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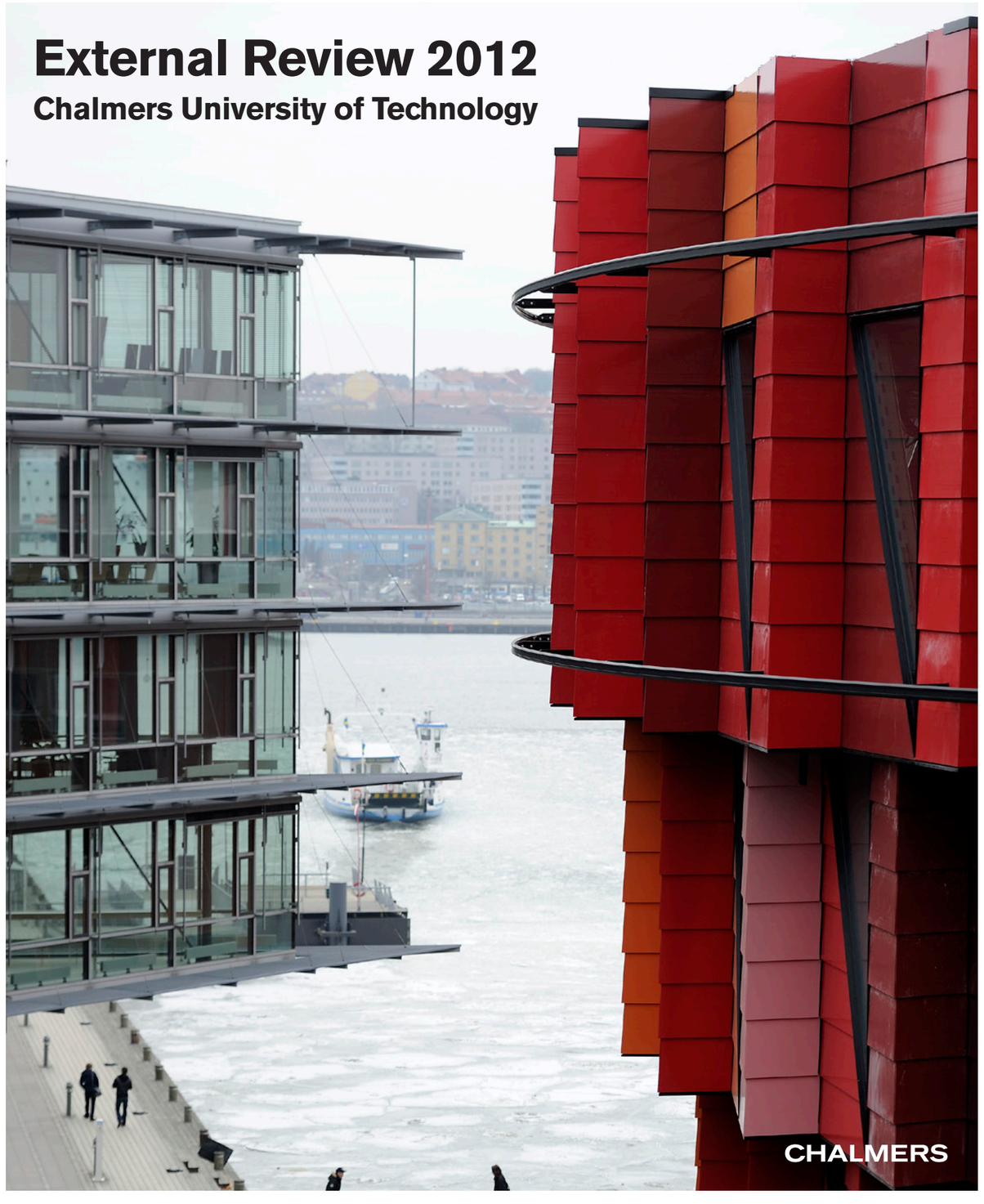
BUILT ENVIRONMENT

A CHALMERS AREA OF ADVANCE

External Review 2012

Chalmers University of Technology



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PREFACE BY PRESIDENT AND VICE PRESIDENT

During the past five years we have developed a governance model at Chalmers that encourages integration of education, research and innovation, engagement of researchers/teachers, and responsible leadership. By providing incentives for “clustering” around areas where Chalmers already has great strength in our 17 departments, the clusters or Areas of Advance foster attraction, growth and competitiveness for us and our collaborators in addition to building excellence and competence.

In February 2010 a new organisation model was established with eight Areas of Advance (AoAs) in a matrix with the departments and schools of education. Our strategy for the AoAs is to match scientific excellence, education and innovation towards sustainable technology shifts and societal challenges in areas where we can make a difference. The AoAs are platforms for interdisciplinary research and dynamic meeting places, where academia, industry and society can join forces.

At this time, Chalmers has come to a point in its development process where it would be most useful to get an external evaluation in place. The AoAs are developing, although at different rates and along different routes, and we are interested in knowing whether we are on the right track to become a “21st Century University”.

Therefore we have invited teams of generalists, who are interested in best practice of universities, and specialists, who can identify our real risks and possibilities, to evaluate our progress and give recommendations and strategic advice towards the future.

Karin Markides
President and CEO

Anne-Marie Hermansson
Vice president for the Areas of Advance

2 CHALMERS IN BRIEF

2.1 CHALMERS' VISION AND MISSION

Our vision:
A sustainable future.

Our mission:
To become one of the world's most attractive universities through internationally acclaimed education and research combined with a professional innovation process.

Our goals:
Excellent research, world-class education, efficient innovation, and a first-class work environment.

2.2 ORGANISATION

Chalmers University of Technology in Gothenburg conducts research and education within technology, natural sciences, architecture, and shipping, in close contact with external bodies. Our inspiration derives from the pleasure of discovering and the desire to learn. The aim is to make an active contribution to sustainable society development, both nationally and internationally.

Research, Education and Innovation Today Chalmers has some 10.000 students and 2.800 employees. Undergraduate education in Sweden is tuition-free for Swedish and European students, whereas students from outside Europe pay tuition fees or receive scholarships. Two-thirds of the University's operations involve research and doctoral programmes. This embodies innovative, applied research as well as prominent fundamental research. Research and education take place in Chalmers 17 departments.[1] Furthermore, Chalmers hosts six national competence centres financed by Vinnova (the Swedish Innovation Agency) and the Swedish Energy Agency, and two Linnaeus centres supported by the Swedish Research Council (Vetenskapsrådet). There are also a number of centres cooperating across traditional departmental boundaries. We are involved in a number of international research collaborations and strategic alliances, including the Alliance for Global Sustainability, UNITECH International, Nordic Five Tech and CESAER. Value creation in relation to innovation and entrepreneurship at the university is promoted and supported by a number of organisations (science parks, incubators, venture capitalists, etc.) in and around Chalmers which are coordinated through the new Innovationskontor Väst (IKV, the Innovation office in Western Sweden).

The Chalmers Areas of Advance (AoAs) span across our 17 departments and bring together the three components that make up the knowledge triangle: research, education and innovation.

Through scientific excellence, the AoAs give Chalmers a clearer profile, greater visibility and new opportunities to focus on areas, where we can make a difference to major societal challenges.

Two campuses Investments being made on our two campuses are aimed at promoting greater interaction between academia, industry and the community. The Johanneberg Campus is located in central Gothenburg. The Lindholmen Campus is in the expanding Norra Älvstranden area.

Managing a foundation university. In 1994, Chalmers was launched as one of two Swedish foundation universities. As a consequence, Chalmers framework is today governed by the rule of private law. The university is owned by a foundation and operations are run in the form of a limited company through which education and research is conducted. The relationship with the state is mainly based on agreements rather than public law regulation, which applies to state universities and colleges. The private law regulations offer Chalmers the potential, which did not exist previously, to: (i) enter into agreements as an independent legal entity; (ii) acquire properties; (iii) set up new bodies, e.g. subsidiaries; (iv) arrange its own internal organisation; and (v) establish its own service-structure and handle employment issues.

In general, the foundation university's openness and potential has improved Chalmers ability to be a strong collaborative partner for academia, industry and society. Moreover, the innovation system has been reinforced and the university has taken a more distinct entrepreneurial approach.

1. http://www.chalmers.se/en/research/Pages/departments.aspx

The board of the Chalmers University of Technology Foundation appoints the University board, which is responsible for the overall planning, and follow-up of the University's activities. Under the University board, the President is responsible for operations generally. The President and the Office of the President represent Chalmers in dealings with the Swedish government offices and with other external organisations. They work with the overall strategy to advance the university and to coordinate and monitor its operation. The Office of the President consists of the following people and responsibilities: First Vice President and deputy executive officer, responsible for planning, development, resource allocation and the assessment of Chalmers departments and library; Vice President for Chalmers undergraduate and master programmes; Vice President for Chalmers' AoAs. Not included in Fig. 1 are: Vice President for Chalmers doctoral programmes, research infrastructure and campus development; Vice President for collaboration including both the innovation system and cooperation with the surrounding community; and Vice President for sustainable development. The Chief Development Officer is responsible for developing new formats for Chalmers activities with other local, national, regional and global actors, and the Chief Resource Officer is responsible for industrial relations and fundraising.

2.3 INCOME

The total income of Chalmers in 2010 was 2 801 million SEK[2]. Of this, 875 million SEK is related to first degree and master's programmes and 1926 million SEK is linked to research and doctoral programmes (Fig 2). Furthermore, the innovation office IKV managed 18 million SEK during 2010 directed towards supporting innovation related activities.

2. 1 SEK is approximately 0.11 Euro and 0.15 US dollars.

The incomes financing the doctoral programmes and research have several private and public sources (Fig 3). The main part of the funding comes from the government directly or indirectly, e.g. from public funding agencies. In 2010, the strategic funding from the government constituted some 4 % of the total income for research and doctoral programmes. In 2012, when the ramping up of the strategic research funding is finished, the yearly amount to Chalmers will have increased from 63 to 176 million SEK.

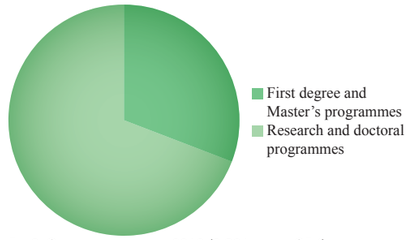

Fig 2. Chalmers' income in 2010 (2 801 million SEK).

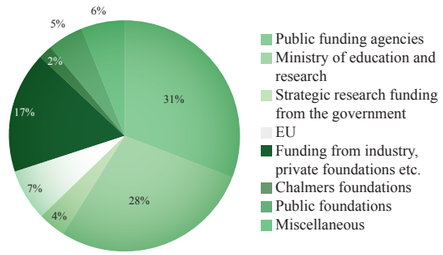

Fig 3. Income to Chalmers for research and doctoral programmes in 2010 (1 926 million SEK).

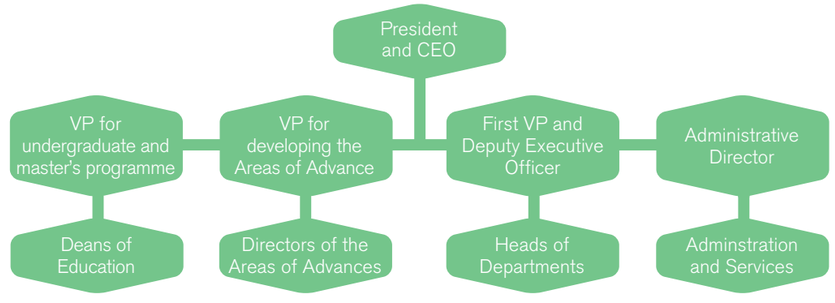

Fig 1. Chalmers management

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INTRODUCTION TO THE AREAS OF ADVANCE

3.1 WHY DID WE NEED TO CHANGE?

Chalmers is consistently reviewing the role of the university to provide attractiveness and to partner in real solutions to global and national societal challenges. Essential components are: excellent research and education, forefront disciplinary and cross-disciplinary research, recruitment of first-class students and researchers, to select and be selected as preferred partner, and an open interactive culture where people meet across boundaries.

This means that we need to:

- Give incentives for interaction between academic disciplines
- Increase our strategic contact with industry and our surrounding society
- Integrate the aspects of the knowledge triangle (research, education and innovation)

3.2 CHALMERS STRATEGY FOR CHANGE

Chalmers strategy to accomplish these changes is the Areas-of-Advance – where we can match excellence in research and education to societal challenges where we can make a difference towards a sustainable future.

The goals of the AoAs are:
To make important contributions towards a sustainable future by performing excellent research and making radical and sustainable technology shifts.

This is accomplished by:

- Integrating the aspects of the knowledge triangle in practice
- Gathering our strengths in cross-disciplinary areas
- Promoting strong basic science from an AoA perspective
- Making visible and practical our strengths to partners and stakeholders worldwide
- Shaping new types of creative meeting places and collaborations across boundaries

3.3 HISTORY

In summer of 2006, Professor Karin Markides joined Chalmers as president. In 2007, she launched Chalmers Initiative – a long-term strategy for how Chalmers will increase co-operation across boundaries in education and research, in order to meet future global challenges and opportunities. The strategy would enable Chalmers to play an even more prominent and active role in social developments and to move towards the vision "Chalmers – for a sustainable future".

Chalmers Initiative was a process for identifying and enhancing the university's areas of strength, by observing all of Chalmers' activities from different perspectives. Three perspectives were applied: Materials and Bio, Systems and Environment, and Industry and Communication; each one led by a vice president responsible for recognizing areas of strength and stimulating growth by creating incentives and support structures at all levels.

During 2008, the work was largely targeted at producing a common view of Chalmers and a shared notion of the University's role in the world. The aim was an even more dynamic operational culture at Chalmers, with an optimum desire for research, education and co-operation, in which individuals and groups enjoy what they are doing and are easily able to enter new territory and new situations, where they can use their depth of knowledge.

In October 2008, the Swedish government presented a historic research and innovation bill, "A boost to research and innovation", containing several components that show strong similarities with the fundamental ideas behind Chalmers Initiative. One example that supported and promoted the development at Chalmers was the new concept of multi- and interdisciplinary strategic areas. The bill focused on quality and excellence, while emphasizing that research must be of value to Swedish industry. Universities were urged to apply for strategic research funding from the government within their respective areas of strength, and in competition with other Swedish universities. Two universities would receive funding within each of the 23 areas, and the allocation of research funding was then tied to a national responsibility to build up Swedish research to the highest international standard. Explicit strategies for how to carry out research in co-operation with companies and other stakeholders in society was included in the universities' applications.

Based on the work already performed in Chalmers Initiative, 5–10 potential areas of strength were easily identified and in spring of 2009 Chalmers submitted 8 proposals to the government. Six of the eight were found excellent/outstanding by the international reviewers, and five of these were also granted strategic governmental funding for the period 2010–2014[3].

