Detmold Conference Week 2017

RMB Conference 2017 // Nov. 23rd

facade2017 // Nov. 24th

ConstructionLab // Annual Report 2015 -17

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Detmold Conference Week 2017

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HOCHSCHULE LUZERN

REUSE OF MODERNIST BUILDINGS V

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Content

Fig. 1: OWL University of Applied Sciences, Campus Emilie

Preface

Prof. ir. Michel Melenhorst; Prof. Dr.-Ing. Uta Pottgiesser

DETMOLD CONFERENCE WEEK

When established in 2008 the 'ConstructionLab' had its focus on 'material and building envelope' and facade2008 was already the 4th conference in Detmold – then still in german language. Also in 2008, the new master programme in 'International Façade Design and Construction (IFDC)' was established and subsequently the European Facade Network (efn) in 2009 – at that time with 5 partner universities and the first international conference 'facade2009' in English. Another impulse was brought into the research group focussing on digital tools for design, planning and fabrication in the architectural field. In 2012 this resulted in the introduction of the 'Master Computational Design and Construction (MCDC)'. Over the years both educational programmes developed their profiles but also discovered synergies and joint perspectives. 'facade2015' made 'Computational Design' in the field of facades subject of discussion and was already pointing in the direction of the new joint 'Master of Integrated Design (MID)' that was accredited in 2016 – together with the bilingual 'Master of Integrated Architectural Design (MIAD)'.

Along with this structural development in research and education the 'ConstructionLab' had a significant increase in third funding in national and international projects. Many of them are represented in these proceedings next the presentations of the conferences. For the first time the 'ConstructionLab' is cooperating with the Project Consortium of RMB and is offering two joint and thematically linked conferences: 'RMB – Reuse of Modernist Buildings' and 'facade2017 - Resilience'.

On this occasion, it is a special pleasure for us to announce the first 'Detmold Conference Week 2017' that combines the two conferences with the 4th RMB Transnational Project Meeting and an efn-Network Meeting. Two multidisciplinary groups and networks will exchange their research results and concepts for the improvement of the built environment. Detmold's students will be involved with a workshop and a poster presentation related to the week's topic of RESILIENCE.

Enjoy the conferences and the proceedings.

Prof. ir. Michel Melenhorst (Speaker since 2017)
Prof. Dr.-Ing. Uta Pottgiesser (Speaker until 2017)

RMB Conference 2017

Nov. 23rd // Reuse of Modernist Buildings

RMB Conference 2017

Nov. 23rd // Reuse of Modernist Buildings

The RMB Conference is organised by the consortium of the Erasmus+ project 'RMB - Reuse of Modernist Buildings. Design Tools for Sustainable Transformations.' (www.rmb-eu.com). The partners (Hochschule Ostwestfalen-Lippe, Universiteit Antwerpen, Universidade de Coimbra, Institutio Superior Técnico Lisboa, Istanbul Teknik Üniversitesi, Docomomo International and the Energy and Resources Institute) are developing and discussing new design and educational concepts for the reuse of modern postwar buildings for housing and other purposes – resilience through reuse. Scholars, PhD and master students present and discuss selected papers and posters.

8.30 **Registration**

9.00 **Welcoming & Introduction**
Prof. Dr. Yvonne-Christin Bartel
(Vice President for Education and Internationalisation)
Prof. Dr. Uta Pottgiesser (RMB-Member)

Resilient Neighbourhoods
Moderation: Prof. Dr. Gonçalo Canto Moniz; University of Coimbra

9.15 **Keynote Lecture - DeFlat Kleiburg**
Xander Vermeulen Windsant - XWV Architecture/
NL architects on Bijlmermeer; Amsterdam

10.00 **Contested Resilience of a Modern Structure or "Dissonant Heritage": Multilayered Identity of the Old Belgrade Fairground**
Anica Dragutinovic - University of Antwerp/
OWL University of Applied Sciences

10.30 **Post-WWII housing estates in Europe: obsolescence or resilience?**
Zara Ferreira - Técnico Lisboa/ University of Lisbon,
Docomomo International

11.00 **Coffee break**

Resilient Building Skins
Moderation: Prof. Dr. Gonçalo Canto Moniz; University of Coimbra

11.30 **Keynote Lecture - Lessons learned: The Renovation of Villa Tugendthat and the Unités d'habitation**
Alex Dill - Karlsruhe Institute of Technology

12.15 **Radium Pavilion of the Portuguese Institute of Oncology in Lisbon. A modernist functional skin.**
Daniela Arnaut, Técnico Lisboa/ University of Lisbon

13.00 **Lunch break**

Reuse and Education
Moderation: Prof. Teresa Heitor - Técnico Lisboa

14.00 **Presentation of RMB**
Aslihan Tavil, Istanbul Technical University; Istanbul, Turkey

14.15 **Dialogue with the community and photo elicitation for reuse of modern buildings design studios: a pedagogical experience**
Dr. Gonçalo Canto Moniz; University of Coimbra
Dr. Paulo Providência; University of Coimbra

15.00 **Coffee break**

Presentation Student Workshops

15.15 **Role of Workshops in Education/ workshop formats**
Prof. Teresa Heitor - Técnico Lisboa, University of Lisbon

15.30 **Student's research and results**
RMB Student Workshop - Marl

16.00 **Poster session, student's results**
Workshop Conference Week - Scientific Approaches

17.00 **Conclusion and Debate**

18.00 **End**

Fig. 1: Marl Town Hall, construction experiments

Introduction: Reuse of Modernist Buildings
Design tools for a sustainable transformation (RMB)

Prof. ir. Michel Melenhorst, Theresa Kellner (Dipl.- Soz.päd, M.Arts Interior Architecture), Anica Dragutinovic (M.Arch.)

Erasmus+
Key Action: Cooperation for innovation and the exchange of good practices
Action Type: Strategic Partnerships for higher education

The project, Reuse of Modernist Buildings - RMB wants to initiate an educational framework of common definitions, approaches and methodologies on a European level. It is based on existing research, educational practices and reference projects in the European countries. RMB will develop a Joint master on reuse of modernist buildings. The preparation and development of this master will take form September 2016 till August 2019.

The Project Partners:
- Hochschule Ostwestfalen-Lippe, Detmold School of Architecture and Interior Architecture - Germany
- Istanbul Teknik Üniversitesi, Department of Architecture - Turkey;
- Universidade de Lisboa, Instituto Superior Técnico - Portugal;
- Universidade de Coimbra, Faculty of Science and Technology - Portugal;
- Universiteit Antwerp, Faculty of Design Sciences - Belgium;
- DOCOMOMO International - Portugal
- and associate partner ´The Energy and Resources Institute´ (TERI) - New Dehli, India

The project consortium took form by selecting partners according to their complementary experiences and competences in the field of design methodology, practical adaptive reuse, refurbishment and improvement and policy-making on housing and urban development. Since one of the aims of RMB is to combine a broad spectrum of European practises the partners are geographically chosen accordingly.

Projects cause

Demographic and climate change has resulted in huge qualitative and quantitative challenges and demands for the European building sector. The need for suitable and affordable housing in the city centres and urban agglomerations is increasing and cannot, and should not, be fulfilled with new constructions only. A major task for the building industry should be realized through the refurbishment of the existing housing stock, as well as conversion from other building typologies such as warehouses and offices, with special focus on the so-called modernist era.

Given the differing vintage of the building stock and its expected development non-OECD countries (OECD = Organisation for Economic Cooperation and Development) face huge growth in expected construction. OECD countries have a large stock of residential buildings, most built before 1970, that is not growing quickly and will be retired slowly. Currently, the rate of residential building refurbishment to improve envelope efficiency is low, estimated to be 1% per year (BPIE, 2011). Urgent policy action is required, because energy efficiency refurbishments are potentially expensive and likely to make economic sense during major refurbishments that occur only every 30 or more years.
Source: Transition to Sustainable Buildings, OECD /IEA (2013)

Fig. 2: Marl Hill Houses; new concepts for living

RMB is unique in its identification of the main study subject since it focuses on a very specific, oft problematic, very important segment of the building stock; modernist architecture. Neighbourhoods, quarters and buildings from this era are in danger of being destroyed with the risk of specific cultural elements and environments at loss.

Three aspects in Focus

Modernist architecture can be characterised on the level of modernist technology, modernist architecture concepts and the societal impacts of modernism.

On a technological level, refurbishment shows how difficult modern structures are to adapt to high contemporary standards. Modernist architectures experimental nature, its fragile constructive systems makes its attractiveness but also its vulnerability to non-professional refurbishments. (Fig. 1)

Fig. 3: Marl large scale Social housing blocks

On a conceptual level, modernist architecture shows a re-definition of the habitat trough new inside- outside relations and open floor plans, supported on innovative urban design goals. This was a major effort to prevent from the excesses caused by the unhealthy, unhygienic industrialized cities. Modernist architects sought for new worldwide solutions for cities and buildings. Once innovative and very adequate, today modernist typologies for housing and other communal facilities such as schools, often don´t meet our contemporary needs. (Fig. 2)

On a societal level, the global large-scale replication of modernist buildings has led to a critical perception of this huge building stock. This lack of acceptance and appreciation complicates a sustainable reuse and retrofit into energy efficient and user-friendly buildings. (Fig.3)
Through the specialised input by the project partners, RMB addresses all three levels in its educational pact.

RMB´s educational methodology

RMB is able to integrate different European approaches and knowledge on conversion and refurbishment of this specific post war era to meet these professional challenges. The partners in RMB will contribute specific knowledge and input regarding spatial patterns, cultural heritage, climate and construction principles, social and technical evaluation and the monitoring of built spaces. Thus creating a well-balanced adequate curriculum for preparing graduates for this international job market and strengthen the European common ground in this specialized expertise.

RMB´s Innovative aspects and expected outcomes

RMB is innovative in the sense that it will contribute to the urgent speed up of the transformation of our building stock, create better job chances for students in the field, generate more jobs for the building industry as a whole and most of all wants to improve people's lives and build greener and better societies. RMB follows very close the definition of the EU Commission on innovation.

RMB makes knowledge and existing teaching formats accessible on a European level. Specific parts from the curricula of the partner institutions are inserted in to a comprehensive well-balanced educational pack. The combination of these contributions forms a unique program pool.

The teaching formats contribute to the execution of the EU targets on Modernisation Agenda's priority areas and the implementation of the 2013 Communication on opening up education. RMB will explore combinations of ´traditional´ e-learning formats, on site events -such as conferences and workshops- as well as extended very innovative e-learning options in digital fabrication and building integrated management (BIM). It will improve the possibilities of a remote teaching in design education, which is not self-evident. The results are to be disseminated to a wider audience through open courses, open sources and best practice syllabi.

In an up-to-date adaptation, and optimisation of the environmental performance in construction process, with respect to the modern legacy lies an important task for architects, stakeholders and future users. The expected results will be valuable to extend the yet very limited database and knowledge on buildings user behaviour, which is currently a restraint to the potential improvement of energy policies and environmental sustainability strategies. Researchers who develop buildings' performance simulation models, can use the conclusions regarding user behaviour.

State of things in the development of RMB

In the first year of RMB the main effort was to compile the curriculum and the accompanying description of content, goals and formats of the modules within the curriculum. Parallel, the role of the partners is further defined, a RMB course statement is produced, and a start is made in collecting case studies. Tests with workshops, projects, and courses started from spring 2016. The development and production of the course materials is the next step, the dissemination of project results and scientific output started in the first year but will become more important in the later phases of RMB.

Fig. 4: Student workshop Marl - May 2017

Methodology

The case study design projects forms the spine of the RMB master. Teachers with different professional backgrounds support these case study design projects. Each semester (Figure 5: Modules) will set specific accents, students work on location for one semester and then move to the next.

First semester:
HS OWL/ Universiteit Antwerp, Project on the axis Detmold-Antwerp + Document and analyse/ type and function/ history of Modernism

Second semester:
IST/ Universiade de Coimbra: Project in Portugal, + focus on Social aspects/ Assessment of buildings in use/ Environmental design

Third semester:
ITÜ + partner/ free project location in the southeast of Europe + Building construction /Reporting and writing /preparation of thesis

Fourth semester:
Thesis at one of the partner schools.

The semester starts with workshop (W) on location. Modules (A/B/C) are related to the design projects (P), the intensity of the relation however may vary, from direct interaction trough building survey to background information over lectures.
The modules A have the strongest direct connections, the B Modules somewhat more remote, the C Modules on and off. (Fig. 5)

Input, learning objectives and graduation skills:

RMB is open for students with a bachelor diploma from different backgrounds such as: architecture, heritage or urban planning. Students who already have a master but want to specialise in the field of reuse will also be recruited for RMB.

The students learn to deal with heritage- and reuse issues in a self-conscious, methodological clear and respectful way. They will approach the topic of conservation, transformation and reuse from a broad perspective, have a holistic multidisciplinary view and knowledge on reuse but will be specialist as well because of the Masters specific focus on the field of Modernist Architecture.

Output qualities and professional (job) perspectives

After graduating from RMB, Students will be able to further develop their gained knowledge, and solve independently and in a responsible manner, complex assignments in the field of heritage and reuse, in design practise as in science and research.

Through the helicopter view on reuse on a European scale and the international collaborations with students and teachers during the master courses, they will be well prepared for the European job market. Through the application of distant learning and designing skills in the project-based learning during their RMB master, students are very well equipped for contemporary working practices of ´footloose´ offices with collaborators in different geographical locations. They combine a high sensitivity for local conditions with a broad experience and knowledge of international best practises, and cooperative, effective working skills.

