.net">www.fig.net</a> ]
FIG 3D Cadastre WG WG	International Federation of Surveyors 3D Cadastre Working Group [ <a href="http://www.fig.net/organisation/comm7/index.asp">www.fig.net/organisation/comm7/index.asp</a> ]
GDMC	Geo-Database Management Center [ <a href="http://www.gdmc.nl/">www.gdmc.nl/</a> ]
Geo-ICT	Geo Information and Communications Technology
Geomatics	Geomatics, Master of Science [ <a href="http://www.tudelft.nl/en/study/master-of-science/master-programmes/geomatics/">www.tudelft.nl/en/study/master-of-science/master-programmes/geomatics/</a> ]
Geonovum	Dutch organisation making geo-information accessible for the public sector, developing standards for this and helping to make better use of geo-information [ <a href="http://www.geonovum.nl/">www.geonovum.nl/</a> ]
GeoSamen	Shared vision of government, private sector and scientific community on the future of the geo-information section [ <a href="http://geosamen.nl/">geosamen.nl/</a> ]
Geo-TG	Geo-information Technology and Governance [ <a href="http://www.bk.tudelft.nl/en/research/research-programmes/geoinformation-technology-governance/">www.bk.tudelft.nl/en/research/research-programmes/geoinformation-technology-governance/</a> ]
Gideon	Key geo-information facility for the Netherlands
GI-Governance	Geo-Information Governance
GII	Geo-Information Infrastructure
GILD	Geo-information and Land development
GIMA	Geographical Information Management and Applications, Master of Science [ <a href="http://www.msc-gima.nl/">www.msc-gima.nl/</a> ]
GIS technology	[ <a href="http://www.bk.tudelft.nl/en/about-faculty/departments/otb-research-for-the-built-environment/about-otb/chairs/gis-technology/">www.bk.tudelft.nl/en/about-faculty/departments/otb-research-for-the-built-environment/about-otb/chairs/gis-technology/</a> ]
GitHub	A web-based Git repository hosting service. [ <a href="http://github.com/">github.com/</a> ]
GNSS	Global Navigation Satellite System
GRS	Geoscience & Remote Sensing, Department
GSDI Association	Global Spatial Data Infrastructure Association [ <a href="http://gsdiassociation.org/">gsdiassociation.org/</a> ]
INSPIRE	Infrastructure for Spatial Information in the European Community [ <a href="http://inspire.ec.europa.eu/">inspire.ec.europa.eu/</a> ]
ISO/TC 211 WG	International Organization for Standardization/Technical Committee 211: Geographic information/Geomatics [ <a href="http://www.isotc211.org/">www.isotc211.org/</a> ]
ISPRS	International Society for Photogrammetry and Remote Sensing [ <a href="http://www.isprs.org/">www.isprs.org/</a> ]
ITC	Geo-information Science and Earth Observation (Faculty at the University of Twente) [ <a href="http://www.itc.nl/">www.itc.nl/</a> ]
JRC-SI Wuhan-Delft	Joint Research Centre-Spatial Information Wuhan-Delft [ <a href="http://jrc.tudelft.nl/spatial-information/">jrc.tudelft.nl/spatial-information/</a> ]
JUPEM	Jabatan Ukur dan Pemetaan Malaysia (Department of Survey and Mapping Malaysia) [ <a href="http://www.jupem.gov.my/">www.jupem.gov.my/</a> ]
KOD	Kenniscentrum Open Data (Knowledge Centre Open Data) [ <a href="http://www.bk.tudelft.nl/over-faculteit/afdelingen/otb-onderzoek-voor-de-gebouwe-omgeving/kenniscentrum-open-data/">www.bk.tudelft.nl/over-faculteit/afdelingen/otb-onderzoek-voor-de-gebouwe-omgeving/kenniscentrum-open-data/</a> ]
LADM	Land Administration Domain Model [ <a href="http://isoladm.org">isoladm.org</a> ]
LUP	Land Use Policy [ <a href="http://www.journals.elsevier.com/land-use-policy">www.journals.elsevier.com/land-use-policy</a> ]
M4S	STW Maps4Society cooperation programme [ <a href="http://www.stw.nl/nl/programmas/maps4society">www.stw.nl/nl/programmas/maps4society</a> ]
NASG MoU	China National Administration of Surveying, Mapping and Geoinformation (Memorandum of Understanding) [ <a href="http://en.nasg.gov.cn/">en.nasg.gov.cn/</a> ]
Nationale GI-minor	National GEO Information Minor [ <a href="http://www.nationalegiminor.nl/main.php">www.nationalegiminor.nl/main.php</a> ]
NCG	Nederlands Centrum voor Geodesie en Geo-informatica (Netherlands Centre for Geodesy and Geo-Informatics as of 1-1-2014, successor of the NCG KNAW) [ <a href="http://www.NCGeo.nl">www.NCGeo.nl</a> ]
NEN	NEderlandse Norm/Nederlands Norm Instituut [ <a href="http://www.nen.nl/About-NEN.htm">www.nen.nl/About-NEN.htm</a> ]
NGinfra	Next Generation Infrastructures [ <a href="http://www.nextgenerationinfrastructures.eu/">www.nextgenerationinfrastructures.eu/</a> ]
NLeSc	Netherlands eScience Center [ <a href="http://www.esciencecenter.nl">www.esciencecenter.nl</a> ]
OGC	Open Geospatial Consortium [ <a href="http://www.opengeospatial.org">www.opengeospatial.org</a> ]
RWS	Rijkswaterstaat (Ministry of Infrastructure and the Environment) [ <a href="http://www.rijkswaterstaat.nl/english/index.aspx">www.rijkswaterstaat.nl/english/index.aspx</a> ]
SDI	Spatial Data Infrastructure
Sol	Survey of Israel [ <a href="http://mapi.gov.il/en/Pages/default.aspx">mapi.gov.il/en/Pages/default.aspx</a> ]
SURF	Collaborative ICT organisation for Dutch higher education and research [ <a href="http://www.surf.nl/en/about-surf">www.surf.nl/en/about-surf</a> ]
TNO	Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek [ <a href="http://www.tno.nl/en/about-tno/">www.tno.nl/en/about-tno/</a> ]
UN-GGIM	United Nations Committee of Experts on Global Geospatial Information Management [ <a href="http://ggim.un.org/">ggim.un.org/</a> ]
UTM	Universiti Teknologi Malaysia [ <a href="http://www.utm.my/">www.utm.my/</a> ]

TABLE 10.7 Abbreviations used in this paragraph



*Second Wuhan-Delft JRC Workshop. August 2014, Delft.*



TU Delft Open, 2016

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