These five became Chalmers first Areas of Advance:

- Energy
- Materials Science
- Nanotechnology and Nanoscience
- Production
- Transport

Further consideration led the management to point out another three AoAs based on their great potential to tackle future global challenges:

- Information and Communication Technology, ICT
- Built Environment
- Life Science

In the fall of 2009, the eight AoAs were formally established at Chalmers, and to supplement the strategic governmental funding with an additional 50% from internal funds and provide seed funding for the three AoAs that lack strategic governmental funding. This co-funding shows Chalmers commitment to the AoAs (as stated in the strategic proposals to the government) and is used as an instrument to develop and broaden the scope of the AoAs compared to the descriptions in the proposals.

A number of incentive tools have been and will be developed through the co-funding from the President. They promote bottom-up initiatives and support activities that contribute to practical integration of the knowledge triangle. Some examples are:

(i) Initiative seminars that address challenging issues that are important for humanity and for a sustainable future, and gather representatives from academia, industry and society.
(ii) The new graduate course package Generic and Transferrable skills in which graduate students undertake focused research, and interact with graduate students from disciplines whom they don't normally meet, while developing personal and professional skills that will enhance their broader career development.
(iii) The open assistant professor programme in which excellent young researchers are recruited to an AoA and may choose in which department(s) they want to develop their career.
(iiii) Development of new undergraduate courses related to challenges addresses by the AoA.
(iv) Promotion of long term alliances with preferred industrial partners, as well as regional clusters with leading representatives from academia, the public and the private sector.

3. The sixth strategic area, Information and Communication Technology, ICT, was also judged outstanding by the evaluators, but fell just short of getting strategic governmental funding.

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DEFINITION OF AND ASSIGNMENT TO THE AREA OF ADVANCE

The Areas of Advance were a new concept at Chalmers. In the early phases of the development, many interpretive and formative discussions were held concerning the purpose and nature of the AoAs and how they related to formal organisational bodies such as the departments, educational programmes, research infrastructures, collaborative agreements, and centers. A number of formal documents published between 2009 and today will demonstrate how the concept grew to what it is today.

In the President's decision to establish the AoAs (Aug. 2009), she writes:

President's decision to establish the AoAs (Aug. 2009)

Within the AoAs and in interaction with others, Chalmers shall:

- Coordinate, focus and make visible its activities
- Develop and integrate Chalmers leading research, education and innovation to accomplish desired effects in society
- Create new meetings across boundaries within Chalmers and with the rest of the world
- Increase its resources through an increased inflow of funding and through interconnection of existing activities

Chalmers' AoAs are nourished by the basic sciences. Sustainable development, innovation and entrepreneurship are driving forces.

In spring of 2010, Professor Anne-Marie Hermansson was appointed vice president with responsibility for developing the AoAs. During fall of 2010, the acting leaders of the AoAs were formally appointed as directors (and co-directors).

Assignment and delegation to the Directors of the AoAs

The AoA director is a networking leader for the AoA in accordance with current legislation, established Chalmers documents, and the operational plan of the AoA. The director is part of a coordination group led by the vice president for the AoAs.

Assignment

The director of the AoA shall:

- Develop, coordinate and describe the excellence profiles and goals of the AoA
- Integrate learning, research, innovation, communication, and coordination
- Develop activities within the AoA that aim to integrate disciplines and connect departments
- Communicate the whole AoA, including its external partners
- Be responsible for analyzing Chalmers strengths in relation to the surrounding world
- Create plans for strengthening the AoA in line with Chalmers vision and goals within the limits of the given resources
- Be responsible for contacts with external parts and for innovation within the activities of the AoA
- Propose allocation of strategic governmental funding
- Analyze the demand and propose areas for recruitment in consultation with involved department heads

Delegation

The Vice President for the AoAs delegates to the Director of the AoA to:

- Decide on matters required to develop the AoA in agreement with Chalmers vision and strategy and in accordance with the established operational plan
- Propose allocation (within budget) of the strategic governmental funding and the presidents co-financing to the vice president for the AoAs
- Allocate budgeted funding which is at the director's disposal

Upcoming decisions on matters of principal nature or for other reasons essential to the AoA shall be reported to the vice president for the AoAs.
In matters of strategic or principal nature that may affect the departments or the undergraduate education, the director shall consult with the heads of departments and/or deans of education.

In January 2011, a more specific assignment to the AoAs was formulated in the overall operational plan of the AoAs:

Long-term goals of the AoAs according to the operational plan (Jan 2011)

The AoAs shall develop and present:

- Excellent research environments
- Efficient innovation environments
- Integration of education, research and innovation (the knowledge triangle)
- Strategic interaction with industry and society
- Open creative meeting places
- A sustainable organisation and management structure for the AoAs
- Co-operation between AoAs, departments and schools of education

Long-term goals, 2011–2014

- The AoAs have identified and contributed to solving future grand challenges
- Chalmers keeps the strategic government funding granted in 2009
- External financial resources have been created for the excellence profiles of the AoAs that do not have strategic government funding
- The active fields of the AoAs are dynamic and open to researchers in basic sciences as well as more applied areas
- Chalmers AoAs are known, within and outside of Chalmers, to be excellent environments for research, education and innovation
- The excellence profiles of the AoAs have been included in Chalmers undergraduate and graduate educations
- Research within the AoAs has been utilized to a greater extent than before
- The AoAs have increased their networks and collaborations with external companies
- External funding to activities within the AoAs has increased
- The AoAs have been evaluated in 2012 with good results

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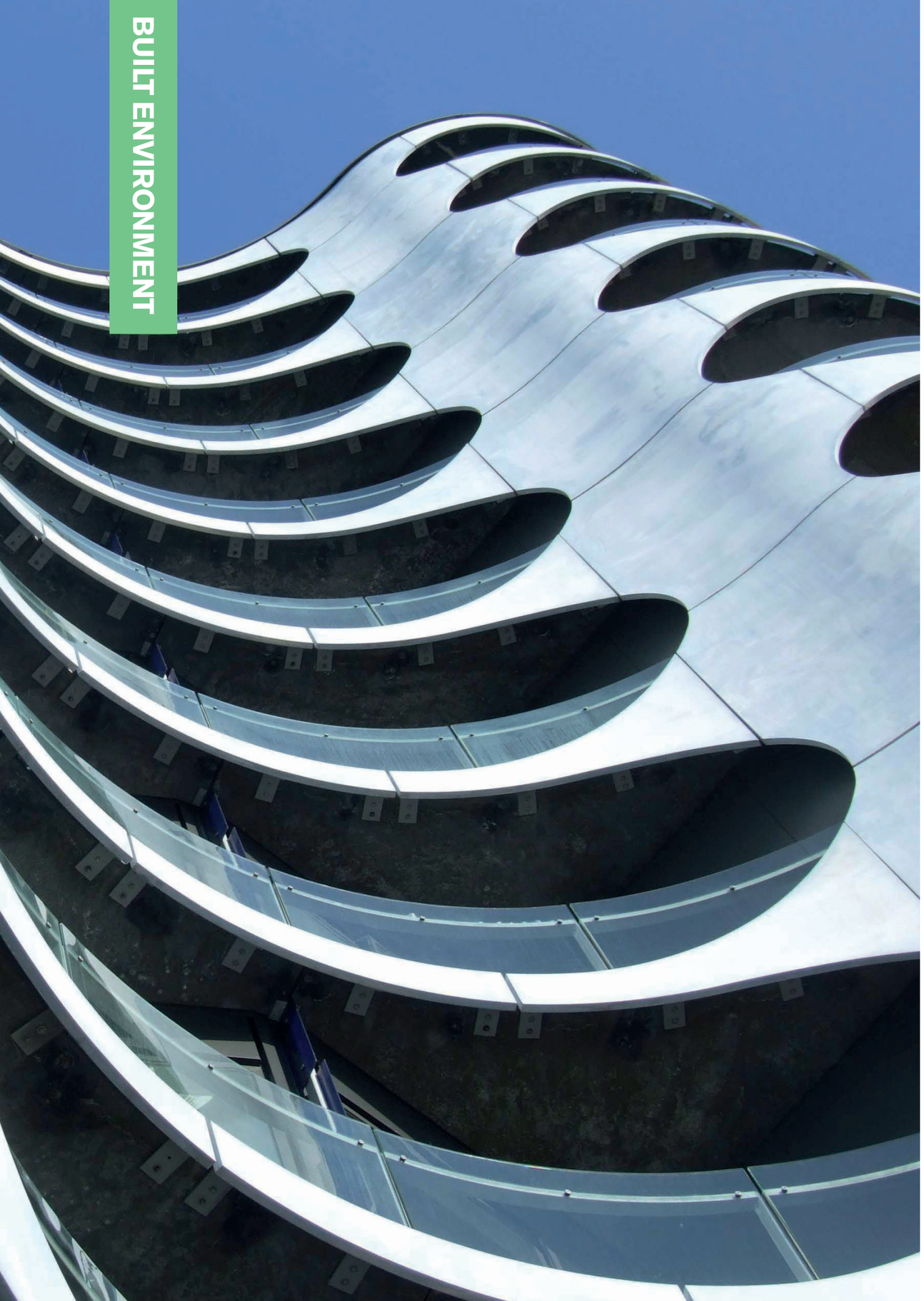

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INTRODUCTION TO THE BUILT ENVIRONMENT AREA OF ADVANCE

DIRECTOR: NINA RYD

Taking an integrated approach to a sustainable built environment, Chalmers Area of Advance gives opportunities for developing strategies as well as new technologies required for the transition of the current society into a low carbon society, encouraging significant energy savings and increased use of renewable energy. The ongoing rapid demographic change and urban growth are other great challenges, hence opportunities to achieve sustainability. However, cities, properly managed, can be transformative arenas in which natural resources are used more efficiently and economically, contributing to a high quality of life for everyone, including the increasing ageing society. Consequently sustainable urban futures will achieve breakthroughs in technology, planning and governance and the engagement of all relevant actors – people, industries, and governments. Furthermore, ensuring secure supply of provisioning food and water is a prerequisite for human well-being. The development of technologies and processes within water and wastewater systems are also considered through a holistic approach within the Built Environment Area of Advance.

In the spring of 2010, a task force initiated the development and mapping of Built Environment AoA through building understanding and acceptance of the AoA concept, inventory of centres, national and international benchmarking, selection of assistant professors, and dialogue with heads of departments at Architecture, Civil and Environmental Engineering, Energy and Environment and Technology Management and Economics, and with industry representatives, to identify excellence profiles. A workshop with 45 invited scientists was arranged in the fall of 2010. Active collaboration was initiated with Johanneberg Science Park, a joint venture between Chalmers and the City of Gothenburg, and Chalmersfastigheter, Chalmers' campus development subsidiary.

A strategy seminar was held in September 2010 aimed at specifying the AoA's target objectives, timeframes, activities, and boundaries, as the mapping had shown that there were several parallel processes in place, with their own logics and stakeholders, e.g. the establishment of the research centre Mistra Urban Futures (see 7.5.1).

As a follow-up, in the fall of 2011, a study was made with the aid of a professional communication consultancy firm to analyse internal and external stakeholders' conception of Built Environment AoA in order to formulate a powerful vision and to initiate the building of a strong brand.

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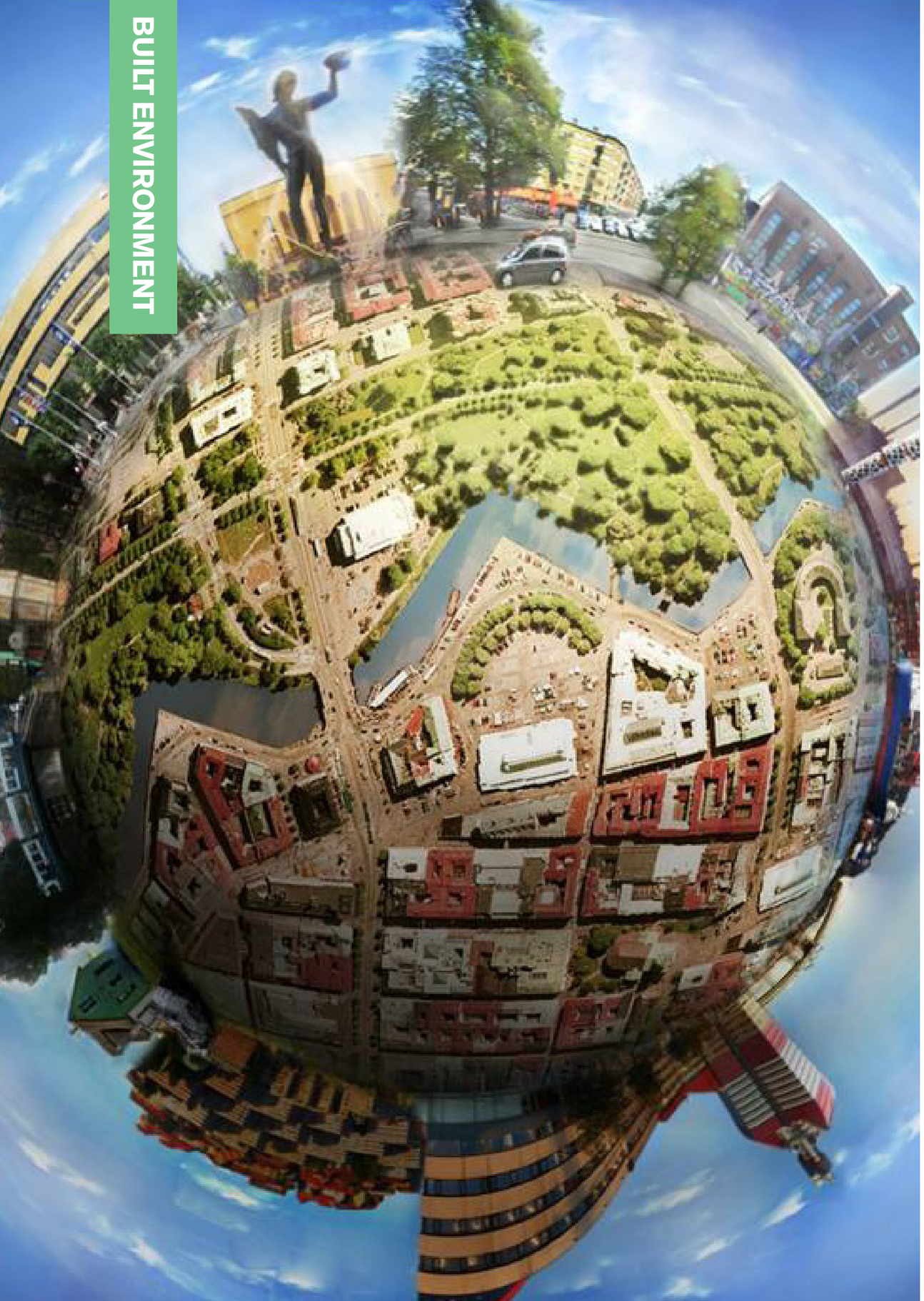

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LONG TERM VISION AND MISSION

6.1 VISION

Our vision is to make a real and tangible difference in the transition towards a sustainable development through crossdisciplinary and curiosity driven research focussed on societal challenges.