RMB targets in Internationalisation in education, job prospects and general benefits

Due to discrepancies in the European job market and employment situations, graduates are well aware of the fact that they may have to leave their country to work in a different country or to be able to work in their countries but in international projects. In several international networks, Bachelor and Master Students already have the opportunity to get familiar with the challenges and requirements of the global job market in the building sector. This experience related to language training, intercultural and interdisciplinary competences is very much appreciated by the students as relevant for their professional future. RMB will add an extra level to this by not only offering a coherent international study

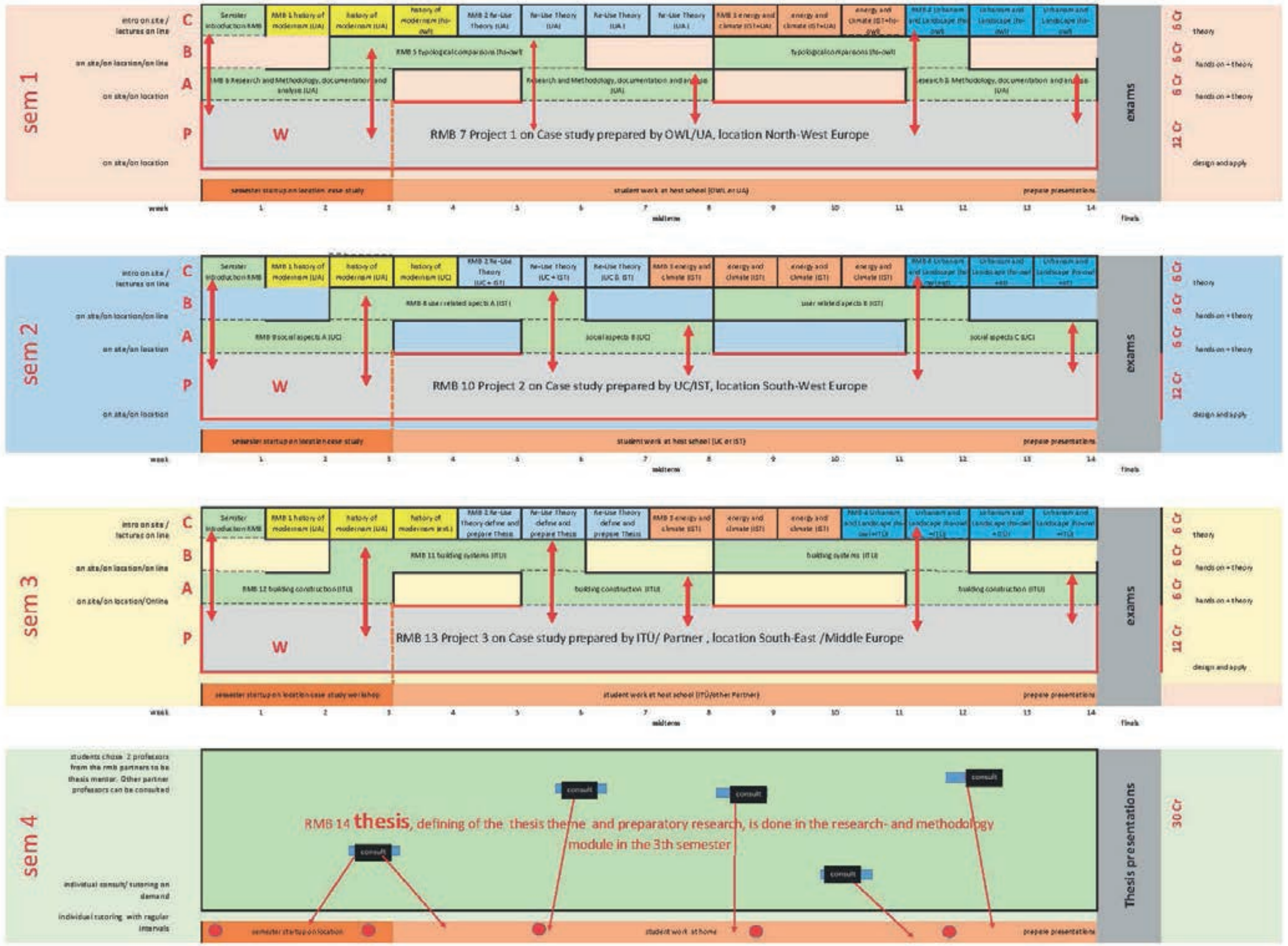

Fig. 5: Modules

program, combining the local and the international but also by inserting in this curriculum cooperation with industry and with other institutions to investigate and solve relevant practical, technical and societal questions. Students get acquainted with industry and with praxis via internships, graduation assignments, conferences, workshops and guest speakers. This connection between academic education and the practice is perceived as an asset for the future profession of the graduates.

The participating partners are convinced their cooperation will better prepare graduates to the requirements of a European and international job market. So first students will benefit from this, secondly the building industry as well as authorities will profit and of course, in the end the urgent European topics on human habitat will find better solutions.

The project is accompanied by a Supervisory and an Advisory Board:
Tim Rieniets, Initiative StadtBauKultur NRW, Germany (SB)
Alex Dill, KIT, Germany (SB)
Luc Verpoest, KU Leuven, Belgium (SB)
Friedemann Roy, Worldbank, USA (SB)
Wessel de Jonge, TU Delft, Wessel de Jonge Architects, Netherlands (SB)

Notes

Xander Vermeulen Windsant

Director of Xander Vermeulen Windsant XWV Architecture/ NL Architects on Bijlmeer; Amsterdam, Netherlands
(DeFlat Kleiburg - Mies van der Rohe Award 2017)

Xander Vermeulen Windsant (born: 1979, Haarlem, NL)

Xander Vermeulen Windsant is principal architect and director of XVW architectuur. Xander studied at Delft University of Technology from 1999 to 2004 and graduated with Honours. After working with one of the leading architecture offices in Amsterdam, he established XVW architectuur in 2010 in order to independently address a new agenda for architecture emerging in the ongoing economic crisis.

Since starting his office he worked on a range of predominantly residential projects, both private and collective. In the collective housing projects collaboration with the future inhabitants is a key aspect of the development proces.
In 2017, one of these projects, Kleiburg, was named the winner of the EU prize for Contemporary Architecture, the Mies van der Rohe Award 2017 (in collaboration with NL Architects).

He has been a visiting critic at the Faculty of Architecture, Delft University of Technology. He regularly writes for Dutch Online Architecture platform Archined.nl.

Fig. 1: Photo https://xvwarchitectuur.nl

DeFlat Kleiburg

Kleiburg is one of the biggest apartment buildings in the Netherlands: a bend slab with 500 apartments, 400 meter long, 10 + 1 stories high.

Kleiburg is located in the Bijlmermeer, a CIAM inspired residential expansion of Amsterdam designed in the sixties by Siegfried Nassuth of the city planning department. De Bijlmer was intended as a green, light and spacious alternative for the -at that time- disintegrating inner city.

The Bijlmer was designed as a single project. A composition of slabs based on a hexagonal grid. An attempt to create a vertical garden city.

Traffic modalities were radically separated; cars on elevated roads and bicycles and pedestrians on ground level. They would no longer share the same space.

Now the area houses about 100,000 people of over 150 nationalities.

The Bijlmermeer had a very optimistic start. But soon the enthusiasm for this radical residential area was overshadowed by fear-for-the-unknown. Fed by heavily economized execution, bad publicity, lack of understanding, poor maintenance and the sudden emergence of a new residential dream type -the suburban home- the Bijlmer turned into a slowly disintegrating parallel universe.

A renewal operation started in the mid nineties. The characteristic honeycomb slabs were replaced by mostly suburban substance, by 'normality'.

However it was decided to keep the most emblematic area intact -flanking the stunning, for-ever-futuristic elevated subway line. The so-called Bijlmer Museum came into being; a compact refuge for Bijlmer Believers. Kleiburg is the cornerstone of the remaining ensemble.

Bulldoze?

Kleiburg is the last building in the area still in its original state; in a way it is the "last man standing in the war on modernism".

Housing Corporation Rochdale, however, had plans to demolish it. They calculated that a thorough renovation would cost about 70 million Euro...

But bulldozing the masterpiece by architect Fop Ottenhof would lead to a collapse of the magnificent urban composition.

In anticipation to the fierce resistance by 'believers' and pressure by the local government, that hoped to avert demolition, Rochdale launched a campaign to rescue the building: Kleiburg was offered for ONE EURO in an attempt to catalyze alternative, economically viable plans.

Over 50 parties responded with a range of ideas from student or elderly housing to woon/werk-units, or homes for the homeless.

Klusflat

Four teams were selected to further develop their ideas. Ultimately Consortium De FLAT consisting of KondorWessels Vastgoed, Hendriks CPO, Vireo Vastgoed and Hollands Licht, was chosen with their proposal to turn Kleiburg into a Klusflat. ‘Klussen’ translates as to do it yourself.

The idea was to renovate the main structure -elevators, galleries, installations- but to leave the apartments unfinished and unfurnished: no kitchen, no shower, no heating, no rooms. This would minimize the initial investments and as such created a new business model for housing in the Netherlands.

The ambition was to open up new ways to live, to offer new typologies by combining two flats (or even more!) into one, by making vertical and horizontal connections.

The future residents could buy the shell for an extremely low price and then renovate it entirely according to their own wishes: DIY. Owning an ideal home suddenly came within reach…

Bliss

By many, repetition was perceived as evil. Most attempts to renovate residential slabs in the Bijlmer had focused on differentiation, the objective, presumably, to get rid of the uniformity, to ‘humanize’ the architecture.

But after two decades of individualization, fragmentation, atomization it seemed an attractive idea to actually strengthen unity: Revamp the Whole!

It became time to embrace what is already there: to reveal and emphasize the intrinsic beauty, to Sublimize!

Interventions

In the eighties three shafts had been added on the outside featuring extra elevators: although they look ‘original’ they don’t belong there, they introduce disruptive verticality. But it turned out that these concrete additions could be removed. There was still enough space in the existing shafts; new elevators could actually be placed inside the existing cores. And the brutal beauty of the horizontal balusters could be restored!

Sandblasting the painted balusters revealed the sensational softness of the pre-cast concrete: better than travertine!

Originally the storage spaces for all the units were located on ground floor creating an impenetrable area, a ‘dead zone’ at the foot of the building. By relocating the storerooms to the upper levels near the elevators the ground level could be freed up for more interactive forms of inhabitation: apartments, workspaces, daycare. As such the plinth would be activated: a social base embedded in the park.

The interior street that served as the connector between parking garages and elevator cores was a fundamental ingredient of the Bijlmer. It was located on the first floor at plus three meters and forced the underpasses to become low. And unpleasant. But since lowering the elevated roads was one of the central ideas of the renewal of the area the inner street became obsolete. Now larger openings could be created connecting both sides of the building in a more scenic and generous way.

On the galleries the division between inside and outside was rather defensive: closed, not very welcoming. There was room for improvement. The opaque parts of the facade were replaced with double glass. By opening-up, the facade becomes a personal carrier of the identity (even with curtains closed).

In addition a catalogue of facade modules was created from which the future inhabitants could choose a set of window frames that would match the customized layout of their FLATs: openable parts, sliding doors, double doors, a set-back that creates space for plants or people. As such a personal ‘interface’ could come into being that could activate the galleries.

Gallery illumination has a tendency to be very dominant in the perception of this type of single loaded apartment buildings. The intensity of the lamps that light up the front doors on the open-air corridors overrules the glow of the individual units. The warm ‘bernstein’ radiance of the apartments is obscured behind by a screen of cold lights. What if all gallery lights worked with energy saving motion detectors? Every passer -by a shooting star!

Notes

Anica Dragutinovic

M. Arch.; PhD Candidate, University of Antwerp; Antwerp, Belgium
Research Assistant, OWL University of Applied Sciences; Detmold, Germany

Anica Dragutinovic is a PhD candidate at University of Antwerp, Belgium since 2016/17. Her PhD research is focusing on Modern architecture of Belgrade (Serbia) that is disintegrating due to disrepair or being altered beyond the recognition, and therefore urges repair and re-use strategies. She is a research assistant and a coordinator of the Master Program MIAD/MID – Facade Design at OWL UAS since 2016; and a member of the “Reuse of Modernist Buildings” (RMB) project. She obtained Master of Architecture in 2016 at University of Belgrade – Faculty of Architecture in Serbia. During the studies she has had different internships on international level, and won several prizes.

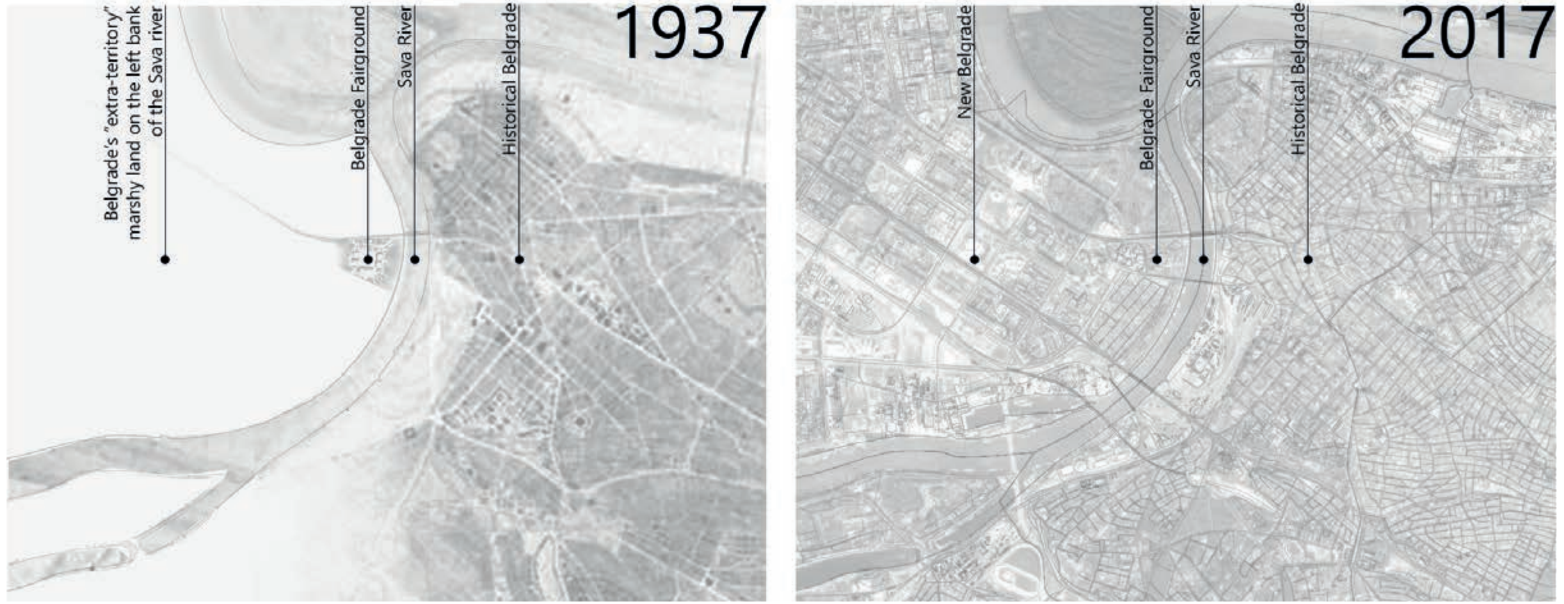

Fig. 1: Maps of Belgrade, 1937 and 2017 (Illustration Anica Dragutinovic, according to the General Plan from 1939 and the current condition [4]).

Contested Resilience of a Modern Structure or "Dissonant Heritage": Multilayered Identity of the Old Belgrade Fairground

CO- Authors: Uta Pottgiesser[1], Michel Melenhorst[2].
[1]University of Antwerp, Antwerp, Belgium
[2]OWL University of Applied Sciences, Detmold, Germany

Abstract

The Old Belgrade Fairground, a great example of the Early Modernism in Belgrade, underlined the modernization and Europeanization of the capital city of the Kingdom of Yugoslavia. The Fairground's construction in 1937 on the bare terrain of today's New Belgrade was the first step of urbanisation of Belgrade on the left bank of the Sava river and was followed by the construction of the modern city after WWII. During the 80 years long history, the purpose of the Old Belgrade Fairground has been changed several times creating multilayered identity of the urban complex. The Modern exhibition space of the inter-war period was transformed into the infamous concentration camp during WWII. Structures that survived the bombings were re-used as a habitat for youth brigades that participated in the construction of New Belgrade, while its previous purposes were suppressed. During the rebuilding of the city in the post-war period, the Old Belgrade Fairground was ignored. As forgotten place of memory it was partly adapted by artists into ateliers and partly became shelter for poor people. Despite its multileveled historical, cultural and architectural significance, the Old Belgrade Fairground today is neglected. Although a pioneer of Modern Movement in Belgrade, and at the same time an important memorial place, it is today a ruined structure that is decaying. Its multiple histories and "too much identity" created absence of any planned activity in order not to make a wrong one. After its ability to absorb different functions and adapt to huge transformations, its resilience is being contested by disability to balance the complex history. The paper investigates on the transformations and presents a concept of "dissonant heritage" as an instrument for renewal of the Old Belgrade Fairground that needs to use all of its complexity in order to truly recover from the past.

Old Belgrade Fairground // Modern Structure // Multilayered Identity // Resilience // Dissonant Heritage.

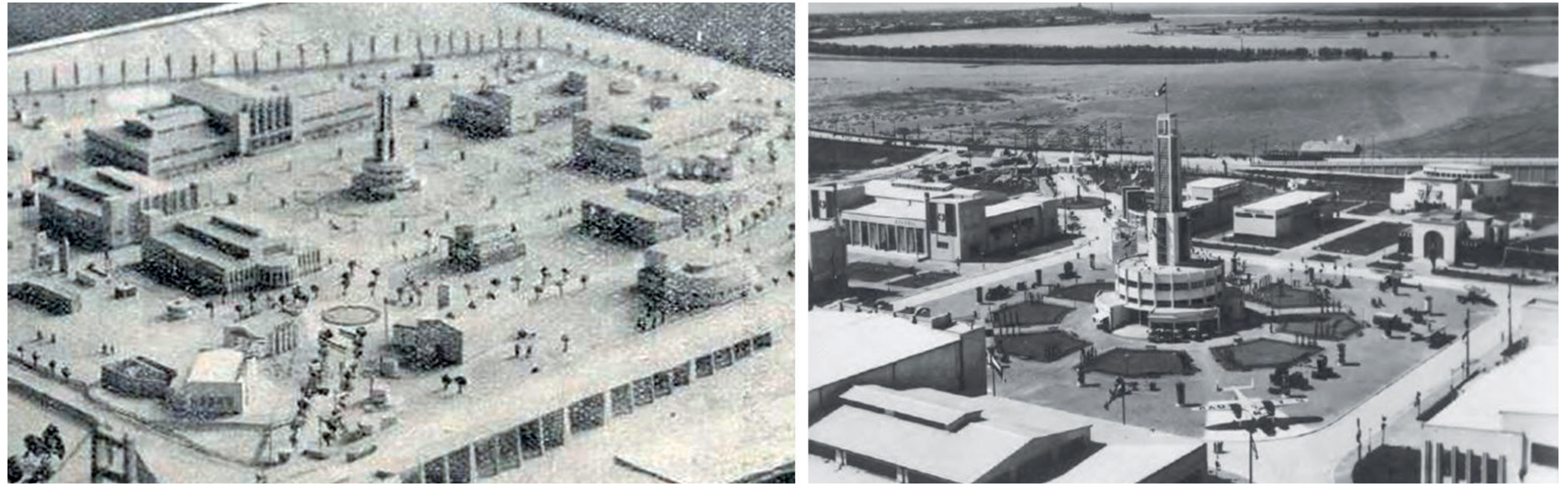

Fig. 2: Model of the Belgrade Fairground presented on the First Salon of Architecture in Belgrade, 1938 [11] and the appearance of the Fairground [6].

Fig. 3: The beginning of the building of the Belgrade Fairground, 1937 [12].

Introduction

Etymologically, a term resilience is derived from Latin resiliens "act of rebounding" (1620s) and presents a principle of resilire "to rebound, recoil". From 1824 its meaning refers to "elasticity" [1]. Commonly, the term resilience is defined as a)"the capability of a strained body to recover its size and shape after deformation caused especially by compressive stress" and b)"an ability to recover from or adjust easily to misfortune or change" [2]. As the term was applied in numerous disciplines and fields of study in the recent years its meaning became malleable. Resilience has a conceptual openness that enabled it to be redefined in different contexts. In the field of architecture and urban sciences, the concept of resilience could be defined as the ability of a system to absorb, adapt to or recover from change returning its basic shape and structure. This paper investigates on architectural resilience, more precisely on the ability of a structure to adapt to different functions - functional resilience.

The paper focuses on a modern structure that was initially designed as mono-functional, as an exhibition complex, however was used later in a variety of ways through "user's various interpretations" (unintended functions) that approved the adaptive capacity of the complex. "The quality of being adaptable" is one of the definitions of the term "elasticity", which is additionally synonym for resilience [3].

The Old Belgrade Fairground: Formation of the modern structure

The Old Belgrade Fairground is an urban complex on the left bank of the Sava River, hidden in greenery between the two bridges and New Belgrade. However, when the complex was built in 1937 it was the first structure on the bare terrain of today's New Belgrade. (Fig. 1)

In the inter-war period, urbanisation of the huge empty area had multiple symbolic significance. After the Kingdom of Serbs, Croats and Slovenians was founded in 1919, the area symbolised no more a barrier, a "no man's land", but the unification and a new beginning. The area was meant to be a modern extension of at that time oriental Belgrade, and the construction of the fairground was supposed to represent the western tendencies of the young state and its capital. The complex, built according to the project of three architects Milivoje Trickovic, Rajko Tatic and Djordje Lukic, was a symbol of modernity: from composition to detail. Vukotic Lazar and Djokic [5] describe that "This spatial composition became a metaphor of an urban complex that was completely realized according to a plan. Every single detail was planned and designed by professionals, with no improvisations so often in previous period." The composition was organized functionally, with dominant constructivist tower, as a central motive, and pavilions distributed around it. The elements of traditional city (square, street, block) were implemented in the composition, that was at the same time "an example of the concept of urban avant-garde of 1920s" [6]. (Fig. 2)

In the first phase of the construction, it was realized 14 out of 36,33ha. As the fairground was on the marshy terrain, a lot of pre-construction works had to be done. (Fig. 3)

Until the First Fair, the Central Tower, five Yugoslavian Pavilions, Nikola Spasic Endowment's Pavilion, four foreign pavilions (Italian,

Fig. 4: a) The 1. Yugoslav pavilion, b) The 2. Yugoslav pavilion, c) The 3. Yugoslav pavilion [13], d) The 4. and 5. Yugoslav pavilions [6] (left to right).

Fig. 5: The Belgrade Fair, 1938: a) A part of the Fairground [8], b) The First International Automobile Fair [7], c) Air Force Exhibition: parachute-jumping tower [8] (left to right).

Hungarian, Romanian and Czechoslovakian), and a small number of private pavilions were built. For the Second autumn Fair, additionally there were Pavilions of Germany, Turkey and around 20 private pavilions [6]. (Fig. 4)

The five Yugoslavian pavilions were designed by the group of the three architects (the authors of the main urban composition). The pavilions differed in size: the biggest was the 3. Pavilion (5.000m2), the 1. and 2. Pavilions (2.100m2), the 4. and 5. Pavilions (1.600m2). The primary elements of the construction were wooden ("bondruk") combined with bricks and concrete elements. Facades were plastered and colored white. The Central Tower, landmark of the Fairground, was designed by the architect Aleksandar Sekulic. The core of the tower was built in reinforced concrete, and the circular part of brick walls with concrete ceilings. The Spasic's Pavilion was designed by the same architect, also as a masonry structure (brick walls with reinforced concrete columns), plastered. The primary elements of construction of the Hungarian and Czechoslovakian pavilions were reinforced concrete frames with brick walls. All other pavilions were load bearing masonry (brick) structures. The roof construction of all pavilions was mainly wooden, and facades were always plastered [14].

Complex history of The Old Belgrade Fairground: Identification of the "user's interpretations"

The First Belgrade Fair was organized in September 1937 with approximately 250.000 visitors and numerous exhibitors. In the next two years different types of events were held in the complex [7]. (Fig. 5)

In September 1939, only two years after the first fair was held, WW II started, but fairs were organized in the next two years, dominated by Italian and German exhibitions. In the same time, not far away from the Fairground, a temporary camp for German emigrants from Bessarabia was built. They were temporary placed in barracks and tents and transported from here to Germany [9]. The war officially started in Yugoslavia with a German air strike on Belgrade in April 1941. The capital of Yugoslavia was largely damaged, but the Fairground wasn´t strongly affected. During the first six months of occupation, the pavilions remained empty and abandoned. After the split of Yugoslavia, the Sava River became the border once again, now between Serbia and the newly founded Independent State of Croatia (NDH). According to this, the left bank of the Sava River together with the Fairground was officially part of NDH, however under the command of the Gestapo. The whole site was transformed into the infamous concentration camp "Judenlager Semlin" (Jewish Camp in Zemun) in December 1941. The camp has a significant place in the European history of Holocaust as half of the Serbian Jews were killed or died in the camp. Few months later, in May 1942, after the "final solution" for Jews in Serbia, the camp changed the name into "Anhaltelager Semlin" (Zemun Concentration Camp) and the purpose: it became a camp for political prisoners, mainly from

Fig. 6: The Old Belgrade Fairground, 2017. (Photography Anica Dragutinovic).

Fig. 7: The 1., 3. and 5. Yugoslav Pavilions, 1944 (left to right) [14].

Serbia, but also other parts of Yugoslavia. Until May 1944 around 32.000 prisoners passed through "Anhaltelager Semlin", 10.600 of whom were killed or died. The camp was closed in July 1944 [10]. Post-war, liberated Belgrade, became a capital of once again unified Yugoslavia - newly founded Federal People's Republic of Yugoslavia, re-established by the Communist Party of Yugoslavia (led by Yugoslav Partisans - the largest anti-fascist resistance movement in occupied Europe and its leader Marshall Josip Broz Tito). Within the plans for rebuilding the devastated county, re-emerged the question of Belgrade's "extra-territory" - the marshy land on the left bank of the Sava River. The area was conceived as a new centre of administration, culture and economy of Yugoslavia and symbolised a new beginning once again. The remains of the Fairground, as the only existing urban structure, went through huge transformation, as it was necessary for its new purpose: a habitat for youth work brigades. It became a basis for the youth brigades that voluntary participated in the construction of New Belgrade. The youth brigade actions were organized only until 1950, when the political and economic crisis in Yugoslavia (caused by its split with Soviet Union) stopped the construction works. The Old Fairground was abandoned once again.