6.2 MISSION

The Built Environment AoA's mission is to display and focus crossdisciplinary research in the built environment sector and to collaborate across borders to achieve excellence – in order to contribute to solving future challenges and a sustainable society. The AoA integrates research, education and innovation and creates new meeting places for academy and societal stakeholders.

The Built Environment AoA acts in accordance with national environmental priorities and Chalmers' strategic plan for development 2011 – 2015 to promote a feasible and sustainable societal development that creates a good social situation for all people, an acceptable utilisation of water, natural resources and energy and economic growth. In this, the built environment has a crucial role to play as it provides the physical means for living, working, travelling, and other activities defining our society. Also from the production process perspective, the built environment is special, due to the size, long technical lifetime and considerable environmental impact of the products.

During 2011, the Built Environment AoA has focussed its activities on:

- Achieving long term robust research funding
- Supporting excellent research environments and efficient innovation environments and create open and creative meeting places where education, research and innovation are integrated guided by curiosity and commitment
- Supporting and developing boundary spanning leadership with a sustainable management and communication structure and a strengthened collaboration between AoAs, departments and schools
- Highlighting and supporting strategic collaboration with industry and society
- Strengthening the international perspective with an increased participation in European research collaborations

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7

WORKING PROCESS AND MANAGEMENT

7.1. MANAGEMENT

Since June 2010, the development of the Built Environment AoA is led by a director, Associate Professor Nina Ryd, and a coordinator from Operative and Strategic Support (OSS), Dr Stefan Forsaeus Nilsson. The AoA is subdivided into five excellence profiles, cf. Figure 2 and is being developed in collaboration with heads of departments, heads of divisions and the Dean of Education in Architecture and Civil Engineering. As of yet, no individuals have been assigned the tasks of excellence profile leaders. This is part of a deliberate strategy to instead develop the profiles in groups of researchers who have shown commitment and interest for the AoA. An strategic reference group has been set up with representatives from departments, industry and schools.

Since December 2010, the AoA has also engaged a parttime communication officer, Eva Hellberg. Her time is shared between the AoA and Johanneberg Science Park (JSP), ensuring a tighter collaboration between the AoA and JSP in the joint efforts to realise Chalmers' strategies for developing the south part of the Johanneberg campus.

The AoA has benefitted from project and process management support from OSS, in particular with respect to development of excellence profiles and strategic funding applications.

Personnel engaged in the management of Built Environment AoA during 2010 and 2011 have been:

- Director – Associate Professor Nina Ryd, department of Architecture (50 %)
- Coordinator – MSc Pernilla Ottosson (until Q1, 2011) and Dr Stefan Forsaeus Nilsson (from Q2, 2011), Operative and Strategic Support (40 %)
- Communication officer – Eva Hellberg (20 %)
- Administrative support – Per Skogsäter
- Support for developing boundary spanning leadership – Gunnar Jonnergård and Peter Lysell (Administration and Services)

The organisation of the AoA is based on a number of departments, research centres and educational programmes, most of which were already ongoing or even started to develop in parallel (for example Mistra Urban Futures and/or Johanneberg Science Park AB) when the AoA was established. Since these have international scientific advisory boards with experts in their respective areas we chose not to establish an AoA advisory board on top. The AoA director has also been invited as a member in several of the collaborative units' boards. However, in the autumn of 2011 we decided to establish a strategic reference group, in order to gain further co-ordination of topdown and bottomup initiatives, comprised by:

- Professor Greg Morrison, Deputy Head of Department at Civil and Environmental Engineering
- Professor Fredrik Nilsson, Department of Architecture & R&D Manager at White
- Dr Karl-Gunnar Olsson, Head of Programme in Architecture and Engineering

7.2. INTERACTIONS WITH THE HEADS OF DEPARTMENTS AND THE DEANS OF EDUCATION

Since the start of AoA, we have chosen to interact with the department heads at Architecture and Civil & Environmental Engineering. One reason for this was the already initiated Built Environment Node started by the former heads of the departments aiming to increase the cooperation and exchange between architects and engineers at Chalmers. Another reason was the facility planning process initiated by Chalmersfastigheter[1], intending to modernize and co-locate major parts of the two departments' workspaces. However, the property driven process came to need iterative loops in order to redefine the synergies that a closer co-location of the two departments could generate, taking into account also the establishment of the AoA and the setting up of Johanneberg Science Park, with a profile focussed on the built environment, energy and material sectors.

Hence, several crosslinked development processes are going on in parallel at different speeds. Moreover, the Built Environment AoA has interest in interaction also with other actors at Chalmers, e.g. the Department of Energy & Environment and the Transport and Energy AoAs. However, these interactions are not to the same extent influenced by the other ongoing planning and establishment processes.

1 Chalmers' campus development subsidiary

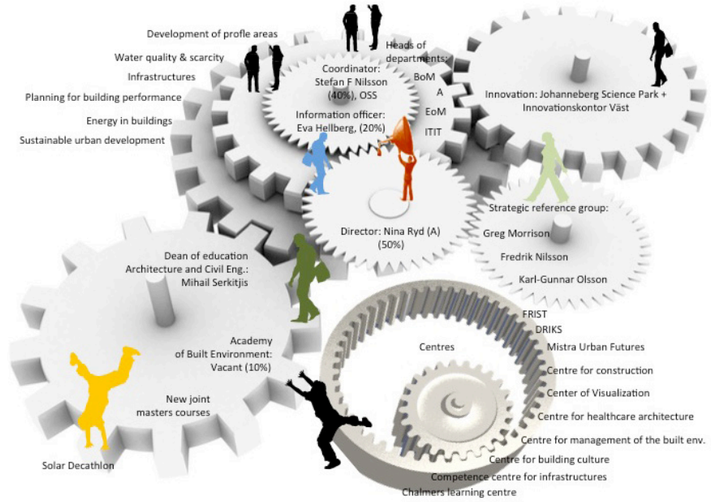

Figure 1. Organisation of the Built Environment AoA.

Another important partner is the newly established Mistra Urban Futures – a consortium which also had a startup and a conceptualization phase developing concurrently with the AoA.

The first two years of development has thus been characterized by numerous co-ordination and crossconnecting meetings with several partners, each of which seeks to shape their future role and function in relation to Chalmers' overall objectives.

With Deans of Education, Heads of Programmes and Directors of Master's Programmes in relation to the AoA, specific interaction aimed at the repackaging of the master's programes with the development of common AoA courses such as for example the Solar Decathlon course (see 10.4.2).

Heads of Departments:

- Ulf Jarfelt – Civil & Environmental Engineering
- Catharina Dyrssen – Architecture
- Henriette Söderberg – Energy & Environment

Education:

- Mihail Serkitjis – Dean of Education in Architecture and Civil Engineering
- Bert Luvö /vacant – Academy of Built Environment
- Assistant Professor Liane Thuvander and Senior Lecturer Dr Barbara Rubino – Department of Architecture – co-ordination and course development of Solar Decathlon
- CEO Fredrik Hörstedt – Chalmers Professional Education – a commercial assessment for commissioned courses
- Stefan Forsaeus Nilsson – OSS – Project Management Solar Decathlon

Interaction with Transport AoA:

- Professor Anders Hagson – Department of Architecture (10 %)

Interaction with Energy AoA:

- Professor Jan Olof Dalenbäck – Department of Energy & Environment
- Peter Wennerhag – CIT Energy Management AB
- Per Mejling – Department of Architecture (75%)

7.3. BOUNDARY SPANNING LEADERSHIP

Leadership across boundaries is challenging since it requires both individual and collective change. This programme/course is developed on a Built Environment AoA initiative, together with Gunnar Jonnergård (previously at Chalmers) and Peter Lysell from Sharing Insight. The original intention was to create a network were the directors of Chalmers Centres with strong connections to the Built Environment get to know each other's subject areas. However, by also getting them to know more about them selves and their inner drivers we believe they will develop in their roles as leaders and that this also will have a positive impact at their future possibilities at making conscious choices; choices that will lead them and their centre organisation to success. "People who grow produce growth". For these reasons, the Built Environment AoA launched a program focusing on leadership and organizational development across boundaries. The content covers a whole range of areas such as experience, personality analysis, team exercises, reflection, leadership theory and models, which together provide both the knowledge, experience and a toolbox to use in future in their daily work as centre directors. Moreover, the intention is also that the participants act as ambassadors for the AoA through their networks.

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The program consists of four parts. These are divided into the following areas: Leadership [2 days], Idea and vision of a centre at Chalmers [1 day], Program Design and Communication [2 days], Monitor and Evaluate [1 day]. Each section includes one or two days and is conducted in collaboration with the training company Sharing Insight facilitated by Peter Lysell.

The program has been successful. We have many positive comments from the participating centre directors were they gratefully highlight the unique opportunity of reflecting their own organisations in each other's as well as their personal growth. They also emphasise the well designed balance between leadership theory and practice. Moreover, how they after each different occasion have been able to enhance and also implement gained experience.

(References: Peter Lysell, Sharing Insight, and some of the participants in the programme for example: Professor Monica Billger, Chalmers Centre of Visualization, Professor Kent Gylltoft; Centre for Structural Engineering and Design, Assistant Professor Thomas Pettersson, DRICKS, Department of Civil- and Environmental Engineering, Assistant Professor Ann-Margret Strömvall director of FRIST: Forum for Risk Investigation and Soil Treatment).

7.4. PROFILE AREAS AND ACTIVE FIELDS

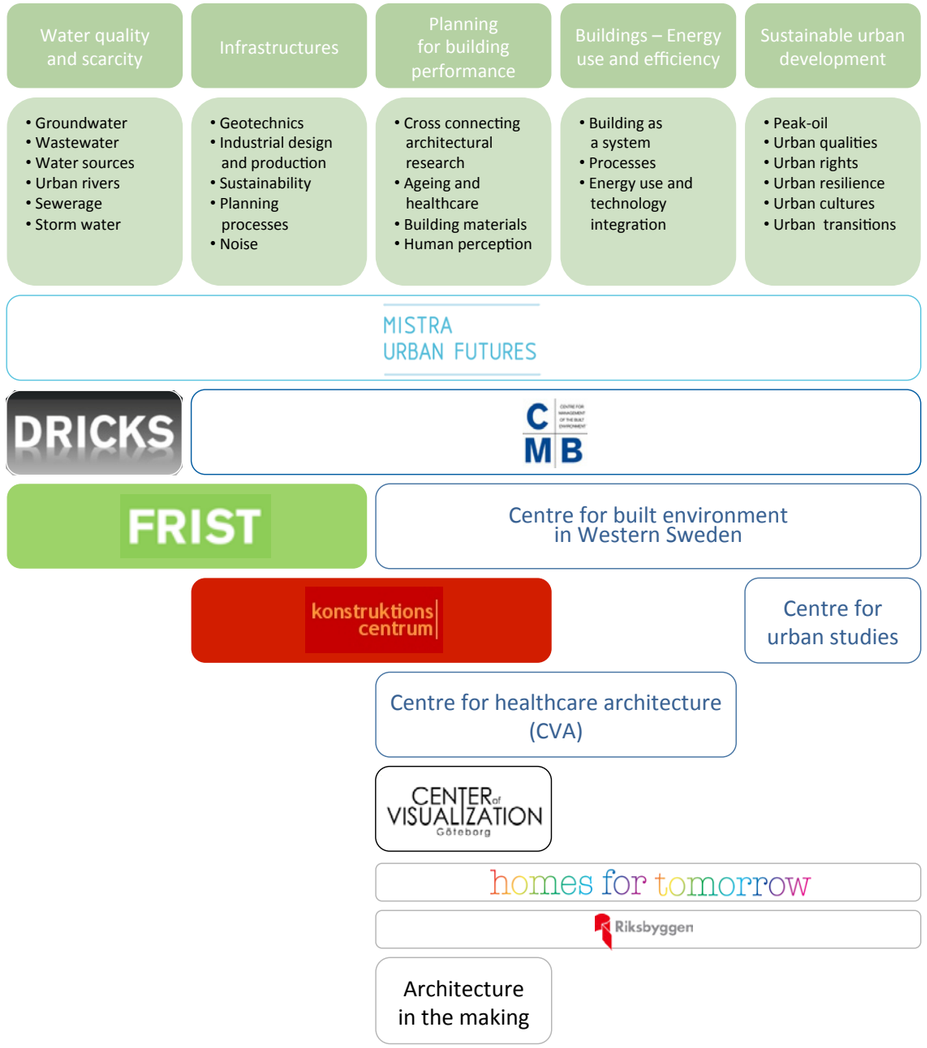

Figure 2. Profile areas, active research fields, centres and cross-disciplinary research projects of the Built Environment AoA.

7.4.1. Water Quality and Scarcity

The world's water situation is predicted to become more challenging in the future. There will be greater demand for clean water, and water resources are becoming progressively scarcer and poorer. Changes in global climate are causing less precipitation and more evaporation in some parts of the world, thereby reducing quantities in rivers, lakes and other water sources. At the same time, escalating pollution is degrading water quality, destroying aquatic ecosystems and affecting the lives of people without access to safe water and basic sanitation. These problems are more prevalent in developing countries but developed ones are not immune to these challenges.

In developing countries, degradation of the water environment is a major problem, as it is exacerbated by the discharge of untreated or insufficiently treated domestic and industrial wastewaters and the addition of agricultural runoffs and non-point sources to rivers, lakes, groundwater and sea. The absence or limited presence of appropriate technologies for water and wastewater treatment is restricting access to clean water and contributing to degrading water quality and poor health. Therefore, there is a need to improve this situation.

In developed countries, on the other hand, vast amounts of money and energy have been invested to purify water before distribution and treat wastewaters prior to discharge in order to protect the water environment. Advanced treatment and reclamation technologies, which are often costly and energy intensive, have been adapted in various municipalities and industries. However, continued practice of this money- and energyintensive approach is not sustainable.

Priority areas for research:

- Innovative technology for treatment of groundwater, in particular with respect to metals and organic contaminants.
- New concepts for wastewater treatment, comprising energy recovery, electricity production and recycling of material resources.
- Protection of raw water sources for drinking water to prohibit disease outbreak among consumers due to waterborne infections and chemical and drug contaminants.
- Urban rivers for handling of surface water, reducing risks for flooding and restoring groundwater levels, but also as means for raising attractiveness of urban areas and providing recreational value.
- Infrastructures for sewerage are reaching their capacity limit. Instead of just increasing the capacity of today's infrastructure, alternative system architectures may comprise semicentralised systems with local treatment plants and/or separated mains for different kinds of sewage.
- The first flush of storm water is often more contaminated and hazardous than leachate from landfills, due to leaching of chemicals from asphalt surfaces, construction materials, etc.