From 1951 a group of artists populated the remained structures and adapted them into ateliers. As it was not planned to reconstruct the Old Fairground, a new one was planned and constructed on another location. In the following years, while New Belgrade was largely constructed, the Old Fairground was left to decay for the next 70 years. Eventually, it was pronounced as a cultural good in 1987 and the Urban Plan for the memorial complex was made in 1992 [9]. However, the protection was only formal and a memorial complex was never built. Today, this is one of the most devastated city areas, completely isolated from the other parts of Belgrade [5]. It is populated by poor inhabitants and partly used in commercial purposes. (Fig. 6)

Levels of formal transformation of the modern structure

The "user´s interpretations", previously described, were as a matter of fact huge transformations that indeed tested the adaptability of the structure. As it was already stated, resilience is the ability to absorb, adapt to, but also to recover from change. The modern structure absorbed and adapted to huge transformations, however its resilience is contested by disability to recover from changes returning its basic shape and structure.

There were few levels of formal transformation that led from modern to the devastated structure. During the war years the Old Fairground's shape and structure were pretty much the same, despite the traumatic functional transformation. However, it was heavy damaged in 1944, when the Allied aircraft bombed occupied Belgrade. The Fairground was additionally damaged during The Belgrade Offensive in October 1944 [9]. (Fig. 7)

Although strongly damaged, the pavilion structures remained. In the first post-war years the next "user's interpretation" completely changed the spatial composition of the Old Fairground. The youth brigades were supposed to "clean" the complex first and to re-use the remaining structures. Some of them were repaired (the Central Tower, Spasic's, Czechoslovakian, Italian, Hungarian, German,

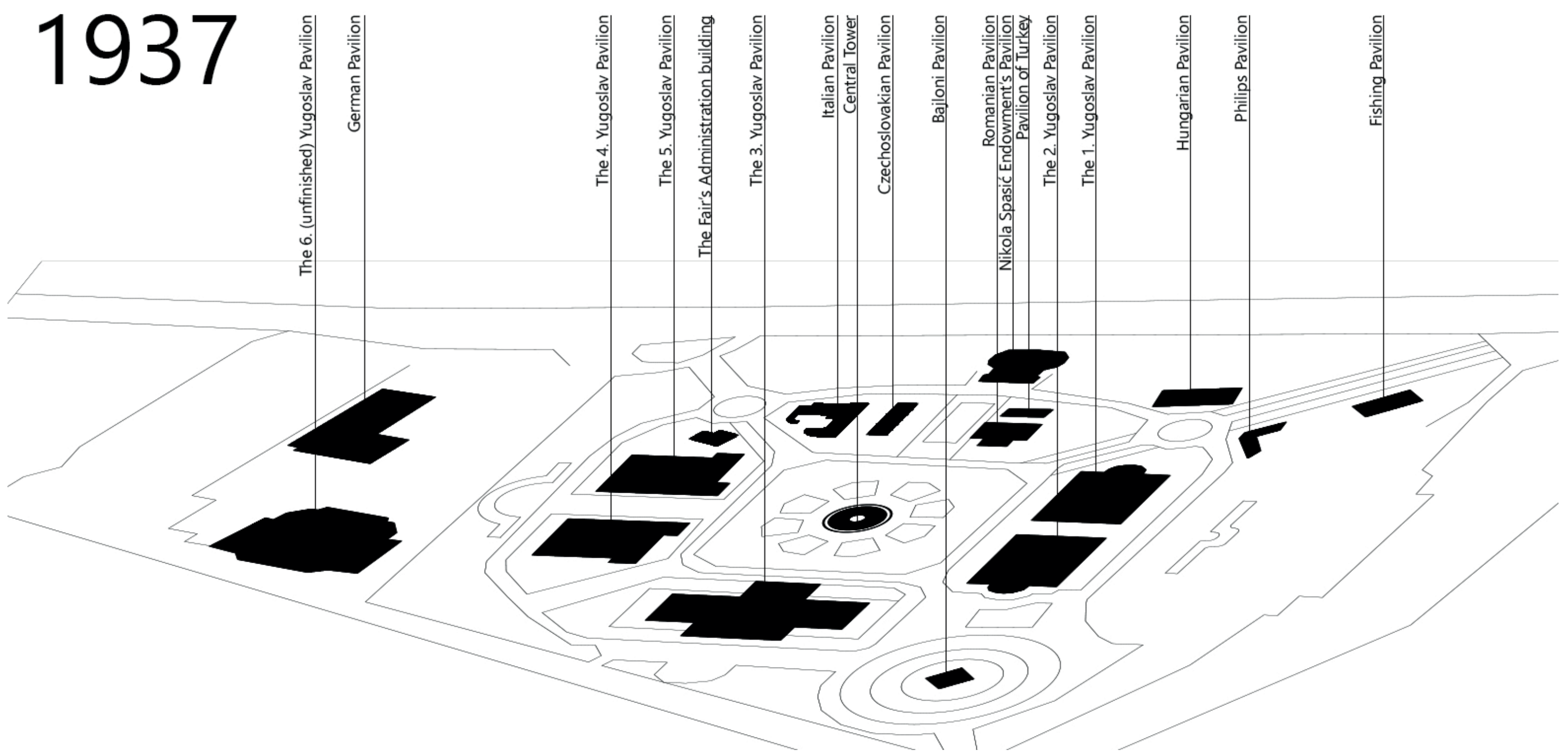

Fig. 8: Transformation of the Old Fairground 1937 (Illustration Anica Dragutinovic, according to the initial spatial composition and the current condition [15]).

Turkish and Romanian pavilions), and some were demolished and recycled (all five Yugoslav pavilions and most of the private pavilions). The criteria was of course the state (shape), but might be also the size, "as the size of the biggest pavilions was dysfunctional for the new purpose". The new buildings constructed from the material of demolished pavilions were rows of barracks and warehouses [10]. The appearance of the complex was drastically different from the initial one from 1937. After this transformation from 1950, the urban pattern of the complex has not changed any more. It was only additionally degrading over the last seven decades, and is today a ruined structure that is literally disintegrating. (Fig. 8 , 9)

Multiple identity, (un)necessary memory and a dissonant heritage

In the last ten years the problem of the Old Belgrade Fairground became more visible, as more initiatives for its adequate re-use and different exhibitions were held. The complex 80 years long history and different "user's interpretations" created multiple identity of the complex. Built as a symbol of modernity, it became a place of execution. In the post-war years, within the construction of the socialist society as "post-historical, or rather, supra-historical project of construction of new, progressive modernity, opposite decadent and reactionary past", the history of the Old Fairground was suppressed, as it was part of the undesired past(s) for New Belgrade´s identity [9]. The new (anti-fascist and communist) government had great respect to the war victims no matter their nationality, but at the same time was reserved to anything related to ex-crown-regime. "The new regime wanted to monopolize modernization of the country", and any previous efforts were minimized. Therefore they ignored the Master Plan from 1923 and the Fairground itself. Vukotic Lazar and Djokic [5] state that "Most of concentration camps all over the Europe were reconstructed exactly as they were during war, with intention to remember these terrible moments of mankind history", however, "this meant reconstruction of bourgeois complex, and maybe support to bourgeois habits of citizens." Therefore, the Old Fairground, despite its architectural, cultural and memorial significance, became the forgotten place of (un)necessary memory. Although formally protected as a cultural good 30 years ago, nothing changed until today. Its multiple histories and "too much identity [5]" created absence of any planned activity. However, the multilayered identity of the Old Fairground could (should) become an instrument for the renewal of the complex. Incorporating contradictory layers of its complex history, both progressive and destructive, into a solution would produce a dissonance.

The concept of "dissonant heritage" was introduced by Tunbridge and Ashworth [16]. They make a distinction between past, history and heritage, stressing that dissonance is inevitably created in the interpretative process of producing heritage from history (that is produced from past). The concept of dissonant heritage they present is related to different interpretations, articulations or understanding of the history through heritage. Furthermore, not-producing heritage, forgetting and ignoring past, is also a form of interpretation of history and creating a dissonance [16]. According to it, the Old Fairground is already a dissonant site, as the different "user's interpretations" created the dissonance. An attempt to create a cohesion and unity, instead to present diversity and plurality, would mean further contestation of the site. Instead,

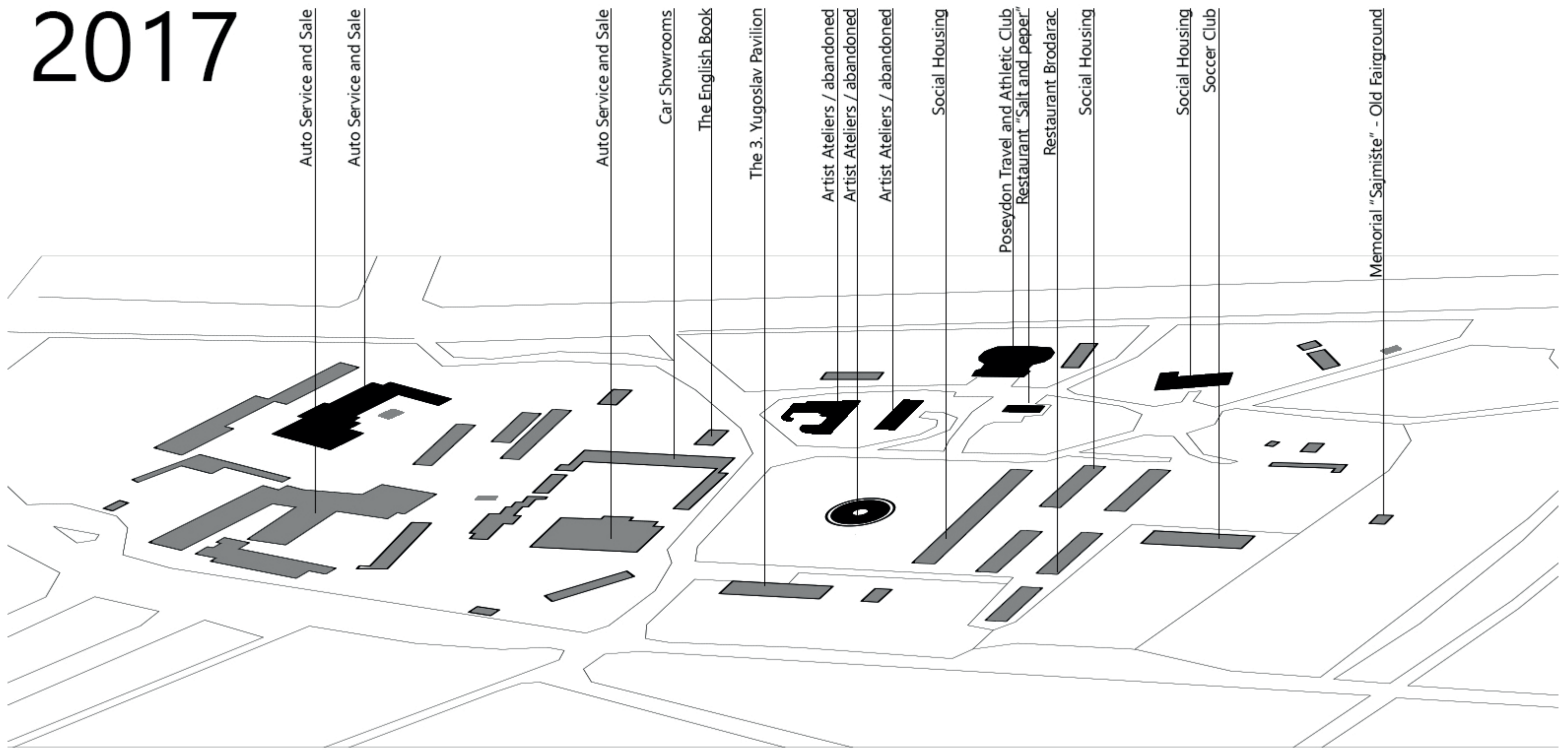

Fig. 9: Transformation of 2017 (Illustration Anica Dragutinovic, according to the initial spatial composition and the current condition [15]).

the dissonance needs to be articulated through the incorporation of the diversity of past(s) into a dissonant heritage. After having approved ability of the modern structure to absorb and adapt to change, the third phase of approving the resilience - "to recover from", would be eventually achieved.

Conclusion

The Old Fairground, a pioneer of the Inter-war Belgrade Modernism, went through huge transformations over the time. Adaptability of the urban complex was result of an unintentional polyvalence of the space, reflected through its potential to absorb unforeseen functions. Furthermore, this would connote the functional resilience of the modern structure, if the structure managed to recover from the changes. However, it is today one of the most devastated city areas, despite its historical, cultural and architectural significance. The transformations created multilayered identity of the space that is perceived as a problem for renewal of the complex. Converting it into an instrument for the renewal would be the first step forward after the long period of status quo. In order to finally recover from the past, it is indispensable to incorporate the contradictory and dissonant layers of its complex history into a continual urban space.

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Notes

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Fig. 1

Post-WWII housing estates in Europe: obsolescence or resilience?

Abstract

Endangered by its social, functional and technical obsolescence, many of the Post-WWII housing estates are currently the main focus of problematic urban areas, infrastructurally and socially disconnected from the city. At a time when l'habitat pour le plus grand nombre is in danger, looking back to these estates, built within the framework of the welfare state, is an opportunity and a fundamental step for an integrated discussion on urban development.
Addressing social integration, functional use, and building technology, this paper present successful preservation strategies undertaken in three European post-WWII case studies, demonstrating how reuse can be used as a vehicle for sustainable progress.

Europe // Post-WWII // Housing // Welfare state // Reuse // Resilience

1. The right to housing

In 1948, the Universal Declaration of Human Rights stated that "everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing and medical care and necessary social services, and the right to security in the event of unemployment, sickness, disability, widowhood, old age or other lack of livelihood in circumstances beyond his control". The idea of a house for all, underlined in the Engels' Housing Question (1872) and recalled in the context of Europe's post-XXII reconstruction within the welfare state, l'habitat pour le plus grand nombre seems to be more and more in danger: in the overall context of neo-liberal policies, economic (private and individual) values reigns over social (public and collective) ones. This framework is particular dangerous when it comes to dealing with the refugee situation, escalating across Europe. On another side, more than 11 million dwellings lie empty in Europe, leading us to the unavoidable conclusion that one should be exploring the possibilities of using existing structures, instead of pursuing the option of expanding indiscriminately; the reuse could be considered as a vehicle for the XXI century city sustainable development. From both perspectives – from the lessons that might be taken from the welfare state housing initiatives to the reuse potential – attention must be paid to the post-XXII remaining housing estates.

2. Between hate and love, demolition and renovation

After the WWII, governments across Europe established ambitious social welfare programs in order to improve the citizens living conditions and health standards. Envisaged as holistic creations, these post-war housing estates were organised in such a way as to provide all the necessary facilities, ensuring that residents had access to housing, education, health, work and recreation. Many of these programs involved a new approach to architectural design, through adventurous experiments in the use of new materials and techniques, space creation and social transformation. More than five decades after, these sites are facing a dangerous state of social, functional and technical obsolescence, having become the main focus of problems existing in urban areas, housing large numbers of low-income households, the unemployed and people from ethnic minorities, being disconnected from the city in both infrastructural and social terms.

Between hate and love discourses, the debate about these housing estates still stands between demolition and renovation. In the final of the XX century, following the 1972 demolition of the Pruitt-Igoe housing blocks (Minoru Yamasaki, 1954), in St Louis, that Charles Jencks hailed as the death of the Modern Movement and the birth of Postmodernism[1], "should the grands ensembles be demolished?" was a major question for architects. "Incidental as it may seem today, the question is not completely old hat"[2]; the true is that a long way has to be pursued in order the qualities of the post-XXII housing estates be recognized and safeguarded: the Robin Hood Gardens (Alison and Peter Smithson, 1969-72), despite all the international protection campaigns, ended up demolished last August (2017). In UK, demolition decision was given to hundred "brutal high-rise towers" within the will of the former Britain's Prime Minister, David Cameron, of putting "the bulldozing of sink estates at the heart of turnaround Britain"[3] and political views such as "the overwhelming majority of public architecture built during [the modern] lifetime [being] aesthetically worthless, simply because it is ugly"[4 5].

Nonetheless, all over Europe, post-war housing estates have nowadays begun to be appreciated by users and authorities, as integral part of the current city, beyond the confines of academia and heritage field. Representing an important turning point in attitudes towards the post-WWII housing, is the case of the 1km-length Corviale, in Rome (Mario Fiorentino, 1972-1982). Formerly seen as a symbol of architectural and social failure, is now gathering support for its preservation through an international competition ("Rigenerare Corviale") launched by the Commune of Rome, with the strong support of 8000 inhabitants who admitted to being "fascinated by the monster"[6].

The recently given protection status to the Cables Wynd House (Alison & Hutchison & Partners, 1968), in Edinburgh, featured as a "drug den" in Trainspotting[7], to the Balfron Tower (Ernö Goldifinger, 1972) in London, or to the Cité de l'Etoile (Georges Candilis, Alexis Josic an d Shadrach Woods, 1955), in Bobigny, are cases in point representing the increasingly recognition of this architectural production as heritage as the first positive steps towards its preservation.

3. Obsolescence

The obsolescence of these housing estates may be determined on three main levels: social, functional and technical.
Regarding social terms, it must be said that post-war housing estates were mainly developed towards the outskirts of cities following the satellite Garden City theory, which nowadays suffer from social exclusion, poverty and crime. Conceived as autonomous settlements with a complexity of functions, they are nowadays often not well connected with the current urban infrastructure. Preservation efforts must take into account the access to facilities, public and green spaces; the integration within transport networks; the capacity to be connected to the environment; the morphological organization of the sites and of the buildings; the demographic structure and socio-professional characteristics of the inhabitants, their sense of belonging and security.

In functional terms, dwellings were usually assigned to a typical family (couple with 2/3 children), comprising the basic functions of bedroom, living space, kitchen and bathroom, usually designed with the minimum hygienic and functional conditions and proportions. The social and functional use of dwellings have changed in several aspects: in privacy (number and type of rooms), in technology (we have now new communication systems, such as the internet and cell phones), in family lifestyles and household structures (the important role of women in the labour market and the increasingly diversified ways of working). It became important to promote spatial occupations not envisaged when the buildings were conceived and to address the flexibility of use to meet current lifestyles occupation and reform the levels of satisfaction.

In what concerns the technic dimension, not only the restoration of structural systems, materials and devices is essential, as the main challenge is to address the current high-demanding regulations concerning user safety, fire control, seismic stability, energy efficiency and environmental comfort, including acoustic insulation, ventilation and lighting.

Whether discussing demolition, or the growing phenomenon of heritagization, the debate has been mainly centred on the question of how to keep these structures alive, while meeting contemporary standards of comfort. Even if it is hard to find examples of rehabilitation works carried out that has globally addressed the referred three main levels of obsolescence, we are now beginning to find very relevant efforts in addressing some of them. This is the case of the work undertaken at the Deflat Kleiburg, in the Netherlands, trying to promote social inclusion, the works by Druot, Lacaton & Vassal in France, addressing functional update, and the building envelope renovation at the Cité du Lignon, assuring technic update in what concerns energy performance.

4. Resilience

4.1. Social update – Deflat Kleiburg, The Netherlands

Kleiburg is located in Bijlmermeer, a modern neighbourhood expansion of Amsterdam designed in the 1960s by Siegfried Nassuth, hosting nowadays almost 100.000 people from 150 nationalities. It was conceived as a vertical garden city, composed by high-rise buildings of social housing laid out in a hexagonal grid, organized around large green spaces and traffic routes separated between cars, bikes and people. Kleiburg is the one of the biggest housing buildings in the Netherlands, 400-meter-long, hosting 500 apartments within 11 stories high. It ended up being the last building in the neighbourhood in its original state, after positive efforts had avoided its demolition: as an answer to the 70 million € bulldozing, Kleiburg was offered for 1 € in an attempt to catalyse alternative and economically viable plans. More than 50 proposals come out, from student to homeless housing. In the end, the building was saved from the wrecking ball through its transformation into a rejuvenated framework called "Klusflat", a DIY concept that enable the inhabitants to customize their renovated apartments by themselves. Completed in 2016, the architects NL architects and XVW architectuur focused their intervention in the renovation of the main structures – elevators, galleries, installations – leaving the apartments unfinished, with no rooms, kitchen, shower, or furniture. (Fig. 1)

Eventually leading to a new business model for housing for Netherlands, this concept minimizes the initial investments (€1,200 per m2), providing a diverse offer of affordable housing for the large majority and a diversity of use that promotes new housing typologies – it is even possible to combine various flats into one, horizontal and/or vertically. The majority of the former criticism received by different actors concerning the neighbourhood was the excessive uniformization; all the proposals to improve it were based on differentiation. Therefore, the goal of the project was to get rid the repetition and emphasize the diversity that was already always present in social terms, by allowing architecture be itself the expression of their own habitat. This was achieved not only through the flexibility of the internal informal planning, but also the transformation of the division between inside and outside in the galleries, that was rather defensive as closed. The closed parts of the façade were replaced by double glass, transforming "the interface (into) a personal carrier of the identity of the inhabitants, even with curtains closed", promoting the interaction among inhabitants. From a common catalogue, "future inhabitants will be able to choose a set of window frames that matches the customized layout of their FLATs: openable parts, sliding doors, double doors, closed panels, a set-back that creates space for plants or people". On the ground floor, efforts were made to turn the building more penetrable within the park and lose some of its barrier character: the storage spaces former entirely located there and therefore creating impenetrable dead zones, were placed on each floor, allowing its replacement by inhabitation; the connections between both sides of the building were double-heighted. (Fig. 2, 3)

Inspiring a mindset, DeFlat Kleiburg received the European Union Prize for Contemporary Architecture - Mies Van der Rohe Award 2017, being the first time that a renovation project wins over a new construction. Besides from being the result of a valuable collective

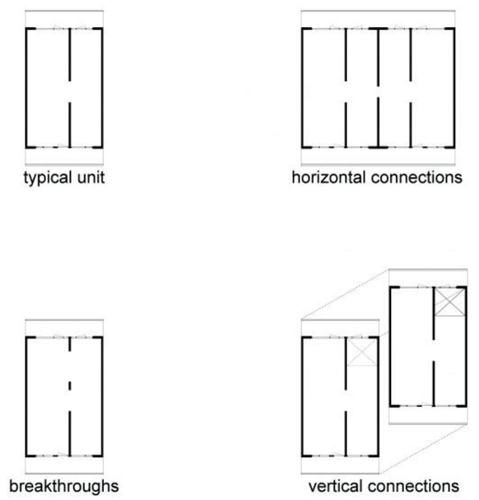

Fig. 2, 3

effort by many people, the jury considered that "it challenges current solutions to the housing crisis in European cities, where too often the only ambition is to build more homes year-on year, while the more profound question of what type of housing should be built goes unanswered. Kleiburg helps us imagine a new kind of architectural project, which responds to changing household patterns and lifestyles in the twenty-first century. A revitalization of typologies of the past is as relevant as experimenting with new, untested models in this quest, just as radically transforming existing buildings is".

4.2. Functional update – Bois le Prêtre, France

Regarding functional updating, the rehabilitation strategy conducted by Frédéric Druot, Anne Lacaton and Jean-Philippe Vassal, for the post-war housing schemes built in France, in response to demolition policies, is already a worldwide reference. This strategy was first laid out in 2004, within the publication PLUS - Les Grands Ensembles de logements. Territoires d'exception. Addition, Extension, Transformation, a study-cum-manifesto challenging the initiatives led by the French government to turn down a significant part of the post-war social housing stock and replace it by new, smaller and more expensive dwellings. Through seven projects presented, PLUS reveals how such housing schemes can be adapted to the current lifestyles, based on the principle "never demolishing, subtracting or replacing things, but always adding, transforming and utilising them". (Fig. 4, 5, 6)

Starting with Tour Bois le Prêtre, Druot, Lacaton, and Vassal have been having the chance to test their conjectures in reality over

Fig. 4

Fig. 5

Fig. 6

the past years, transforming several post-war housing buildings in France, according to their "extension" concept. Bois le Prêtre is a 16-storey prefabricated concrete tower, hosting 96 apartments, designed by Raymond Lopez. It was built between 1959 and 1961, in the North outskirts of Paris, following a real estate survey conducted in 1954 with the aim of discover unoccupied areas where it would be desirable to extend the city to. In 2005, the demolition firstly envisaged, has been avoided and replaced by the launch of a competition for its renovation, which was won by Druot, Lacaton, and Vassal, in 2011. Based on the principle of adding value by space, the proposal consists of adding winter gardens and balconies, built as a self-supporting structure, to the whole periphery of the building, and replacing the former façades by large openings. This way apartments have been enlarged from 8,900 to 12,500 m2, and the light, the views and the comfort of the apartments were optimized. Without modifying the existing structural organization, these external structures allow bioclimatic adjustment of temperatures, reducing the energy consumption by approximately 60%.

By increasing the flexibility of the dwelling space, while promoting the renewal of the typologies and the living conditions, comfort and pleasure, Lacaton and Vassal believes that the inhabitants of each apartment must ask, "What exactly should I use this space for?" Photographs by Philippe Ruault reveal the plurality of responses: eating, living, play, etc. The kitchens and bathrooms were renovated and vertical circulations and access halls were improved; rooms for collective activities were established on the sides of the hall, completely renovated. These new winter gardens and balconies were added to the façade using prefabricated modules, one day per apartment. The works taking place outside allows that the inhabitants could stay in the apartments during the construction process. Instead of the € 20 million estimated for destruction/reconstruction, the cost of the entire transformation project was €12 million, proofing the argument in favor of the renovation as a much more affordable solution than demolition.