The research activities in water related issues are undertaken at the department of Civil and Environmental Engineering in close collaboration with societal and industrial stakeholders through the competence centres Framework Programme for Drinking Water Research (DRICKS) and Forum for Risk Investigation and Soil Treatment (FRIST) (see see 7.5.3 and 7.5.4).

Strategic AoA recruitment: Assistant professor Yuliya Kalmykova at the department of Cilvil & Environment Engineering is financed by AoA funding and her work is focused on sustainable development of cities. Kalmykova is responsible for the project "Urban Metabolism" – a new area of research at Chalmers. The research aims to describe and optimize processes in cities, by tracing the flow of energy and resources. Assistant professor Kalmykova collaborates with MIT: The Massachusetts Institute of Technology. Her research also includes purification of contaminated water. She is also studying, among other things, colloidal forms of organic and inorganic contaminants and test field installations for the treatment of landfill. Kalmykova is supervising two PhD students focusing on sustainable buildings and cities.

Principal Investigators:

- Professor Greg Morrison
  Division of Water Environment Technology, Department of Civil and Environmental Engineering
- Professor Lars Rosén
  FRIST Competence Centre, Department of Civil and Environmental Engineering
- Assistant Professor Thomas Pettersson
  DRICKS, Department of Civil and Environmental Engineering

7.4.2. Infrastructures

The world population is growing rapidly; urban areas are projected to increase by three billion people to 2050. The transport of people and goods is essential to everyday life. The world's cities have a major impact on emissions of greenhouse gases and global warming. The urban environment influences our living conditions, social well-being and health. Thus the performance characteristics and quality of our infrastructures are of fundamental importance to urban sustainability, our well-being and the environment.

The road and railway transport network forms the backbone of European transportation systems, accounting for more than 80 % of passenger transport and 50 % of goods transport. The performance of the road and railway network is largely

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dependent on the state of the critical transport infrastructures such as bridges or tunnels. According to the ECTP Strategic Research Agenda, road transport is expected to double within the next 15–35 years. In its statement on 31 May 2007, the European Conference of Ministers of Transport (ECMT) pointed out that road congestion in Europe annually costs one per cent of the Gross Domestic Product and bridges/tunnels are among the main bottlenecks in the road networks. A large number of bridges and tunnels are located in densely populated urban areas and serve as a vital part of the infrastructure in all European cities. Moreover, the bridge/tunnel stock has a very high asset value as capital to be protected. Bridges in cities, for example, are often key objects and landmarks of the urban architecture.

To ensure a sustainable and resilient development of urban and intraurban transport, infrastructure research needs to address basic civil engineering, such as rock engineering, steel and concrete structures, etc., as well as a number of transdisciplinary issues.

Priority areas for research:
- Understanding of geotechnical – structural interactions is the engineering basis for resilient infrastructure design.
- Industrialised structural design and production and project management that promotes resource and time efficiency in materials, excavation works, construction and maintenance, while maintaining superior structural properties and aesthetic design.
- Sustainability of infrastructure in terms of carbon footprinting.
- Involvement of stakeholders and endusers in the planning process to promote resilience of infrastructures. This also includes the necessity for understanding communicative practices and information needs.
- Mitigation of noise disturbance from infrastructures in urban areas.

The research within the areas above is primarily undertaken at the Department of Civil and Environmental Engineering in collaboration with the Foundation for Swedish Rock Engineering Research (SveBeFo).

Principal Investigators:
- Professor Robert Kliger
  Division of Structural Engineering, Department of Civil and Environmental Engineering
- Professor Lars O Ericsson
  Division of Geo Engineering, Department of Civil and Environmental Engineering
- Professor Anders Hagson
  Department of Architecture

7.4.3. Planning for Building Performance

The global constraint for present and future homes is carbon dioxide – a difficult challenge as present European homes consume 40 % of the total primary energy production and globally homes contribute to 8 % of greenhouse gases. Buildings also account for 40 % of the materials consumed in the world economy and therefore new approaches to future homes have the potential to make a significant contribution to an estimated required 50 % reduction in the material and energy intensity of global consumption. It is thought that the greatest economic potential for reducing greenhouse gases to 2030 is in the building sector and this is mainly based on currently available efficiency measures.

There is also the paramount challenge of rising demands on residential quality from an emerging mosaic of diversified lifestyles and need for adequate services in response to an ageing society. In addition there is the challenge concerning how to respond to the accentuated necessity for new ways of providing advanced and relevant healthcare in residence as well as residential qualities while in a lasting or even a transient healthcare situation as healing environments. Architectural projects for care and healthcare must support patient-focused and evidence-based care processes. Supplementing this approach we also regard as a vital issue the quality of residence from the perspective of staff involved in residential healthcare or elderly caretaking representing for these professionals a predominant working environment.

Priority areas for research:
- Cross-connecting the architectural research themes on architectural history, theory and criticism with practicebased methodologies and architectural engineering and conservation.
- Architecture for an aging society and healthcare architecture, to improve quality of life for elderly, provide better care and optimise the work place for staff in care.
- New building envelopes providing sustainable solutions with enhanced energy efficiency for the building stock using less materials and resources.
- New building materials bringing multi-functionality and added value. An example could by innovative nanostructured concrete composites.
- Innovations in and new concepts for indoor service systems, e.g. for water supply to address water scarcity issues.
- Human perception of new technologies, materials and building concepts, e.g. to provide recreational environments using innovative technology.

The activities in the fields above are planned in close collaboration with the construction industry through the Centre for Management of the Built Environment (CMB), p. 16, and done mainly within the framework of the Formas[2] supported strong research environments Homes for Tomorrow at the department of Civil and Environmental Engineering and Architecture in the Making at the department of Architecture, in collaboration with KTH, Lund University and the Umeå School of Architecture.

Principal Investigators:
- Professor Greg Morrison
  Division of Water Environment Technology, Department of Civil and Environmental Engineering
- Professor Fredrik Nilsson
  Department of Architecture

7.4.4. Buildings – Energy use and efficiency

Chalmers and West Sweden is in the international frontier concerning buildings with low energy use, covering residential as well as commercial, and new as well as existing, buildings. Furthermore, Gothenburg and Chalmers have in many ways a unique heat supply system (district heating and cooling with >85 % waste and renewable resources). Chalmers has a broad scientific interdisciplinary foundation that facilitates continuous development of knowledge for planning, design and management aspects, as well as technologies for construction, of sustainable buildings and building areas. System aspects are given high priority in the research, for instance when it comes to combining sustainable energy supply and energy efficient buildings with good indoor environment.

The interdisciplinary cooperation facilitates in depth knowledge where specific technology knowledge is supplemented with system knowledge and where basic and applied research is often conducted in cooperation with major actors in the building sector. Chalmers has a long tradition of extensive cooperation with different stakeholders in the construction and real estate sectors, as well as with different authorities. There is further an extensive participation in international cooperation within IEA and EU.

The profile "Buildings – Energy use and efficiency" has a close cooperation with SP Technical Research Institute of Sweden[3] in several areas, not least regarding design and evaluation of buildings and systems in buildings. The profile is joint with Energy AoA.

Priority areas for research:
- The building as a system:
  - Functional Requirements (e.g. indoor climate)
  - Building requirements (e.g. architecture, energy, economy, etc.)
- Construction and management processes:
  - Organisation (incl. LCC)
  - Quality assessment
- Energy use and technology integration in buildings:
  - Incentives, directives and legislation
  - Building and system design
  - Energy efficiency and renewable energy

Principal Investigator
- Professor Jan-Olof Dalenbäck
  Division of Building Services Engineering, Department of Energy and Environment

7.4.5. Sustainable Urban Development

Energy efficiency and carbon dioxide emissions of the building stock are gradually improving. Cars become less polluting. But at the same time urban life styles generate increasing mobility need, especially concerning short range passenger traffic and transport of goods, and this eats up decreases in fossil fuel use in vehicles. Private dwelling space has grown, thus being one of the main causes of urban sprawl. Cities spread into regional urban landscapes, and geographers, landscape urbanists, architects and planners have produced interesting perspectives on the urban landscape, however often in more general descriptive ways. Segregation and lack of access to urban space and urban function is a huge problem that needs to be addressed from many approaches – political, social, economical, cultural, physical etc. Other grand challenges to sustainable urban development are, e.g., poverty, crime, excessive use of resources in cities from nearby hinterlands and from far away, lack of equality, segregation, religious and political antagonism and conflict, urban decay and deterioration into slums and environmental degradation.

Priority areas for research:
- Fundamental peak-oil challenges, especially on issues of the organization of transport, delivery of goods and traffic flows, on an urban system level and bring them in close connection to aspects of the formation of urban landscapes.
- Urban Qualities with focus on the importance of the built and socio cultural environment for wellbeing and health. Future cities have to be shaped in ways that support quality of life for inhabitants with different social, cultural and physical needs and aspirations.
- Urban Rights with equal opportunities for all citizens to benefit from the opportunities of city's advantages and the possibilities to avoid its drawbacks. Urban inhabitants are a tremendously heterogeneous collection of individuals and groups.
- Urban Resilience. To successfully understand, reconfigure and manage resources limitations within complex urban systems and processes is key to sustainable urban development. The flows of raw material, commodities and waste transverse local, regional and global territories in ways that are often incomprehensible.
- Urban Cultures, where we interact with friends, family and acquaintances as well as with complete strangers. People often move to a city for its possibilities for rich social, economic, labour and cultural exchange, but also to escape conflict or environmental and economic degradation.
- Urban Transitions towards positive urban change. How can such change best be supported in urban contexts characterized by compound mosaics of formal and informal sites of decisionmaking and action? Urban development is driven by widely differing economic, demographic, physical, social and cultural concerns.

The research at Chalmers within the area of sustainable urban development is conducted primarily within the Mistra Urban Futures centre, cf. 7.5.1, comprising a wide range of stakeholders, and at the department of Architecture.

Principal Investigators:
- Professor Catharina Dyrssen
  Department of Architecture
- Professor Lars Reuterswärd
  Mistra Urban Futures

2 The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning

3 www.sp.se

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7.5. CENTRES

7.5.1. MISTRA Urban Futures

Mistra Urban Futures is a new centre for sustainable urban development with the ambition to become a worldleader in the field in the near future. It offers innovative solution through the production of high quality, effective and socially relevant knowledge. Excellent, effective and relevant knowledge is developed in close cooperation between practitioners and researchers. Through developing such collaboration, the centre aims to make a real difference to the environment and the lives of people in the world´s cities. The inherent strength of Mistra Urban Futures lies in the interaction between research and its application in practice. The centre is intended to provide an arena for the development and transfer of knowledge, while promoting cooperation with business, interest organisations and the public. The knowledge and experience that are essential to understanding, improving and communicating urban development processes are brought together at Mistra Urban Futures. The unique feature of the centre is its capacity to deal with different disciplines and areas of knowledge by combining research and practice. As a meeting place for knowledge, Mistra Urban Futures is enriched by the flow of ideas and experience brought to it by those working actively within the centre. Understanding of how different spheres of knowledge interact generates knowhow that is valuable both within the academic world and in the practical work of urban development. The capacity to work across different disciplines and professions is reaffirmed in both the research and practical spheres.

www.mistraurbanfutures.se

7.5.2. CMB – Centre for Management of the Built Environment

CMB is a collaboration between Chalmers University of Technology and the Foundation for Construction Management. It was formed in 1998 after an initiative from industry to promote and develop management in all parts of the built environment sector. CMB's mission is to support research, to promote education and development and to promote international collaboration. CMB comprises 45 companies and organisations collaborating with 15 research groups at Chalmers University of Technology.

www.chalmers.se/cee/cmb-sv/om-cmb

7.5.3. DRICKS – Framework Programme for Drinking Water Research

The goal of DRICKS is to be a leading centre in the whole field of drinking water research in close collaboration with industrial and societal stakeholders. The collaboration comprises information exchange, where research partners share knowledge on cost efficient solutions to stakeholders through annual seminars and publishing in scientific and popular journals. Stakeholders contribute financially and inkind and support research efforts.

www.dricks.chalmers.se

7.5.4. FRIST – Forum for Risk Investigation and Soil Treatment

The main purpose of FRIST is to initiate research for the development of costeffective treatment techniques, as well as strategies for the investigation and assessment of contaminated sites. FRIST is a partnership amongst Chalmers University of Technology, Renova[4] , NCC and SWECO. In the FRIST reference group there also have representatives from the regional and local authorities, the County Administrative Board of Västra Götaland and the City of Gothenburg. FRIST was established in 2004.

www.frist.chalmers.se

7.5.5. Centre for Structural Engineering and Design (Konstruktionscentrum)

The Centre for Structural Engineering and Design will lay a foundation for efficient and broad collaboration between the different stakeholders of the construction sector. Chalmers, construction companies and representatives of endusers will together build, support, develop and strengthen the area of structural engineering, through targeted education, research and seminars. Efficient and clear communication of results is an important part of the work.

www.konstruktionscentrum.chalmers.se

7.5.6. Centre for Built Environment in Western Sweden

The Centre for Built Environment in Western Sweden is a joint organisation between Chalmers University of Technology and Gothenburg University for the promotion of building culture. Members are departments, faculties, associations, governmental agencies and individuals.

www.chalmers.se/arch/SV/organisation/centrum-for

4 A waste management company

7.5.7. Center of Visualization Göteborg

Center of Visualization Göteborg is an organisation for stimulating growth in the field of digital visualization. The organisation shall help to spread visualisation technology into new and existing industry segments and provide industries with sharper tools in for example production, processes, product development and design. Center of Visualization shall also stimulate crossovers between visualization and other technologies in order to create new innovations and applications.

www.center-of-visualization.org

7.5.8. Centre for Urban Studies

Centre for Urban Studies in Hammarkullen is a joint venture between University of Gothenburg and Chalmers University of Technology. The unit is located in the suburb of Hammarkullen, 15 km outside the city centre. It has the ambition to focus on social sustainability and will investigate the uneven development in the contemporary city of Gothenburg as a whole. The urban development of the last two decades has created a divided city.

www.urban.gu.se

7.5.9. Research Centre for Healthcare Architecture

The Research Centre for Healthcare Architecture is a national area for creation, translation, exchange and dissemination of research based knowledge and education on healthcare architecture with the purpose to support the Swedish healthcare system. The centre is being developed in collaboration with the Forum for Healthcare Building Research, which is a national association for all Sweden's regional healthcare providers, a number of the largest municipalities and architect firms.

www.chalmers.se/arch/SV/samverkan/centrum-for-vard

7.6. INNOVATION AND COLLABORATION WITH INDUSTRY

7.6.1. Johanneberg Science Park

Johanneberg Science Park (JSP) has been formed by the Chalmers University of Technology Foundation and the City of Gothenburg with the aim to develop an environment which stimulates collaboration between academia, industry and other players in society at Chalmers Campus Johanneberg. Initially JSP support specifically the development of the fields of Built Environment, Energy and Materials/Nanotechnology.

www.johannebergsciencepark.com

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8 RESOURCES

8.1. PERSONNEL

112 senior researchers and lecturers, out of which 18 are full professors, are engaged in activities in the Built Environment AoA. 33 (29 %) of these are women. The majority belongs to either the department of Civil and Environmental Engineering (62) or Architecture (41). Additional staff is found at the departments of Energy and Environment, Technology Management and Economics, and Applied Information Technology. The age distribution of the senior staff is somewhat skewed towards the high end, cf. Figure 3.