4.3. Technic update – Citè du Lignon, Switzerland

Concerning technic upgrading, the applied research conducted at the Techniques et Sauvegarde de L'architecture Moderne Laboratory (TSAM), at École Polytechnique Fédérale de Lausanne (EPFL), stands out for the exceptional rehabilitation plan developed for the Cité du Lignon, in Genève, Switzerland, between 2008 and 2011, contributing for its rehabilitation. The Cité du Lignon was a "satellite city", commissioned to the Georges Addor office, built between 1963 and 1971, to host 10.000 people, as a response to the 1960s-population boom. As one of the largest apartments complexes in the world, it is composed by 2700 apartments within an area of 28ha, distributed among a jagged 1km-long block from 11 to 15 storeys, two towers of 26 and 30 storeys and community facilities: a school, two churches, a shopping centre offering a wide range of services to the residents, a medical centre, a sports centre and a youth centre. Besides working as a well socially-sustainable neighbourhood, the project presents remarkable technical and constructive features, in line with the principles of industrial and rationalized structural systems, from the reinforced concrete structure to the 125,000m2 of prefabricated curtain wall, composed by large panels (2.80 x 2.40 and 2.80 x 1.80 meters) with

Fig. 7

interior pinewood frames and exterior aluminium panels. Widely and internationally studied, the Cité du Lignon is very much appreciated by its residents. Its heritage value was legally recognized through a conservation plan approved in 2009 with the aim of preserving the architectural unity of the buildings, the planning design and the landscape quality of exterior spaces. (Fig. 7)

Towards its conservation, and with the aim of updating the complex with the high-standard Swiss regulations reduction of energy consumption requirements, the Canton of Geneva and the consortium representing the building's owners commissioned the TSAM Laboratory an Architectural and Energy Study of the Envelopes (2008-2011), in order to find a balance between heritage protection and greater energy efficiency. Exhaustive surveys of the buildings envelope and diagnosis of its thermal performance were undertaken conducting to 4 different intervention options to transform the Lignon façades: 1 - simple maintenance; 2 – replacement by a replica with intermediate solutions including repair; 3 – refurbishment; 4 – total replacement of curtain walling with a replica. Using multiple criteria, within three main variables – heritage, economy and energy – these 4th options were compared in what regards conservation impact in material, visual and physic–chemical character; works to be carried out, life–cycle estimations, costs and energy needs. Decision–making tools to assist building owners were developed, to support the decision process: besides the 4th option which was not economically sustainable, the other 3 options offered possible solutions, offering a range of options to be selected by the owners according to their financial budget. After these option prototypes have been tested in real apartments, TSAM developed a set of basic working guidelines for each of the solutions, with methods description, specifications, detailing and assembly designs and selection of materials also tested by simulation and under real conditions. Finally, according to the means of apartments owners, the renovation was undertaken in all the façades, producing an overall consistent preservation project that maintained the architectural unity of the site. After some years of use, it was proved that the overall energy consumption improved 70%, being now into compliance with the current standards.

The highly conclusive experience of the TSAM Laboratory and its applied academic research at the Cité du Lignon, turns to be a pilot project of excellence, distinguished with the Europa Nostra and SIA Awards, that is being now extended to other post-war housing

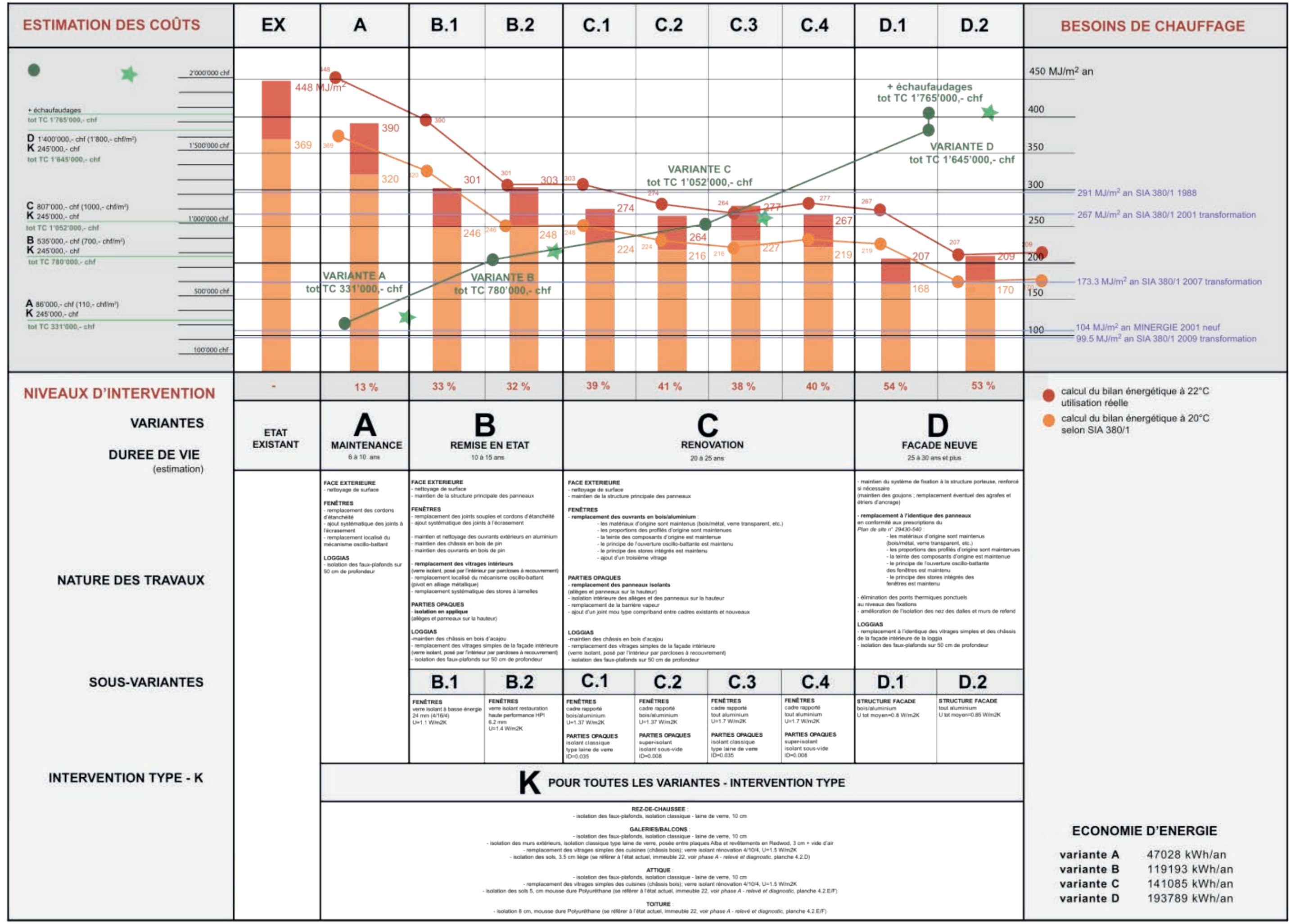

Fig. 8

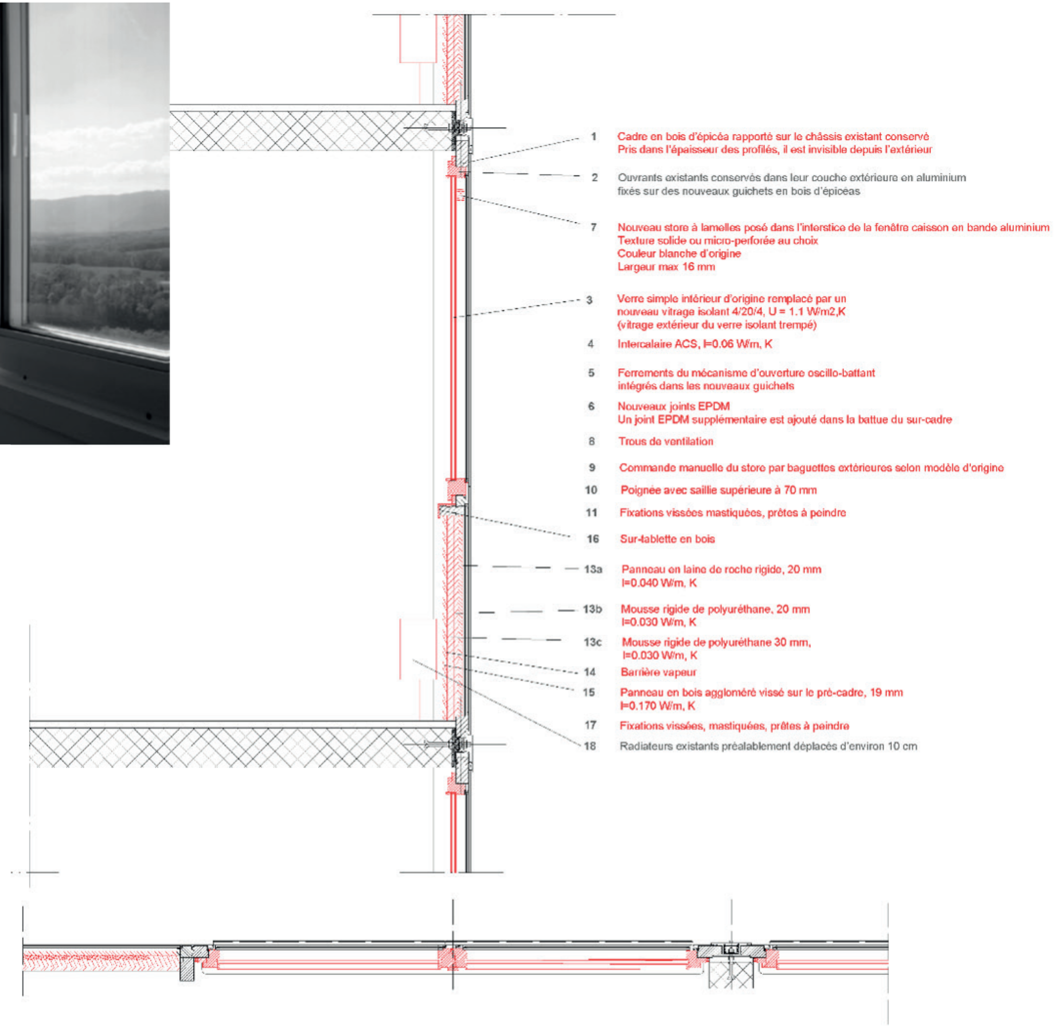

Fig. 9

estates in Geneva. Representing the importance of exhaustive studies in the development of the most appropriate solutions for energy consumption while respecting the architectural identity and the economic available resources of its users, this project reveals how it is possible to balance the qualities of the post-war building stock while updating to the contemporary standards of comfort. (Fig. 8, 9)

5. Towards a sustainable Europe

The need to develop sustainable sites, neighbourhoods and landscapes is one of the main issues for the XXI century. Post-war collective housing remains one of the most significant modern products representing efforts to develop architecture as a vehicle for an egalitarian society and where thousands of people still live today. The proper rehabilitation of these structures, while addressing the demands of the contemporary agenda, can represent a tremendous potential achievement, in an over all context of economic, social and environmental sustainability.

There are several studies documenting post-war housing estates around Europe at different levels[8]. Also, there is several studies on the growing technical and functional obsolescence of 20th century-architecture[9]. Positive developments towards the recognition of the value of the post-war housing estates have been increasing, but we still have a long way to go – specifically, with regard to the preservation of European post-war housing estates, few are the relevant studies, usually applied to specific buildings or housing estates. It is fundamental to look at international case studies, hoping that they may act as recommendations on how to intervene by building a lexicon of practical application that can inform future projects able to be used by practitioners, researchers and policy makers. Collective efforts must be keep evolving towards the establishment of a route for restoring the idea of the right to housing, levered on the potential of the post-WWII European legacy.

Acknowledgments

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Fig. 9: Georges Addor, Dominique Juliard, Louis Payot, Jacques Bollinger, Cité du Lignon, Genève, Switzerland, 1963-1971 – Defining possible levels of intervention, Option C — Refurbishment window panel cross section, 1:20. © EPFL–ENAC–IA–TSAM.

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[9] Numerous institutions have been contributing to the definition of conservation strategies, namely the École Polytechnique Fédérale de Lausanne (Graf, 2014), the Accademia di Architettura di Mendrisio (Grignolo, 2014), the Columbia Graduate School of Architecture, Planning and Preservation (Prudon, 2008) and the Getty Conservation Institute (Macdonald, 2001). DOCOMOMO International 1988-2012: Key papers in Modern Architectural Heritage Conservation (Tostoes, Jecheng, 2014) reveals how the state of the art for this subject has evolved, and Adaptive Reuse. The Modern Movement towards the Future (Tostões, Ferreira, 2016) is the most updated work on the reuse subject. The contribution of Bruno Reichlin has been a reference since the late 1980s.

Notes

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Architect, and PhD candidate at Instituto Superior Técnico in Lisbon University. She teaches Architectural Design Studio since 2009 at Instituto Superior Técnico, Lisbon University. Her Phd thesis is on Architecture regarding the Portuguese healthcare buildings from 1930 to 1970.

In 2017 she was the Executive Coordinator of the International Workshop of the 14th International Docomomo Conference, in Lisbon.

In 2016 she co-coordinated a student's exchange workshop in Liverpool University in London.

She joined several research teams regarding modern architecture: "Inquérito à Arquitectura Portuguesa do Século XX" (2005); Calouste Gulbenkian Foundation publications (2006-2015), "Gulbenkian Headquarters and Museum.The Architecture of the 60s" (2006); and several publications for the Docomomo Ibérico (2009-2011). She's a member of Docomomo International Association.

In 2015 was a jury for Archiprix Portugal. Until 2011 she collaborated with Risco S.A. architecture office on projects such as Ferreira Dias secondary school and the NATO Summit in Lisbon, and Santa Filomena Hospital, in Coimbra.

Fig. 1: Cristino da Silva, Carlos Ramos, Raul Lino and Ernst Kopp, Walter Diestel and Tavares Cardoso. Portuguese Institute of Oncology. Lisbon. Portugal. 1927-1948. Urban view on the built buildings. Cristino da Silva: Pavilions A (1927) and B (1930); Carlos Ramos:Radium Pavilion (1933); Walter Diestel and Tavares Cardoso: Nurses Technical School (1944) and Hospital Block (1948). © Art Library of Calouste Gulbenkian Foundation, Photo Mário Novais.

Radium Pavilion of the Portuguese Institute of Oncology in Lisbon

A modernist functional skin

Abstract

Healthcare buildings are a typology that has not been studied yet in Portugal. The purpose of this paper is to analyze the how the façades of the Portuguese Institute of Oncology (1927 -1948), designed and built in the 20th century, have been, are being transformed in order to fulfil technical and legal requirements.

The main research question was focused on how to keep the identity and architectural character of buildings within the everyday pressure of imperative technical necessities of medical assistance. The methodology established several steps: from surveying bibliographic sources followed by a rigorous architectural analysis, to fieldwork survey, and to the collection of personal statements from an institutional group of people and doctors. Following this methodology we were able to systematize the original designs and their concepts and ideologies, and to understand the main changes occurred, and why.

Through bibliographic sources and fieldwork survey was possible to identify what remains from the original design, and what are the main challenges of updating healthcare buildings within the pre-existent structure and architectural language. From personal statements was clearly identified that the main challenges are financials constraints, and how to establish the balance of the pressure and primacy of medical assistance within the architectural heritage.

A rigorous methodology of documenting and understanding the original design, and from that being able to define strategies of intervention, seems to be the solution to adjust to change. Nevertheless in buildings where saving life's is the primary mission, modernist façades become simply the functional envelope where anything can be done to save a human life.

Healthcare // Facade // Charakter // Resilience

Introduction

As Carlos Ramos stated, in 1929, “If there are buildings that need a permanent renewal of its installations, and a complete reshuffle of its departments, hospitals are undoubtedly, the ones where that necessity comes first”[I]. Following that is vital to understand that change and resilience are within the character of healthcare buildings. Considering resilience as the quality to recover and overcome adversity after the transformation of the original form, the paper questions if that return process is possible and desirable in healthcare buildings.

This typology has not been profoundly studied yet in Portugal. Considering Radium Pavilion of the Portuguese Institute of Oncology (IPO) in Lisbon as an example, this paper is now bringing, on one hand, the understanding of original design considering the bibliographic sources already produced, together with the fieldwork survey documentation about the current state. The fieldwork survey allowed to identify the original design and what remains from it, and also to recognize the challenges of updating healthcare buildings within the pre-existent structure and architectural language. On the other hand the aim is to question the possibility and desire to keep the architectural character of a building where the modernist facades are nowadays just a blur memory of its original design, and a functional skin where anything happens as a reflection of a necessity justified by the primary mission of saving a human life. As Keil do Amaral (1910-1975) stated “[Carlos Ramos] was ‘mainly worried with the plans design, the sections and facades were simply the result of it’”[II], nevertheless design principles were establish in order to achieve a clean and austere volume where structure, infrastructure and technical demands were harmonized.

I. The Portuguese Institute of Oncology in Modern Lisbon

Carlos Ramos (1897-1969) was the architect who designed the Radium Pavilion, which was built between May of 1931 and December of 1933, for the recently established Portuguese Institute of Oncology (IPO). (Fig. 1)

Francisco Gentil (1878-1964), part of the brilliant “1911 generation” of Portuguese doctor’s that emerged at the beginning of the 20th century, was fully committed with investigation of cancer taking the challenge of establishing an oncological institution for research and treatment.

The Government creates the Portuguese Institute for Cancer Study in 1923[III] functioning in a first phase in the Faculty of Medicine in Lisbon (Santa Marta Hospital). Adapting pre-existent spaces did not suit Gentil team, and modern architecture will be the stage for the evolution of medical science. In 1927, the plot of land was bought strategically at the west growing area of the city, and in 1929 the first patient was admitted.

The IPO will be one of the best Cancer Institutes of Europe, and the Radium Pavilion will be the first European construction with effective protection against radiation.

The modernist expression of Radium Pavilion, defined between the latest’s years of Republican Regime and the final of the 1930’s, had a national ephemeral existence due to the “perverted relation between power and architects”[IV]. The Hospital Block (1948) of IPO designed by Walter Diestel, a German architect, translate

Fig. 2: Carlos Ramos. Radium Pavilion. Portuguese Institute of Oncology. Lisbon. Portugal.1933. Southeast façade. © Art Library of Calouste Gulbenkian Foundation, Photo Mário Novais.

the cultural and political frames of the final 1930’s, when the Gold Decade of Public Works, led by Duarte Pacheco, finds its end and a “monumental accent exposed in the program of Regime Public Works approaching a new historicist and regionalist vocabulary, staked on classical roots nearby the nazis and fascists models of the time”[V], comes to light.

The IPO is located in Palhavã, a housing area mainly built in the beginning of the 20th century that has been constantly transformed and renewed. The trapezoidal slightly sloped plot is limited by a railway on the northern and west sides, a high traffic road on the northeast side linking to the city centre, and next to one of the most busy traffic squares in the city, Praça de Espanha. Its main access is made on the southwest limit trough Professor Lima Bastos Street, a local road where the concave shape of the surrounding buildings announces its entrance.

Today IPO it’s composed by 16 pavilions mainly built from 1927 to 1996 and added afterwards.

Its design process met several phases and authors, such as Luís Cristino da Silva (1896-1976), Carlos Ramos (1897-1969) Raul Lino (1879-1974) together with Ernst Kopp (1890-1962), Walter Diestel (1904-?) together with the engineer Tavares Cardoso, and Raul Rodrigues de Lima (1909-1980), each one contributing with, or for, an urban masterplan that changed along the time.

II. Radium Pavilion

In November of 1927, Carlos Ramos[VI] is invited to develop a project for IPO, and develops a proposal that if built “could have been one of the largest architectural complexes in Lisbon in the 1920’s”[VII]. He officially accepts the invitation in January of 1928, and is nominated by a Government Law in April of 1928, together with Marck Anahory Athias (1875-1946)[VIII], to go on a study visit to understand the main cancer centers in Europe bringing to Portugal all the innovative therapeutic, architectural and construction information’s in order design the new Portuguese Institute for Cancer Study.

The study visit took place between February and April of 1929 and was of primary importance for the further developments of the project. They visited cancer centers in France, Switzerland, Germany, Denmark, Netherlands, Belgium and Spain[IX], and from the Report[X] is possible to observe the main references and models brought to Portugal. Besides the study concerning the capacity of cancer institutes and radium treatments specifications, the report also includes plans of the plots and buildings, and photographs where is possible to perceive the roots and models for the masterplan. After the visit the project was presented in 1930[XI] by Francisco Gentil. The project is referred as an "admirable study", where the "ones that know the hygiene principles and hospital construction can appreciate the magnificent architectural work" [XII]. Considered to be too expensive to be built and demanding to manage this masterplan was never built.[XIII] Carlos Ramos develops a reduced masterplan where a Radium Pavilion is considered. Yet again this masterplan proposal never became real, considered "full of inconveniences"[XIV]. Nevertheless, in 1931 Francisco Gentil demands the urgent construction of the Radium Pavilion "[because of] the disease caused on the people working with radiation therapy, and by the emanations of working with it"[XV].

Between May of 1931 and December of 1933 the Radium Pavilion was built and was the first European construction with effective protection against radiation. The II International Congress of Radiology that took place in Stockholm in July 1928 defined an innovative construction method to assure radiation reduction trough the introduction of lead layers. In Portugal, this expensive method had to be adapted for the walls considering the use of a central barite layer of 16 cm and a symmetrical system of plaster, concrete and cork, with a total with of 18, 4 cm. New construction systems, as concrete, fulfilled the construction requirements. The use of lead layers was kept for the floor slabs of rooms where the radiation was used. (Fig. 3)

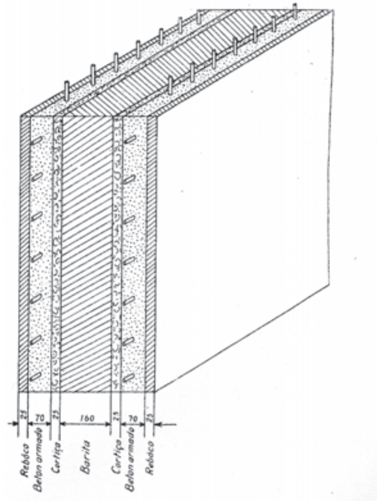

Fig. 3: Carlos Ramos. Radium Pavilion. Portuguese Institute of Oncology. Lisbon. Portugal.1933. Filtration walls.
© Portuguese Institute of Oncology Archive, GENTIL, Francisco, "O Passado, o presente e o futuro", in Separata do Boletim do Instituto Português de Oncologia, Lisbon, Portuguese Institute of Oncology, 1938, 22.

Radium Pavilion is a unitary rectangular prism of three floors, and a modern solarium terrace, where the "functional imperative overlaps the artistic one, establishing it as the reference work of the national modernism directly affiliated with the radical international principles"[XVI]. Program and functional demands, together with new construction technologies generate a clean and austere volume. Symmetry is the defined compositional hierarchy established through the higher volume containing the stairs, placed on the central axis of the volume. The volume walls are defined by a smooth surface where the openings were carefully defined by the structural grid and functional needs, "the plan is defined based on

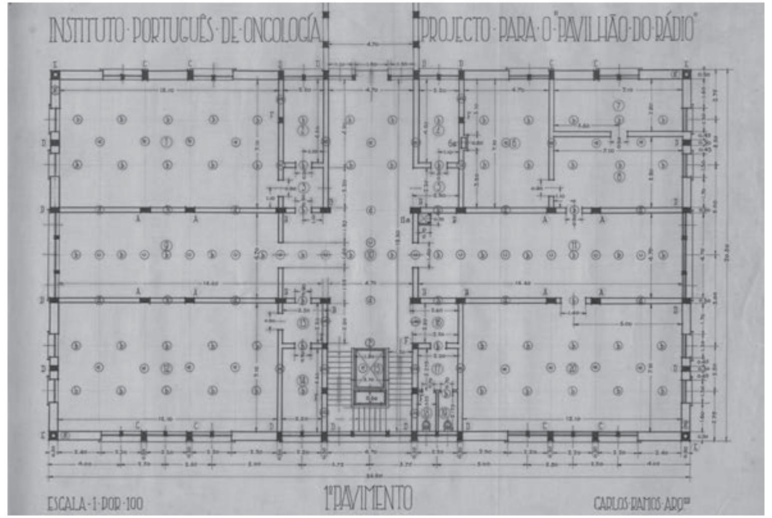

Fig. 4: Carlos Ramos. Radium Pavilion. Portuguese Institute of Oncology.Lisbon. Portugal.1933. First Floor.
© IPO Archive. Ana Tostões

a rigorous 2,5mX2,5m grid, generator of all the design: from the definition of the openings, to the structural system articulated on the definition of one, two, or three modules. This project rule integrated in the construction can be the rigor and formal comprise key of this building when compared with the contemporary ones"[XVII]. As stated by Keil do Amaral (1910-1975), "Carlos Ramos was the most dry of the first modernists, because he was 'mainly worried with the plans design the sections and façades were simply the result of it'"[XVIII]. This can be seen in the stairs exterior volume where the openings follow the stair levels generating an asymmetric composition. (Fig. 4)

III. From transformations to the classification as "Monument of Public Interest" and the establishment of a "Protection Zone"

Like all buildings, changes and transformations were added to Radium Pavilion. However, in 1975, it suffered a profound and visible transformation of its original volume. An entire floor was added where the "modern solarium terrace" was previously designed. (Fig. 5, 6)

The area expansion was completed together with new, and needed, comfort equipment as heating, cooling and ventilation systems, and with the improvement of cold and water systems, sewage and gas infrastructures no longer fulfilling the demanding needs. Also the oxygen, and the vacuum plumbing's where introduced. Is obvious the need of technical update, the air conditioning is a system that nowadays there's no question about it but was not available in 1933. The question is how it should be introduced in a modern building in use?

The new plumbing's systems didn't follow any design orientation; they were defined wherever they were needed in a simplistic functional decision. The new heating system was introduced through convector radiators placed all over the walls with no kind of criteria. Identical lack of understanding of the character of the building was present when was needed to decide where the cooling and ventilation ducts systems should cross, be placed, and where they meet the skin of the volume to reach the exterior to bread.

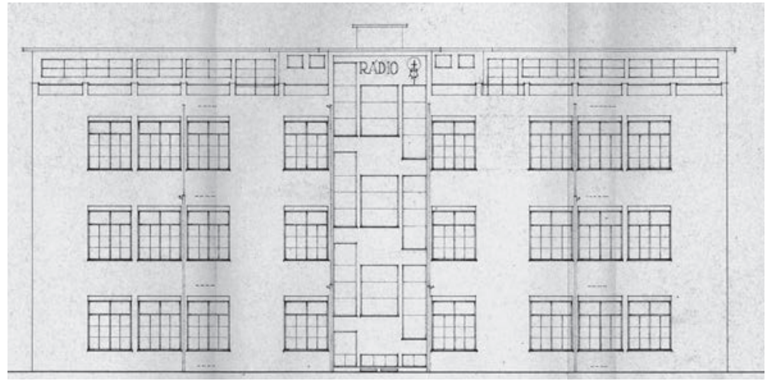

Fig. 5: Carlos Ramos. Radium Pavilion. Portuguese Institute of Oncology.Lisbon. Portugal.1933. South facade. © IPO Archive. Daniela Arnaut

Fig. 6: Radium Pavilion. Portuguese Institute of Oncology.Lisbon. Portugal.1975. South facade. © IPO Archive. Daniela Arnaut

As a result for the need of more space, the new floor compromised the compositional hierarchy established through the higher volume containing the stairs, placed on the central axis of the south facade. As is possible to identify from image 5 and 6 the added windows follow the alignment form the ones below, however don't respect the proportion of the previous ones. Two doors were added on the ground floor symmetrically to the central axis of the volume adding new circulations paths.