A total of 62 PhD students are being supervised by 41 of the senior staff.

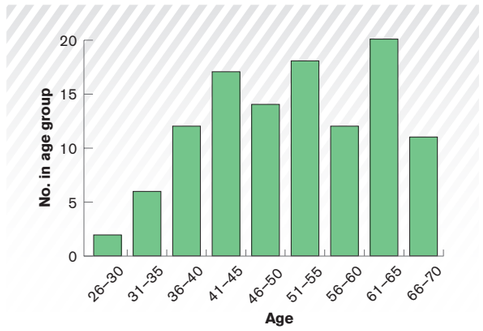


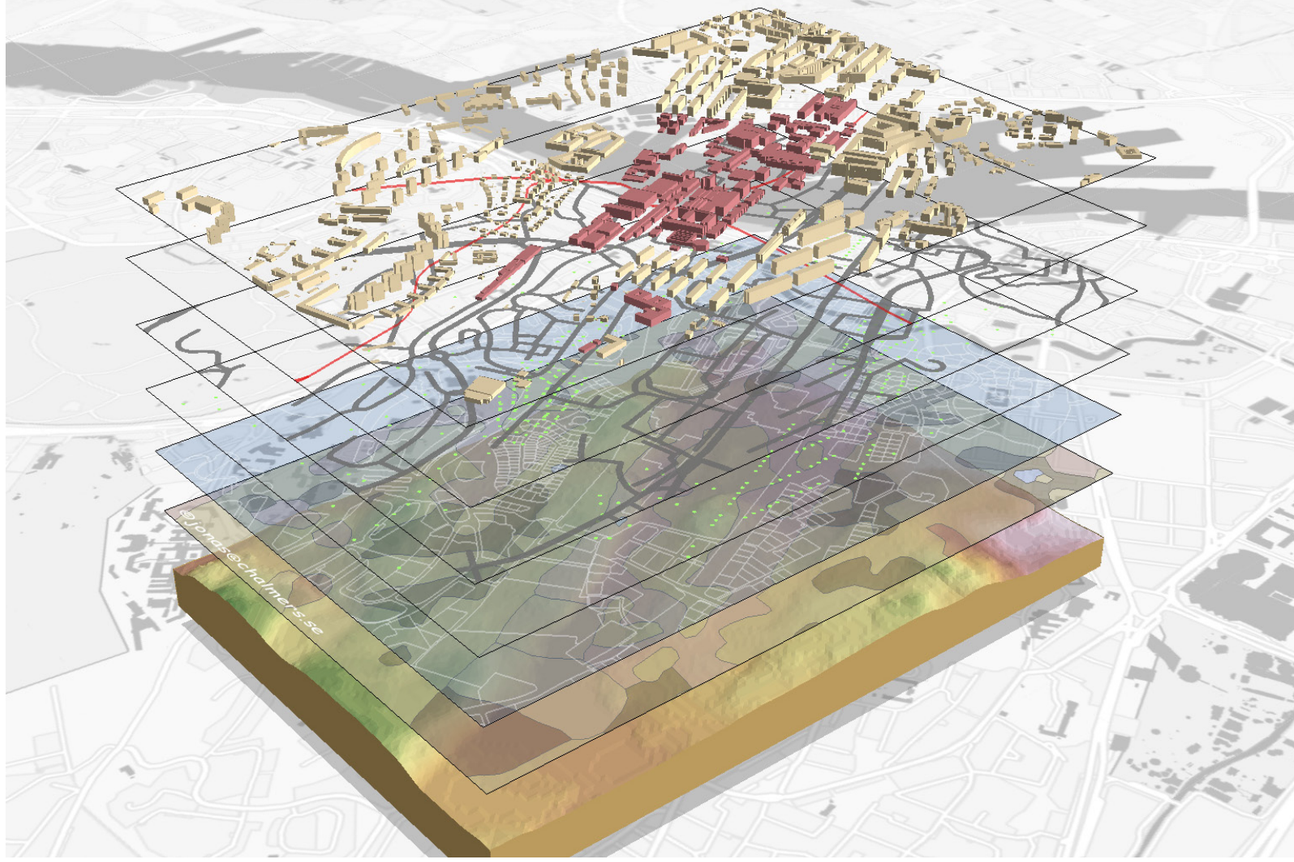
Figure 3. Age distribution of senior staff at Built Environment AoA

8.2. FINANCIAL SITUATION

The financial situation for the AoA is shown below in MSEK:

	2010	2011	2012	2013	2014	2015	2016
Chalmers:							
AoA development	2.5	2.5	2.5	2.5	2.5	(2.5)	
Strategic assistant professor incl PhD student	2	2	2x2	2x2	2	2	
Strategic and Operative Support	0.5	0.5	0.75	0.5	0.5	0.5	
External funding:							
Homes for Tomorrow (Formas[6])	5	5	5	(5)	(5)		
Architecture in the Making (Formas[6])			5	5	5	(5)	(5)
Urban energy systems (Vinnova[7]), shared with Energy AoA		0,75/2	(10/2)	(10/2)	(10/2)	(10/2)	
Chalmers co-funding of strategic projects:							
Homes for Tomorrow			2,5	2,5	2,5		
Architecture in the Making			1	1	1	1	1
COINS[8] agreements:							
Riksbyggen		1	1	1	1	1	
Future Coins							
Education:							
AoA Course Development			0,375				
Solar Decathlon(US Energy Department & external funding)			(5x2)	(5x2)			
Total in MSEK	10	15.4	>20	>25			

6 The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning
7 The Swedish Governmental Agency for Innovation Systems
8 COINS – Chalmers Open Innovation System



The Built Environment AoA is financed through special establishment funding from Chalmers of 2.5 + 2 MSEK/year and use complementary funding from other sources, i.e. external funding from governmental research councils and industry, to support integrating activities in the "knowledge triangle" context. Additional Chalmers funding has been received for the certain strategic projects of approximately 3.5 MSEK/year, supporting increased trans-disciplinary activities. A joint project with the Energy AoA has also received funding of 0.75 MSEK from Vinnova's[9] call on Challenge Driven Innovation. Co-financing from industry has at this stage resulted in external funding for two PhD students (50 %).

The total external funding for research in Built Environment AoA was 88 MSEK in the Year of 2010. The largest external funding sources are Formas[10] (20 MSEK) and the European Commission (6 MSEK).

8.3. FINANCIAL DISTRIBUTION

The Chalmers establishment funds are used to co-finance individual researchers and teachers' additional coordination costs in order to implement the knowledge triangle.

Examples are:

- Strategic recruitments of excellent Assistant Professors including their PhD students (2.5 MSEK x 2)
- Co-funding of post-docs operating across department boundaries (0.4 MSEK/year)
- Co-funding of senior faculty (10–20 %) promoting cross-border and new challenge-driven research
- Coordination of comprehensive research call applications where researchers from multiple departments and/or industry and/or society are involved (0.1 – 0.2 MSEK/application)
- Networks, e.g. Boundary Spanning Leadership (see 7.3) (0.2 MSEK/year)
- Initiative seminars (0.2 MSEK/year)
- Cooperation and exchange with industry, e.g.seminars and workshops, and co-financing of strategic senior lectures/ adjunct professor (Professor of the Practice)
- Development of interdisciplinary courses in which faculty from several departments work together (about 0.1–0.2 MSEK)
- Increased internationalization (exchange, co-financing of guest researchers)
- Boosting the strategic projects Homes for Tomorrow and Architecture in the Making (see 10.4.1) with international trans-disciplinary excellence (2.5 MSEK/year + 1 MSEK/year)

9 The Swedish Governmental Agency for Innovation Systems
10 The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning

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8.4. RESEARCH INFRASTRUCTURES

8.4.1. Acoustic laboratories

Chalmers division of Applied Acoustics has one of the leading acoustic laboratories in Europe. Its research facilities support researchers in their contribution to a sustainable built environment and infrastructure as well as European industry in its development of products and services with appropriate sound and vibration properties. The laboratories comprise a teaching laboratory (the converted reverberation chamber), an anechoic chamber, a sound insulation suite (comprised of four reverberation chambers), a test hall, and a laboratory space for vibroacoustic research. There is also a Psychoacoustics and Infrasonics & Low Frequency laboratory located in a hemi-anechoic chamber for psychoacoustic testing. Moreover, there are facilities for air-borne ultrasonics experiments, measurement, and testing. The Room Acoustics Group also has a substantial part in what today are called auralization techniques. These open the possibility to listen to binaural and ambisonics simulations of the sound fields of rooms and outdoor environments, already at the planning stage using virtual acoustics software. The Room Acoustics Group also has its own flexible and modular virtual reality lab, where vibration, auditory and visual stimuli can be combined.

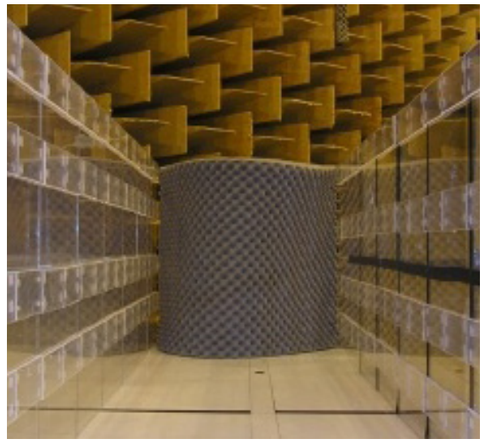

Figure 4. A scale model of a city canyon (a street with high buildings on both sides) for experimental investigation of sound propagation in urban environments.

8.4.2. Visualization facilities

Today researchers and professionals are increasingly using digital technologies in their everyday work to document, analyze and communicate all facets of the built environment. The Center of Visualization (see 7.5.7) is an organization for stimulating growth in the field of digital visualization and work-ing in collaboration with several of Chalmers AoAs. The organization help to spread visualization technology into new and existing research and industry segments and provide industries with sharp-er tools in for example production, processes, product development and design. Center of Visualization also stimulate crossovers between visualization and other technologies in order to create new innovations and applications, i.e. the development of “Urban Games” in collaboration with Mistra Urban Futures.

8.4.3. Demonstration project for future housing – on site

Positive Footprint Housing is a research and development collaboration between Riksbyggen, Chalmers, Gothenburg University and Johanneberg Science Park on the future of housing to be built in direct connection to Chalmers’ Campus Johanneberg. The project aims to be a comprehensive solution in the international forefront of sustainable growth and urban development – environmentally, economically and socially – focusing on care for the residents. Design, selected materials used, and construction methods, will ensure maximum resource efficiency and energy saving, high architectural quality and positive impact on the environment. During planning, predesign, design and construction the housing project will serve as a laboratory for fullscale research, innovation and inspiration about future living, housing and sustainability. The demonstration project will serve as an active platform in education of architects, engineers and social scientists around accommodation and resource issues. With seminars, workshops and exhibitions it will also serve as a meeting place for residents, property owners/managers, researchers, students and professional specialists. In 2011, approximately 40 researchers from AoA, Gothenburg University and SP Technical Research Institute of Sweden gathered in various workshops to identify forefront bordercrossing research and education projects.

8.4.4. Facilities for the future Built Environment AoA at Chalmers’ Campus Johanneberg

We are planning to build a completely new type of knowledge environment in which we mix business, civil society and academia at one place. Our vision is to create a sustainable campus environment that is based on knowledge development for regional growth. Through the future physical structure the Campus Johanneberg will support a higher integration of education, research and innovation. This will be achieved through close collaboration between academia, industry and society on site. We are now working to enable significant changes in current buildings, creating new construction and expansion spaces for Chalmers AoA Built Environment. This will also contribute to shared attractive and inspiring venues. The aim is to create an area that is at the forefront of technological, sustainable and social development and that the buildings themselves will be subjects of research. In close collaboration with the client organizations we are formulating visions for the physical development and the university’s future activities. Securing that the future educational and physical knowledge environment contributes to the universities’ international competitiveness. Master plans for the future campus development are prepared by Chalmersfastigheter[11].

11 Chalmers’ campus development subsidiary

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9 STRATEGIES

9.1. RECRUITMENT

The current strategy for recruitment to the AoA is focused on international excellence, both on senior level and Post doc level, in order to enhance the strong research environments Homes for Tomorrow and Architecture in the making for which we will use the Chalmers co-funding at a level of approximately 3 MSEK. Moreover, we will recruit second a strategic assistant professor during 2012 to complement and develop our AoA profile areas – preferably with the orientation towards sustainable urban infrastructure.

9.2. THE PROMOTION OF INCREASED NATIONAL FUNDING

In 2011, the AoA management has worked systematically to influence the direction of the forthcoming Swedish Government's Research and Innovation Bill of 2012. Primarily by Chalmers' own proposals, but also through direct dialogue with government officials and state secretaries in the ministries involved and intensive collaboration within the board of the Swedish Universities of the Built Environment (see 10.3.2) and with the CEO of The Swedish Centre for Innovation and Quality in the Built Environment (see 10.3.2). The uniquely coordinated proposals have now been submitted to the Ministry of Education.

The Swedish Government is accumulating strength around the Future Commission, whose mission is to point out how major future challenge should be met; how to achieve sustainable growth and meet the challenges posed by strong urbanization, climate change and new demographics. Hence, in order to build the New Sweden – the construction sector plays a central role. Public and private sectors, academia, funding organisations and users of the built environment must therefore work together in new ways. An external change that also shows that Chalmers president has been forward thinking and acting strategically initiating the Built Environment AoA.

Consequently, it is obvious that far more resources is needed to research, development and innovation in the planning and building sector to meet the complex future challenges and also support Swedish architecture, engineering and construction companies to be internationally competitive.

The coordinated proposals are therefore formulated to gradually increase the annual efforts in R&I at universities, colleges and institutes as well as for common development areas, so that – after an initial period of four years – funding turn into at least one billion SEK annually. That is, a doubling of current grants levels. We also see – along with the sector's different players – a need to create a specific R&I council focusing on Built Environment exclusively. In addition to this, we also promote the establishment of a Strategic Innovation Agenda for the Built Environment – a program of the type proposed by the Swedish research councils in "For Swedish success in research and innovation 2013–2016".[12]

A unique aspect of this coordinated work is that the private actors in the built environment sector have committed to finance the same amount as the proposed gradual increase governmental funding. The proposal is at least another three billion SEK for research, development, innovation & implementation, and generic skills transfer over four years – in addition to what the sector is investing in the current situation. The prerequisite is that the Swedish Government makes a similar commitment. Actors from the building sector are also interested in being represented in the recommended Built Environment R&I Council.

The coordinated proposals have been developed in close cooperation with representatives of architectural, engineering, construction, installation, client, and real estate companies, and the trade associations Swedish Construction Clients Forum, Swedish Property Federation, the Swedish Construction Federation, Swedish Federation of Consulting Engineers and Architects, and the federation of Construction Materials Industries.

12 Input to the Research and Innovation Bill of 2012 from the six largest public research funding organisations.

9.3. INTEGRATION OF THE KNOWLEDGE TRIANGLE

The Built Environment AoA's mechanisms to implement the knowledge triangle are:

- Supporting research, education and innovation challenges that are too complex to be handled within a single department at Chalmers (also the starting point of our profiles as well as the joint projects with the Transport and Energy AoAs)
- Promoting a systematic interaction between education, research and innovation,e.g. as an academic party to support the establishment of Johanneberg Science Park
- Highlighting initiatives that previously tended to fall through the grid because they involve large coordination efforts between educational elements and research in various departments, as well as high degree of business involvement
- Supporting R&I initiatives that relevant to the civil and industrial sector in the field of Built Environment, which are not by themselves defined by scientific disciplines
- Invitations to interdisciplinary collaboration in a proactive manner, e.g. through new meeting venues, panel discussions and workshops
- A dynamic dialogue about excellence in research and the pros and cons of working on the "depth" and "transverse"
- Faster turning of knowledge into practice by highlighting and communicating good practice and commissioned education
- Careful listening to future bottom-up initiatives and making the commitment of individuals, i.e., students, researchers, entrepreneurs and innovators who are key players in the AoA

9.4. STRATEGY FOR COMMUNITY BUILDING

Researchers and teachers engaged in the AoA Built Environment have their employment at different departments within Chalmers. However, several AoA mechanisms intend to support this loosely coupled network in order to develop a productive and creative community as well as comparative advantage. The AoA boosts and co-finances individual researchers to broaden their cross-disciplinary networks. Moreover, the AoA promotes sharing activities in order to identify future challenges driven by ambitions, enthusiasm, and long term thinking that also shapes an environment where critical feedback is considered constructive with respect to each other's profession. The international relations are essential as well as an increased interaction with society.

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9.5. INTERNATIONAL STRATEGY

In order to ensure a long term robust research funding situation, the European Commission's Framework Programme for research is one of the most fruitful sources to turn to. The AoA has been fairly successful as it comes to participation in European collaborative research, and is currently co-ordinating three and partner of four projects in the ongoing Seventh Framework Programme (FP7):

- *TailorCrete*
  New industrial technologies for tailormade concrete structures at mass customised prices
  (August 2009 – July 2013)
  Coordinated by Danish Technological Institute (DK)
  Principal Investigator: Associate Professor Karin Lundgren, Division of Structural Engineering, Department of Civil and Environmental Engineering

- *HOSANNA*
  Holistic and sustainable abatement of noise by optimized combinations of natural and artificial means
  (November 2009 – October 2012)
  Coordinated by Chalmers
  Principal Investigator: Associate Professor Jens Forssén, Division of Applied Acoustics, Department of Civil and Environmental Engineering

- *CO2NTROL*
  Integrated solutions for noise and vibration control in vehicles (September 2009 – August 2012)
  Coordinated by Fraunhofer (DE)
  Principal Investigator: Professor Wolfgang Kropp, Division of Applied Acoustics, Department of Civil and Environmental Engineering

- *FC-DISTRICT*
  New μ-CHP network technologies for energy efficient and sustainable districts (September 2010 – August 2014)
  Coordinated by Mostostal (PL)
  Principal Investigator: Dr Bijan Adl-Zarrabi, Division of Building Technology, Department of Civil and Environmental Engineering

- *PANTURA*
  Flexible Processes and Improved Technologies for Urban Infrastructure Construction Sites
  (January 2011 – December 2013)
  Coordinated by Chalmers
  Principal Investigator: Professor Robert Kliger, Division of Structural Engineering, Department of Civil and Environmental Engineering

- *URBAN-NEXUS*
  Furthering Strategic Urban Research
  (September 2011 – August 2014)
  Coordinated by Netherlands Institute for City Innovation Studies (NL)
  Principal Investigator: Associate Professor Jaan-Henrik Kain, Mistra Urban Futures and Department of Architecture

- *SONORUS* – The Urban Sound Planner – Marie Curie Initial Training Network
  (Under negotiation, starts around May 2012)
  Coordinated by Chalmers
  Principal Investigator: Professor Wolfgang Kropp, Division of Applied Acoustics, Department of Civil and Environmental Engineering

The scientific content of FP7 has seen a shift towards more built environment related issues over the last years, in particular through the introduction of the Energy Efficient Buildings programme as part of the financial crisis recovery package in 2008, and this is expected to remain in the forthcoming framework programme Horizon 2020. Hence, there are ample opportunities to increase further the income from European collaborative research and to engage divisions and research groups not currently involved. An untapped potential lies in the individual grants for curiosity driven research from the European Research Council (ERC), which the AoA has not yet succeeded in receiving.

The strategy to increase the AoA's EU funding is to closely monitor the progress of the draft work programmes of the FP7 Cooperation themes and inform researchers at an as early stage as possible on call topics of potential relevance. For this, the expertise of AoA Coordinator Dr Stefan Forsaeus Nilsson will be used, as he is also engaged as one of Chalmers' two EU advisors and thus well connected to the information streams from FP7 programme committees.

The targets for 2012 are:
- To obtain at least one new collaborative project with a principal investigator from a research group or division not currently running an EU project
- To obtain at least one mobility grant from the Marie Curie programme
- To submit at least one high-quality application for an individual ERC grant

9.6. COMMUNICATION PLAN

The overarching goal for the AoAs is to achieve scientific excellence in strategic areas, where Chalmers has the ambition to be an international forerunner. Another goal is to integrate research, education and innovation according to the so called Knowledge Triangle. This will strengthen the visibility of Chalmers' strategic research and provide more opportunities for international education and research exchange.

9.6.1. Our message

The AoA aims to exhibit and focus cross-disciplinary research in the Built Environment field and collaborate across borders in order to achieve excellence and contribute to a sustainable society and addressing future challenges. The AoA integrates research, education and exploitation of results, and provides new meeting places for academy, industry and public actors.

9.6.2. Objective

The main objective with this communication plan is to define and coordinate activities fit for purpose to help the AoA to reach its targets. Further, it is a toolbox and a support for staff to enhance the uptake of their communication efforts. The plan is valid through 2012, and will be evaluated and revised annually. The Director of the AoA together with the communication officer are responsible carrying out and monitoring the activities.

9.6.3. Overarching communication targets

- Display the Built Environment AoA to significantly increase and secure its long term funding.
- Mediate the process internally and externally for developing South Campus Johanneberg to promote added value from an innovative knowledge cluster environment.
- Display and communicate several good examples of successful cross-disciplinary collaborative projects promoting sustainable development.

9.6.4. External communication

To meet an increasing demand on science communication from funding organisations, it is becoming more and more necessary to improve methods for communicating with external stakeholders.

Communication targets 2011:
- Built Environment AoA shows that it can address complex problems and future challenges and attract, engage and influence society and position the AoA.
- Built Environment AoA has established strategic communication channels aimed at stakeholders of high priority.

External stakeholders:
- Research funding organisations
- The Swedish Agency for Economic and Regional Growth (Tillväxtverket)
- The Swedish Research Council (Vetenskapsrådet)
- The Swedish Governmental Agency for Innovation Systems (Vinnova)
- The Swedish Council for Working Life and Social Research (FAS)
- The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (Formas)
- The Swedish Energy Agency (Energimyndigheten)
- Politicians
- Region Västra Götaland
- Business Region Göteborg
- The County Administrative Board of Västra Götaland (Länsstyrelsen)
- The Göteborg Region Association of Local Authorities (Göteborgsregionens Kommunalförbund)
- Contractors
- Consultancy firms
- Construction material manufacturers
- Students
- The general public
- International researchers

Channels for external communication:
- Articles in scientific journals
- Dissertations
- Conferences
- Networks
- Seminars and workshops

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9.6.5. Internal communication

The AoA's communication officer, in collaboration with colleagues from the departments, supplies tools and support for communication activities. All AoA staff are important for the communication work and take responsibility for forwarding news and information of interest for the AoA. A good general knowledge on ongoing activities creates participation and increased possibilities for reaching the targets.

Communication targets 2012:

- Staff and students at Chalmers are familiar with the notion of excellence within the Built Environment AoA, the AoA's profile areas and the strategies for cross-disciplinary and cross-border collaboration.
- Staff at Built Environment AoA is familiar with strategies for increased funding.

Internal stakeholders:

- Staff at Chalmers
- Staff at Built Environment AoA
- Management at Chalmers
- Students

Channels for internal communication:

- Internal web site
- External web site
- Meetings
- Operational plan
- Boundary spanning leadership: Network for managers and directors at Built Environment AoA
- AoA Directors' meetings
- Heads of Departments' meetings
- Communication officers' meetings
- Newsletter
- Seminars and workshops
- E mail
- Printed material
- Newspapers and popular press
- Annual reports

Activity	Target group	Objective	Method	Responsible	Deadline
Externally					
Funding	Funding organisations	Strategies for long-term funding	Dialogue with CRO Anders Wennberg, Johanneberg Science Park and OSS	AoA Director	2012
Communication activities: regional, national, international)	Stakeholders of high priority	Identify and plan communication activities to attract, engage and influence, and position the AoA	Workshop with key persons to prioritise target group, identify activities and define content	Communication officer	Jan 2012
New external web site	External stakeholders	A clear and uniform web site	Develop the web site and make it more "alive"	Communication officer in collaboration with other AoAs	2012
Internally					
Operational plan	Staff within Built Environment AoA	Disseminate state of play regarding organisation, research, education, etc., and define long-term operational goals		AoA Director	Mar 2012
Communication collaboration	AoA communication officers	Collaboration focussed on strategic communication	Discussion on strategic needs based on the AoAs targets. Exchange of creative ideas – how to strengthen the AoAs through communication? Define methods and processes to support long-term planning and effectiveness	Communication officer	2012
Inter-departmental update	Staff at Architecture and Civil and Environmental Engineering	Increased collaboration between the departments	Joint department meetings	AoA Director and communication officer	Spring 2012
Boundary spanning leadership	Manager and directors within Built Environment AoA	Support to cross-disciplinary leadership	New network under guidance by Gunnar Jonnergård and Peter Lysell	AoA Director	Spring 2012

Table 1. Planned communication activities

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10 IMPACT 2010–2011

10.1. BIBLIOMETRIC INDICATORS OF EXCELLENCE

10.1.1. Results for the whole Area of Advance

It is still too early to assess the citation impact of papers published after the creation of the AoA in 2009. The overall bibliometric evaluation of our research performance is therefore based on works published in 2001–2009 by researchers at present belonging to the AoA (regardless of their affiliation when publishing the papers).

To be able to present and compare publication records in different scientific fields, we have chosen to use the following indicators:

Top 10 % the number of publications among the 10 % most highly cited in their area.

Top 5 % the number of publications among the 5 % most highly cited in their area.

Cf the field normalized citation score; i.e. the number of citations per publication compared to the average number of citations for publications in that particular field. If Cf > 1.0 for a set of papers, they have a higher than average citation score.

Jf the field normalized journal impact score; i.e. the impact factor of the journals where a set of papers have been published, compared to the average impact factor of journals in the same field.

For more detailed definitions, see appendix 1. All figures are based on data from the Thomson Reuter database, and the results apply only to articles published in journals covered by Web of Science. However, this is a serious limitation, as only about 30 % of our scientific publications in the Built Environment area falls within this category.[13] There are great differences within the area: the technical subfields are more visible than those oriented towards economy, management and societal issues, and the field of Architecture is almost completely invisible in Web of Science. This means that the results presented below should be treated with caution.

13 According to Chalmers' publication database, refereed journal articles account for 36 % of the scientific pub-lications from the Built Environment AoA, the rest being monographs, book chapters and conference papers. 84 % of our journal articles in 2010–2011 were published in journals covered by Web of Science.

Bibliometric results: Built Environment AoA
Data from Web of Science, 2001–2009, representing 112 senior researchers

	Number of publications	Share of publications
Articles	281	
Top 10%	37	13 %
Top 5%	19	7 %
Cf	1.02	
Jf	0,95	

The results indicate that the researchers within the Built Environment AoA published a higher than average number of highly cited papers: 37/281 (13 %) of the papers belonged to the 10 % most cited in their fields.

The citation score (Cf) for the 281 papers was 1.02 – i.e. on par with international standards. The journal impact score (Jf) was 0.95, i.e. slightly below the international average.

10.1.2. Results for individual researchers

Below is a list of senior researchers in the Built Environment AoA who have published at least two highly cited works, or one very highly cited work, in 2001–2009. We have used two criteria to pick out highly cited works: either they belong to the most highly cited (top 10 %) papers according to the Web of Science database, or they have at least 30 citations according to Google Scholar[14]. A "very highly cited work" is one with at least 100 citations according to Google Scholar . This solution was chosen due to the poor and uneven coverage of the Built Environment AoA by Web of Science. Still, the table does not present the full picture. Some areas, like Water pollution or Acoustics, are more highly cited than others, like Building Technology or Architecture, regardless of the database used.

Ptop10: number of articles published in 2001–2009 and belonging to the 10 % most highly cited in their subject area (according to Web of Science data).
Pgs30: number of publications from 2001–2009 that have received at least 30 citations, according to Google Scholar.
Pgs100: number of publications from 2001–2009 that have received at least 100 citations, according to Google Scholar.

14 Google Scholar citation data have been calculated using the Publish or Perish software (http://www.harzing.com/pop.htm)

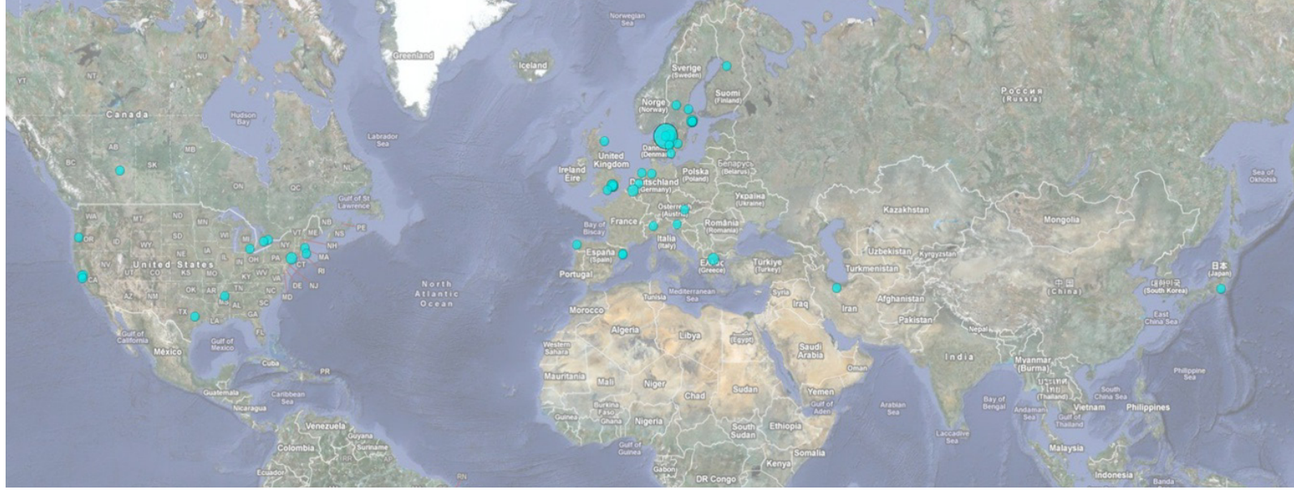

Figure 5. Map of international co-publication partners.

Name	Division	Ptop10	Pgs30	Pgs100	Gender
Gylltoft, Kent	Structural Engineering		2		M
Hagentoft, Carl-Eric	Building Technology	1	2		M
Josephson, Per-Erik	Construction Management		2		M
Kadefors, Anna	Service Management		1	1	F
Kleiner, Mendel	Applied Acoustics		3		M
Lundgren, Karin	Structural Engineering	2	4		F
Morrison, Gregory	Water, Environm., Technology	10	13	4	M
Rauch, Sebastien	Water, Environm., Technology	10	11	3	M
Räisänen, Christine	Construction Management	2			F
Strömvall, Ann-Margret	Water, Environm., Technology	2			F
Ulrich, Roger	Architecture	2	7		M
Wilén, Britt-Marie	Water, Environm., Technology	5	5	1	F
Winch, Graham	Construction Management		4		M
Västfjäll, Daniel	Applied Acoustics	3	7	2	M

10.2. SELECTED LIST OF SIGNIFICANT PUBLICATIONS IN 2010–2011

A large part of the work during 2010 has been focused on improving existing platforms for research, education and innovation. The research initiated in 2010 has resulted in a number of not yet published results which are being prepared for journal publication. However, ongoing research has led to a number of publications of important results. A selection of papers from 2010 and 2011 are listed in Appendix 3.

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10.3. NATIONAL AND INTERNATIONAL COLLABORATIONS

The Built Environment AoA collaborates with national and international universities, companies and institutes. Figure 5 shows a map of selected essential collaborations.

10.3.1. Selected examples of important international collaboration partners and networks

- AGS Alliance for Global Sustainability
- CIB International Council for Research and Innovation in Building and Construction
- UN Habitat
- NINA Nordic Institute of Acoustics
- SURF – The Centre for Sustainable Urban and Regional Futures, University of Salford
- Maseno University, Kisumu Action Team (KAT) & Bondo University College
- College of Architecture and Urban Planning (CAUP), Tongji University
- ACC – African Center for Cities
- EAAE European Association for Architectural Education

10.3.2. Important national networks

Swedish Universities of the Built Environment

Swedish Universities of the Built Environment[15] is collaboration between research groups involved in education of civil engineers and equivalent at the four major Swedish universities with technical faculties: Chalmers, Luleå University of Technology, Lund University and the Royal Institute of Technology in Stockholm. The purpose is to promote built environment research and education and ensure that it gets opportunities to satisfy the need for new crossdisciplinary knowledge which is required in a sustainable society. The activities are organised in seven theme groups. Built Environment AoA is represented in the organisation's board.

15 www.sverigesbygguniversitet.se

The Swedish Centre for Innovation and Quality in the Built Environment

The Swedish Centre for Innovation and Quality in the Built Environment[16] (IQS) was founded in 2010. It is the result of a merger between the Swedish Construction Sector Innovation Centre (BIC) and the Council for Constructing Excellence (BQR). The mission is to add strength to quality work and innovation processes in the construction sector. Change involves interplay between the government, the industry and the research community. The role of IQS is to weave these together.

IQS has coordinated the input from the built environment sector to the Swedish Government's Research and Innovation Bill of 2012. It contains a proposal for an extensive publicprivate research and innovation programme. Built Environment AoA is represented in the board of IQS.

Other important national networking partners are the Swedish Geotechnical Institute SGI[17], SP Technical Research Institute of Sweden[18], the Swedish Society of Civil and Structural Engineers[19] and the Swedish Association of Architects[20].

10.4. ACTIVITIES

10.4.1. Strategic research projects

Homes for Tomorrow

Homes for Tomorrow is a strong research environment which will support our future homes in the global era with new technologies, materials and spatial structures which radically reduce resource and energy intensity. The findings will also underpin the retrofit of current homes through new technologies and experiential developments. NASA's knowledge of how to design residential space adds an extra dimension. The new material developed for March Expeditions also lends itself well for construction. Combined with knowledge about environmental building in the Swedish building industry and research, this opens new opportunities to build attractive homes with the environment in mind, a potential export success. This program will give the opportunity to show the construction industry that Sweden is a country of innovation, which also connects to sustainable development.

Home for Tomorrow is funded with 25 MSEK over three + two years from Formas[21]. It receives an additional funding of 7.5 MSEK from Chalmers which is intended for the recruitment of an international top researcher.

Members of the project team are Professor Greg Morrison, Professor Carl-Eric Hagentoft, Dr Daniel Västfjäll, Professor Kent Gylltoft and Professor Maria Nyström. External partners are Staffan Bolminger (Älvstranden Utveckling), Johanna Engberg (White), Lennart Hedström (CEO Chalmersfastigheter), Agneta Kores (CEO Familjebostäder), Claes Roxbergh (Skanska), Gert Wingårdh (CEO Wingårdhs), Larry Toups (JSC-NASA) and Professor Larry Bell (Sasakawa International Centre for Space Architecture, University of Houston).

16 www.iqs.se
17 www.swedgeo.se
18 www.sp.se
19 www.svr.se
20 www.arkitekt.se
21 The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning

Architecture in the Making: Architecture as Making Discipline and Material Practice

The architectural profession is facing new challenges: Sustainable development promotes advanced building technology; the reuse of the existing building stock will be an increasingly important task; urban development have to integrate different fields of knowledge; advanced ICT tools influence design practice and modes of production. Current challenges represent opportunities for the architectural profession in creating sustainable built environment, and the potential of architectural thinking in managing complexity can contribute to research. For this we need to develop integrated theories and methods, clearly based in architecture as a discipline, in which design thinking stands at the centre. This strong research environment defines the built environment as a material culture, and the architectural profession as a "making discipline".

From this perspective, connecting to sustainable development, four research themes are identified: "Material mechanisms", "History", "Investigative modelling", and "Alteration". It assembles a unique set of leading Swedish researchers, international scholars and architectural practitioners, to create a dynamic research platform promoting the potential of architectural thinking in research on complex issues in built environments.

Concentrated research projects will be combined with externally oriented activities which will make significant contributions to theories and methods in architectural research as well as practice.

Practice oriented research and creatively making discipline for, sustainable development:

Material making: to develop analyses of the material in architecture; concepts, artefacts and tools in design processes

History: investigating history as built environment and tradition

Investigative modelling: explorative, digital processes and "hands on" modelling

Alteration: conservation and transformation as architectural practice, existing built environments and cultural values

Architecture in the Making is funded with 25 MSEK over five years from Formas[22]. It receives an additional funding of 5 MSEK from Chalmers which is intended for increased cross connection between departments within the AoA by co-funding excellent international researchers. The four Swedish Schools of Architecture (SSA) at Lund University, Chalmers, Royal Institute of Technology (KTH) and Umeå University have collaborated through the platform Swedish Schools of Architecture to propose two strong research environments in architectural theory and method, Architecture in the Making (hosted by Chalmers) and (Architecture in effect (hosted by KTH).

22 The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning

Director: Professor Fredrik Nilsson, Chalmers department of Architecture. Senior researchers: Claes Caldenby (Chalmers), Catharina Dyrssen (Chalmers), Liane Thuvander (Chalmers), Paula Femenías (Chalmers), Tim Anstey (KTH), Johan Mårtelius (KTH), Kerstin Barup (Lund), Thomas Olofsson (Umeå).

Resilient infrastructures – Adaptive Capacity in Urban Transportation Infrastructures

The strong research environment, proposed to Formas[23] in 2011, resilient infrastructures will support our development of infrastructures from a future resilience perspective in human settlements. Here the immediate challenges are effective planning, development and the use of new materials and technologies which radically reduce resources and minimise disturbance to the urban environment and life. The future challenge is to provide infrastructures along a timeline which includes adaptive capacity to likely change. The concept of resilience is central to the understanding of temporal and sustainable construction processes in the urban environment. We recognize that the stability of the relevant social, engineered and ecological systems can change over time and in space (Blackmore and Plant 2008). A resilient infrastructure therefore has the capacity to absorb disturbance and reorganise during change while retaining essentially the same functions and structures. Resilience for infrastructures implies a temporal process in construction – divided into strategy, intervention and postconstruction – where new ideas and technologies interplay to provide adaptive capacity, efficiency and robustness. The specific aim of this strong research environment is to bring together leading researchers in areas related to planning, design, construction and management at Chalmers within interdisciplinary projects which contribute to the resilient infrastructure concept. The research will be tested on the transdisciplinary arena with society and industry to promote the introduction of sustainable infrastructures with adaptive capacity.

Collaborative R&D Project: Riksbyggen – Johanneberg Science Park – Chalmers

A collaboration project aimed at developing one or several apartment blocks close to the Chalmers campus is being run by Built Environment AoA, Johanneberg Science Park and the realestate company Riksbyggen. Other stakeholders involved are Gothenburg University, SP Technical Research Institute of Sweden and the City of Gothenburg. The ambition is that the buildings and the apartments will be a source of inspiration for future sustainable living, and that they can be used as a fullscale laboratory in the AoA's research and education. The project, named Positive Footprint Housing, will be in the absolute forefront of sustainable development and it will contribute to the urban development of Gothenburg. Social acceptance is instrumental in developing the buildings, and the ambitions are very high as regards design, energy consumption, choice of materials and construction methods. During the spring of 2011, approximately 40 researchers from Architecture, Civil and Environmental Engineering, Energy and Environment, Gothenburg University and SP Technical Research Institute of Sweden have gathered in various workshops to identify bordercrossing research and education projects.

Urban Energy Systems – Demo Site Gothenburg in collaboration with AoA Energy

The project, which received funding from the Vinnova[24] programme Challenge Driven Innovation in the autumn of 2011, aims at studying how the development of a manifold of technologies can influence the energy system as a whole, and how this whole can influence and interact with the parts to obtain a sustainable system. This is done by collaboration between different actors in order to identify possible synergies between different technologies and system areas, and by defining a project for studying how these can be achieved through new organisational thinking. The project will apply a holistic view over the stationary energy system, the interaction with transportation systems and industrial processes, and verify ongoing and planned research and demonstration projects in Gothenburg. The output will be a test bed where products, services and processes from various demonstration projects are evaluated with respect to interactions with other technologies and influence on the overarching energy system in regards to potential, costs and appropriate time of introduction to increase industrial opportunities.

Expected results are:

- A new model for collaboration between stakeholders with which synergies have been achieved and exploited in a new demonstration site for the 400 years anniversary of the City of Gothenburg in 2021[25]
- Gaps between areas of responsibility can be spotted in time
- The energy system has become more sustainable and robust and through this the city has become more attractive

23 The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning

24 The Swedish Governmental Agency for Innovation Systems
25 www.goteborg2021.com

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10.4.2. Education

Architecture & Engineering

The undergraduate programme for Architecture and Engineering combines design with natural sciences and technology. In it, students are trained in observing and sensing the needs of people, activities and society. At the same time, their ability to design and communicate proposals for buildings and spaces is developed. The programme attracts students with an interest in mathematics and technology as well as in form and building design. There are only a few similar educational programmes in Europe. Experience shows that graduated students develop into either architects or engineers and bridge the gap between these two professional cultures.

Architecture and Engineering teach theory, methods and tools of both architecture and construction. The educational culture of engineering based on subject courses is continuously combined with studios of the architectural tradition. The purpose is to create an investigative, creative and reflective mindset based on both technology/science and aesthetics/humanistics. The first three years provide a scientific basis with mathematics, mechanics, building physics and materials science. There are also fundamental architect courses treating form, colour, sketching and architectural history. A series of architect projects run in parallel with the courses where form proposals are produced through sketches, models and physical experiments.

Solar Decathlon

During the autumn of 2011, Built Environment AoA has submitted two preproposals to the international student competitions Solar Decathlon 2013[26] and Solar Decathlon China 2013[27], hosted in the US and China respectively. Results from the pre-qualifications are expected to be announced in January 2012, and if either of the proposals is successful Chalmers will be the first Swedish university to participate in the highly acclaimed Solar Decathlon competition, where architecture and engineering students design and build solar powered single-family houses.

The project will become the new backbone of the extended Sustainable Building Diploma Unit, which goes from being a 60 credits part of the Design for Sustainable Development track to becoming an independent track of 120 credits. In fact, students have already started working on preliminary house designs in the Sustainable Building-Competition studio. Taking part in the competition will be a challenge for staff, departments and students, but it is a unique chance for innovation, for defining new frontiers for transdisciplinary research and to redefine and strengthen the cooperation with industry. Several industrial partners have already been identified and contacted. Interesting partners, beside representatives from construction companies, are consultant firms, the Swedish timber industry, among them producers of single family houses with integrated solar power production, the car industry, with the new electricpersonal car models which are very tightly connected to the home environment. The Solar Decathlon project is supported by the management of Chalmers University of Technology, as a particular form of project based education, very well aligned with the university's overarching strategy to integrate education with research and innovation. In addition to industrial partnerships, it is expected that support can be raised also from public sponsors, such as the regional development office of West Sweden (Region Västra Götaland) and different national government agencies.

The responsible teacher for the project is Dr Barbara Rubino at the Department of Architecture and project manager for the preproposal process has been the AoA Coordinator, Dr Stefan Forsaeus Nilsson. An important resource in the project is Lecturer Jonas Lundberg at the Department of Architecture, who, through his shared position with the London Metropolitan University, has previous experience from Solar Decathlon participation. Other core staff committed to the project is Associate Professor Angela Sasic Kalagasidis from the Department of Civil and Environmental Engineering, Professor Jan Gustén from the Department of Energy and Environment and Associate Professor Mario Plos from the Department of Civil and Environmental Engineering.

Professional Education

In collaboration with Chalmers Professional Education, a commercial assessment was conducted and a business plan developed during the autumn of 2011 for the establishment of new commissioned courses. This includes market and competitor analysis, mapping of potential educational clients and decision makers, identification of Chalmers' knowledge content within the field of Built Environment as regards skills, interests and conditions, industrial relevance, subject knowledge and teaching skills, networking etc. Chalmers Professional Education is Chalmers organisation for specially tailored education of professionals in industry. Their aim is to provide industry with world-leading knowledge in technology related knowledge areas. The programs are designed in accordance with industry's needs and requirements. The vast majority of faculty interviews are now completed. However, the business interviews are to be done. A number of possible course topics have been identified where we are working on the development of attractive course descriptions. We will also conduct a competitor analysis as well as a market analysis.

10.5. SUCCESS STORIES

10.5.1. East African Academy

About one billion people lack water, electricity and sewage; one in three of the world's city dwellers live in a slum. Of course, difficult living conditions contribute to greater creativity and resource management. Nyström has worked with extreme habitats for almost two decades. She has studied the living conditions in both developing countries and in space – and found many common denominators. Her latest project in Kisumu, Reality Studio, involved two dozen Chalmers students on site in the Kenyan city. Driven by the results, it's now time for a more permanent solution.

The East African Academy, a new school for architects, designers and engineers is a collaboration between Chalmers, University of Gothenburg and several local universities around Lake Victoria. The building itself will reflect the East African Academy's special teaching methods and growth strategy. Inspired by the Luo tribe villages, for example, the school will be built in smaller modules that can be expanded later on. The gardens will be designed for outdoor teaching, and the nucleus will be a workshop where prototypes are built and ideas are tested. Field studies and experience-based learning are central pedagogic concepts. To carry out research in urban development and design in this type of environment demands a down-to-earth approach. According to Associate professor Maria Nyström, you have to live among the people and observe their lives to find viable solutions. Often it's about combining different approaches and executing ideas – rather than retreating to write a dissertation for a few years.

10.5.2. Urban Metabolism

Yuliya Kalmykova, assistant professor at Chalmers' Department of Civil and Environmental Engineering, has been granted 3 MSEK for the project "Sustainable and attractive cities" in Vinnova's[28] program VinnMer. The project is conducted in close collaboration with the Massachusetts Institute of Technology (MIT) and aims to establish a new Swedish research direction at Chalmers, and develop a model for analysis of the flows of the materials and energy within cities; Urban Metabolism. Yuliya Kalmykova will spend two of the project's three years at the MIT. The research team is known for their expertise within the area and will offer a dynamic research environment and a wide international network. The collaboration will support the establishment of an Urban Metabolism research direction at Chalmers which is unique for Sweden. Together they will develop a master's course in Urban Metabolism to be introduced at Chalmers in the autumn of 2012. Knowledge will be produced and exchanged between the groups regarding the use of resources in urban environments, and pathways towards efficient management of resources will be discovered. The derived urban metabolism model will be useful as a decision support for city planners and as an inspiration source for research and innovation towards sustainable urban development.

10.5.3. Internationally awarded successful collaboration between architect and engineering students

Five out of six awards in the ASA[29] Student Design Competition went to Chalmers 2011. Behind the success of the contributions are combined teams from the two programs Architecture & Engineering (A&E) and Sound & Vibration (S&V). However, Chalmers students have been very successful in the annual international student competition about architectural and room acoustics for several years by now.

The competition aims to encourage collaboration between architect and engineering students. It is in the close collaboration between the professions as innovative projects take shape and evolve knowledge.

The sound in our public spaces is important for our wellbeing. This year's competition was about managing noise from an adjacent highway and simultaneously articulate music from an outdoor stage and a small concert hall designed specifically for chamber music. It belongs to the architect's and engineer's core competencies to design spaces, which contributes to our public environment with a rich and varied soundscape. It's about being able to plan, design and construct with sound materials.

Figure 6. The contest ASA Student Design Competition organized by The Acoustical Society of America aimed in 2011 to develop a small concert hall in conjunction with an outdoor scene on a rural location north of New York. Winners were the Chalmers students Anna Arvidsson and Malin Landh from (Architecture and Engineering) and Mihkel Toome (Sound and Vibration).

Students and teachers at Chalmers have shown great enthusiasm for collaboration and the result is excellent. This is a good example of that Chalmers stands up very well in the international development of the Built Environment where architectural and engineering work are becoming increasingly integrated and that integration is a prerequisite for sustainable development.

26 www.solardecathlon.gov
27 www.sdchina.org/en/Default.aspx
28 The Swedish Governmental Agency for Innovation Systems
29 Acoustical Society of America

NOTES:

BUILT ENVIRONMENT

11

APPENDICES

Appendix 1. Bibliometric calculations

The bibliometric calculations in this report are based on data from the Thomson Reuters citation database (known in its online version as Web of Science) and on bibliometric reference data calculated from the offline version of this database.

The publication sets used in the investigation included:
publications of the document types "Article", "Review" or "Letter" indexed in the Web of Science database, subsections Science Citation Index Expanded, Social Science Citation Index and Arts & Humanities Citation Index.

Conference proceedings indexed by Web of Science were not included, as there are no reliable citation reference data for those records.

The publication set for an AoA was defined as all [Web of Science] papers authored by researchers listed by the AoA as belonging to the area. This definition has the following consequences:

(a) The publication sets do not only contain papers strictly within the subject area of the AoA, as some of the researchers listed have also been active in other fields.

(b) The publication sets only contain papers by researchers that are now at Chalmers, but it also includes papers that they have published at other affiliations (before coming to Chalmers).

In other words: the bibliometric results represent the strength of the researchers at present belonging to the AoA, rather than the past performance of Chalmers within the subject area of the AoA.

Definition of bibliometric indicators (Cf and Jf)
The field normalized citation score (Cf) for a set of n papers has been calculated according to the formula:

$$C_f = \frac{1}{n}\sum_{i=1}^{n}\frac{c_i}{e_i}$$

c_i = number of citations to paper i.

e_i = expected number of citations to paper i (i e: the mean number of citations to papers published at the same time and within the same subject area as i).

Self-citations are excluded.

The subject area of the paper is defined by the subject area of the journal where it is published.

We use an open citation window, up to a maximum of five years.

The field normalized journal impact score (Jf) for a set of n papers has been calculated according to the formula:

$$J_f = \frac{1}{n}\sum_{i=1}^{n}\frac{j_i}{e_i}$$

j_i = mean number of citations to papers published in the same journal as i.

e_i = mean number of citations to papers published [by all journals] in the same subject area as i.

The underlying citation data (c_i, e_i, j_i) have been calculated from the Thomson Reuters citation database by CWTS (Centre for Science and Technology Studies) at the University of Leiden.

Google Scholar citation data
For the Built Environment AoA, citation data were also collected from Google Scholar, using the Publish or Perish software.

Appendix 2. Publication statistics 2010–2011

Energy Area of Advance

Number of scientific publications 2010 and 2011

Refereed journal articles:	83
Refereed conference papers:	111
Books:	7
Book chapters:	23
Total:	224

This is an estimate based on data in the Chalmers Publication Library (CPL), as of November 20, 2011. AoA tagging of new publications was introduced in the spring of 2011. However, only about 50% of the 2011 records have been tagged, and still fewer 2010 records. Our estimate is based on (a) the total number of publications authored by researchers known to publish (to a greater or smaller degree) within the Energy area, and (b) the AoA tags of the subset of those publications that have been tagged.

Visibility in Web of Science

Percentage of journal articles covered by Web of Science:	84%
Percentage of scientific publications covered by Web of Science:	30%

Based on publications registered in Web of Science (subset: Science Citation Index Expanded, Social Science Citation Index and Arts & Humanities Citation Index) up to the end of November, 2011.

"Percentage of scientific publications covered by Web of Science": actually the percentage of the total scientific output (224 publications) that consists of journal articles covered by Web of Science (and therefore visible in citation studies based on this database). Web of Science also covers some conference papers and book chapters, but they can't be used for citation studies.

Co-operation statistics
Percentage of papers co-authored with researchers from other institutions.

Type of co-operation

International:	38%
University or research institute (Swedish or International):	48%
Commercial enterprise (Swedish or International):	11%

Based on journal articles covered by Web of Science (as we do not have full address data for other publications).

Publishing channels (journals)
The (refereed) journal articles were published in the following journals:

Title	Papers
Acta Acustica United with Acustica	4
Water Research	4
Journal of Sound and Vibration	3
Quality and Safety in Health Care	3
Applied Acoustics	2
Composites Part B-Engineering	2
Emotion	2
Health Expectations	2
Herd-Health Environments Research & Design Journal	2
IMechE Journal of Rail and Rapid Transit	2
Journal of Environmental Engineering (ASCE)	2
Structure and Infrastructure Engineering	2
Water Environment Research	2
Water Science & Technology	2
ACI Structural Journal	1
Automation in Construction	1
Building and Environment	1
Building Research and Information	1
Cement and Concrete Research	1
Colloids and Surfaces A	1
Color Research and Application	1
Construction and Building Materials	1
Construction Management and Economics	1
Engineering Structures	1
Engineering, Construction and Architectural Management	1
Environmental Innovation and Societal Transitions	1
Environmental Science & Technology	1
European Journal of Parenteral & Pharmaceutical Sciences	1
European Journal of Wood and Wood Products	1
FEMS Microbiology Ecology	1
Group & Organization Management	1
Heat Transfer Engineering	1
Integrated Environmental Assessment and Management	1
International journal for Urban Design and Planning	1
International Journal of Architectural Heritage	1
International Journal of Impact Engineering	1
International Journal of Project Management	1
International Journal of Rock Mechanics and Mining Sciences	1
Journal of Automobile Engineering	1
Journal of Building Physics	1
Journal of Composite Materials	1
Journal of Computational Acoustics	1
Journal of Construction Engineering and Management	1
Journal of Facilities Management	1
Journal of Reinforced Plastics and Composites	1
Journal of Teacher Education for Sustainability	1
Journal of the Acoustical Society of America	1
Journal of Water, Sanitation and Hygiene for Development	1
Magazine of Concrete Research	1
Microchimica Acta	1
Nordic Concrete Research	1
Passepartout	1
Plos One	1
Proceedings of the InstMechE Part D-Journal of Automobile Engineering	1
Software: Practice and Experience	1
Theoretical Computer Science	1
Thin-Walled Structures	1
Tunnelling and Underground Space Technology	1
Waste Management	1
Water Science & Technology: Water Supply	1
Wear	1

Scientific monographs and textbooks
The following scientific monographs and textbooks were published by the AoA in 2010-2011 (the names of AoA authors in bold face):

Sebastien Rauch; Greg Morrison; Andres Monzon
Highway and Urban Environment
416 p.
Heidelberg: Springer, 2010
ISBN 978-90-481-3042-9

Mendel Kleiner
Worship Space Acoustics
311 p.
Fort Lauderdale: J. Ross Publishing, 2010
ISBN 978-1-60427-037-2

Mendel Kleiner
Acoustics and Audio Technology
480 p.
Fort Lauderdale: J. Ross Publishing, 2010
ISBN 978-1604270525

Ola Dahlbom, Karl-Gunnar Olsson
Strukturmekanik – modellering och analys
358 p.
Lund: Studentlitteratur, 2010
ISBN 978 91 44 06894-7

Appendix 3. Selected list of significant articles published in 2010–2011

2011
Application of model based predictive control for water-based floor heating in low energy residential buildings
Building and Environment
Hagentoft, Carl-Eric

2011
Cost-effectiveness analysis of riskreduction measures to reach water safety targets
Water Research
Lindhe, Andreas; Rosen, Lars; Pettersson, Thomas

2011
The influence of material properties on the amount of twist of spruce wood during kiln drying
European Journal of Wood and Wood Products
Kliger, Robert

2011
Three-dimensional modelling of struc-tural effects of corroding steel reinforcement in concrete
Structure and Infrastructure Engineering
Lundgren, Karin; Plos, Mario

2011
Framework for Value of Information Analysis in Rock Mass Characterization for Grouting Purposes
Journal of Construction Engineering and Management
Ericsson, Lars O; Rosen, Lars

2010
Flexural Behaviour of members with a combination of steel fibres and con-ventional reinforcement
Nordic Concrete Research
Gylltoft, Kent

2011
Bridging sanitation engineering and planning: theory and practice in Burki-na Faso
Journal of Water, Sanitation and Hygiene for Development
Kain, Jaan-Henrik

2011
Screening of Organic Contaminants in Urban Snow
Water Science and Technology
Strömvall, Ann-Margret

2010
On the design of structural junctions for the purpose of hybrid passive-active vibration control
Journal of Sound and Vibration
Andersson, Patrik; Kropp, Wolfgang

2010
Effect of Laminate Tapering on Strain Distribution in Adhesive Joints: Exper-imental Investigation
Journal of Reinforced Plastics and Composites
Haghani Dogaheh, Reza; Al-Emrani, Mohammad; Kliger, Robert

2010
Multi-sensory congruence in vehicle sound quality assessment: effects of vibration and irrelevant emotional primes on affective reactions and evaluations of product sounds
Proceedings of the Institution of Mechanical Engineers Part D-Journal of Automobile Engineering
Västfjäll, Daniel; Klei-ner, Mendel

2010
Colour Research with Architectural Relevance: How Can Different Approaches Gain from each Other?
Color Research and Application
Peterson Billger, Monica

2010
Thermal Performance of a Building Envelope – A Probabilistic Approach
Journal of Building Physics
Pietrzyk, Krystyna

2010
Retrofitting the city: Reuse of non-domestic buildings
International journal for Urban Design and Planning
Femenias, Paula

2010
Element associations in ash from waste combustion in fluidized bed
Waste Management
Rauch, Sebastien

2010
Colloid-Facilitated Metal Transport in Peat Filters
Water Environment Research
Kalmykova, Yuliya; Rauch, Sebastien; Strömvall, Ann-Margret; Morrison, Greg

2010
Construction contractors as service innovators
Building Research and Information
Bröchner, Jan