The modernist functional skin mirror of functional interior needs, strategies and materials was compromised. In 2013 Radium Pavilion was established as "Monum ent of Public Interest" by the Portaria n° 389/2013, Artº. 1, recognized as a national cultural value. For any intervention the Decreto-Lei n° 140/2009 defines a list of procedures. The "Protection Zone", defined in Artº. 2 aim to maintain the viewpoints that allow the buildings perception and functional relations between them.

IV. Final discussion

Still in use Radium Pavilion economic viability is assured, and its cultural value is identified. (Fig. 7)

The historical tangible significance of IPO is, especially known through the wide spread importance of Radium Pavilion, based on the modern movement principles of "technical experimentation based on the possibilities of new building materials. […] formal

Fig. 7: Radium Pavilion. Portuguese Institute of Oncology.Lisbon. Portugal. June 2017. South facade. © Daniela Arnaut Archive. Daniela Arnaut

Fig. 8: Radium Pavilion. Portuguese Institute of Oncology. Lisbon. Portugal. June 2017. North facade. © Daniela Arnaut Archive. Daniela Arnaut

investigation […], referenced to the machine metaphor and a somewhat abstract aesthetic. […] a strong ideological component and policy supported on the belief that architecture could function as a social condenser" [XIX] .

This was converted on the classification of the Radium Pavilion as "Monument of Public Interest", and on the establishment of a "Protection Zone". On one hand, the Government played its role on its primary mission "to protect and value the cultural heritage as primary instrument for achieving human dignity, and its fundamental rights, in service of culture democratization, and support of independence and national identity"[XX]. On the other hand this classification didn´t lead to any constraints, or obligatory demand to return to its original design. Are healthcare buildings "beyond" legal restrictions? Does medical assistance prevail above heritage cultural value? Roberta Grignolo stated that legislation can be a "straitjacket", since it adds another layer of invasive legislation and regulations, where "the relationship between technical standards and the opposing requirements intended to protect architectural values, evolves episodically and on the basis of negotiation"[XXI] , for Radium Pavilion there wasn´t any negotiation.

If "resilience" is the quality to recover and overcome adversity after the transformation of the original form, the question is if it is to Radium Pavilion, would its economic viability be in danger? Would it be possible to re-use, and re-think the modernist functional facade, as mirror of new functional interior layouts, infrastructures and materials guided by an overall approach? Would it be possible to distinguish its original architectural character? From what fieldwork survey and the collection of personal statements showed it is possible, but only if planning and professional architectural guidance is established.

As Alexandre Alves Costa states from Fernando Távora "The introduction of new functions or even the new environmental needs and comfort, withdraw the object to 'be eternal' from abstract neutrality and put contemporaneity as a paralleled and mandatory issue." […] "The sediments sequence […] Exist, are present, are readable and constitute de scenery that defines and qualifies the space where we live our contemporaneity"[XXII]. (Fig. 8)

All the transcriptions are free translations from the specified references.

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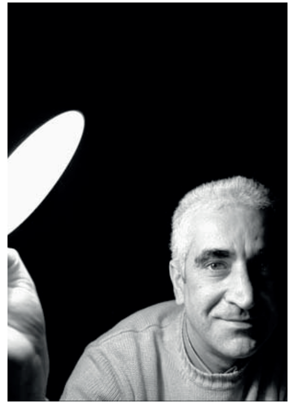

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Fig. 1 Salinas and S. Roque Canal in early 20th century.; Ed. Alberto Malva, Lisboa, SD. Colecção F. Moraes Sarmento. http://aveiro-espaco-tempo-memoria.blogspot.pt/2011/11/canal-de-s-roque.html

Dialogue with the community and photo elicitation for reuse of modern buildings design studios: a pedagogical experience

Abstract

The re-use of modernists buildings is one of todays architectural challenges, considering the necessity of transforming the functionalist response set up by modern architecture, between the 1920s and 1970s. In this sense, the architecture schools need to develop supplementary design methodologies to provide students with tools that could help them to face this new problem, in order to achieve a more responsible architecture.

In the frame of the Erasmus research project, Re-Use of Modernist Buildings, design studios at the university of Coimbra are working with other teachers from social sciences, as Anthropology, Sociology, and Geography. The aim is to put students in open dialogue with stakeholders to develop a participatory process.

More than co-designing solutions, the stakeholders, as users of the buildings, should share with the students ventures concerning theirs everyday life, their memories, theirs practices, in other words, the images and the voices that are part of that building. In fact, a building is not only a physical structure but also a life container, and that should also be part of the project.

During the last year, Design Studio 1C, explored with the unit Anthropology, Culture and Architecture, the integration of photo-elicitation in the design process, namely in meetings with the former users and workers of the Vitasal Industrial Complex.

This paper will explore two dimensions: firstly, the relevance of photo-elicitation for architectural design; secondly, the reflection on the pedagogical experience developed with architecture students, using their work, namely the project portfolio, where the design process of the two units is articulated.

To conclude, the paper aims to characterize the photo-elicitation as a tool for architectural design, in order to train the social responsibility of the architect, because, “to know is to understand” (Filgueiras, 1985).

Design process // Design methodologies // Pedagogical collaborations // Photo-elicitation // Ethnography

The reuse of modern buildings and the design studio teaching

Architecture is both the study of a specific type of construction, a building made according some aesthetic or philosophical consideration, and a practice, namely the practice of architectural design. Architecture as the study of previously constructed buildings is an analytic activity, and states that the knowledge in architecture is embedded in the erected building; the task of knowledge production comes from assessing the building, its social and urban performance, and other analytic criteria. Diversely, architectural design is a practice related to forecast the future, as the project design is literally projected, and starts with a program or general intent; architectural projection (Evans 2000, Gatt e Ingold 2013) is typically an activity in which the synthesis of form and program are the main topics to work in. This difference between studying already existing architecture and projecting architecture has strong epistemological implications, as in the first case the assertions of the study may be supported in reality, and in the second case there is no such condition, as the project is about something that do not has physical existence yet - the only comment is about the coherence between form and program, adequacy to the context, the quality of detailed construction, and other values relating the projective character of the project.

But what about projecting over existing buildings? We could think that working in already existing buildings could be just a variation of the studies on analytic architecture: to study comprehensively the history, context, and other topics of architectural analysis. But that wouldn't allow us to achieve the project, the forecasting dimension that implies a new subject emerging from former stuff – the design result would be only specific technical recommendations that wouldn't construct an architectural project. Therefore, projecting the re-use for already existing buildings is, mostly, an architectural projective task: it should start with an idea, or architectural hypothesis, and then construct progressively the project taking account of the former building qualities and potentials. And it's precisely this "taking account of the former building" that makes a huge difference in terms of architectural design. Because it implies both an assessment about specific qualities of the subject that the design-process may highlight, as well as forecasting of how to incorporate those qualities in a new design. And what does buildings reuse, as building assessment and architectural projection, bring to architectural design methodologies and design studio teaching?
Teaching architectural design is about teaching some specific skills and respective tools: skills of observation and reasoning on what have been observed, skills on drawing and projecting, in a word skills on learning through a reflexive practice (Schön 1983, Schön 1985, Kolb 1984). In the specific case where the knowledge about the architectural subject and the possibilities of projecting it merges in a single action, new design tools are necessary: design tools that allow mediating the past of the building with its projection in the future.

Pedagogical experience to renovate Vitasal modern factory, as a centre for salt studies

Design Studio 1C of the Integrated Master in Architecture, of the University of Coimbra, is part of the RMB Erasmus Project and has been addressing the Reuse of Modernist Buildings topics for several years in order to face with students two main architectural challenges – transform out-dated buildings from the modern period with methodologies that include users in the design process.
In this sense, the pedagogy is more focused on the concepts, methods and tools and not so much on the results. Communitarian facilities, democratic spaces, multifunctional programmes, adaptability, collaboration, participation, co-design, photos, models or maps became keywords to explore the goals of a pedagogical experience that is not new, but is most of the time out of the architects training.

To work with students on the reuse of buildings designed in the modern period (1920-1970), we understood that an interdisciplinary perspective should be introduced. So, to understand the society, we ask the collaboration of Anthropology, to deal with the environment, we join the Geography course, and to work with the existing building, we did a partnership with a construction course – Theories and Practices of Reconstruction. With Anthropology, students learn how to dialogue with users, with Geography, how to map the territory and with Reconstruction, how to survey and to "touch" the building .

The 4th year Reuse Design Study identified in Aveiro a ruin of a modern factory built in the 1950s to transform salt into a commercial product, as a relevant case study to develop a pedagogical experience. Students were challenged to rethink the relation between the city and "salinas" (salt pan or salt flat), taking Vitasal renovation as a starting point. The renovation should not only explore the physical approach, but also the social one, looking for activities that might establish new bridges between the city, the people and the salt. In this sense, salt became the main theme, as a product that could also be part of the memory and identity of the city, and could also be part of its future.

Aveiro is a city located in the banks of the biggest natural sea lagoon in Portugal, known as "Ria de Aveiro", with a strong relation with water. Several water canals extend the sea to the urban fabric promoting a "venezian" landscape. This canals were also the support for an industrial activity, related to the port, to the salt and to ceramics. The salt activity was explored in the "salinas", just in front of the city centre, creating a structure of plots and pathways that was a continuation of the urban fabric. In the end of the 20th century this industry collapsed and the "salinas" were abandoned. (Fig. 1)

Considering the relevant activity of the University of Aveiro in the research on salt, we proposed students to reuse the factory for a Centre for Salt Studies, according to three main functions: research, culture and social. The research spaces could bring the university to the other part of the city, creating a new polo, and establishing a link with everyday activities; the cultural spaces, could explore the salt as an element of Aveiro identity; the social spaces, could bring people to Vitasal area and activate again the S. Roque canal.

The Vitasal complex is constituted by three different buildings with precise functions. The main building combines the administration, in a standard modernist block following the image of "Villa Savoye" (1929), and the industrial area, with a pavilion organized by an amazing structure of three barrel vaults built of masonry and

Fig. 2 Front façade of Vitasal, designed in 1955 by Eng. Elísio Souto Moura. Photo by Gonçalo Canto Moniz

Fig. 3 Vitasal structure of three barrel. Photo by Gonçalo Canto Moniz

concrete, as "Maison Jaoul" (1956). The other two buildings are more traditional, but with some interesting elements. One is a structure to cover water tanks to hygiene salt and the other is only a huge warehouse with a hybrid structure of concrete, masonry and tiles. (Fig. 2, 3)

The project was developed in three stages. Firstly, organised in four groups, students proposed themselves to study the "history", the "social", the "water" and the "territory", starting to understand the object from an urban perspective. The geography course Physical Supports for Architecture introduce the students to the complex environment of Aveiro, a flat city built 19m above sea level. The groups used the theme to analyse Aveiro and Vitasal, and also to propose an urban strategy, as we can see very clearly in the group A, where a new canal creates opportunities to rethink the relation of Vitasal with S. Roque Canal. Secondly, working individually, but still organised by groups, students start to explore the programme in close dialogue with a community of people from Vitasal neighbourhood in a participatory meeting held at the parish house. Thirdly, the students realised a survey of the three existing buildings identifying the constructive systems and the materials in order to know and to understand these structures. The construction course Theories and Practice of Reconstruction promote a strong conscious of the building qualities to inform the transformation

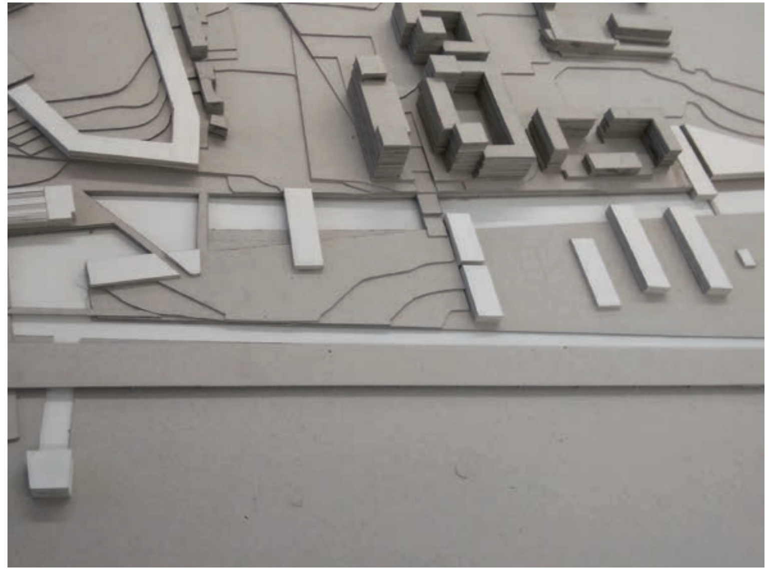

Fig. 4 Canal for students polo parallel to S. Roque Canal. Proposal by Group "Water".

process. The proposals reorganize the territory by exploring the relations with two main elements: S. Roque Canal, by promoting its continuity with the "salinas" through pathways; "Senhor das Barrocas" chapel, by developing a new urban and park area. In this sense, the proposal tried to link Vitasal and the new Centre for Salt Studies with different areas of the city considering that it could act as engine of urban regeneration. (Fig. 4)

Students reinvent the programme of the Centre for Salt Studies with a space organization that could not only be used by the people that will work in the institution, but also be open to the neighbourhood through a library, an auditorium, an exhibition area, a canteen or

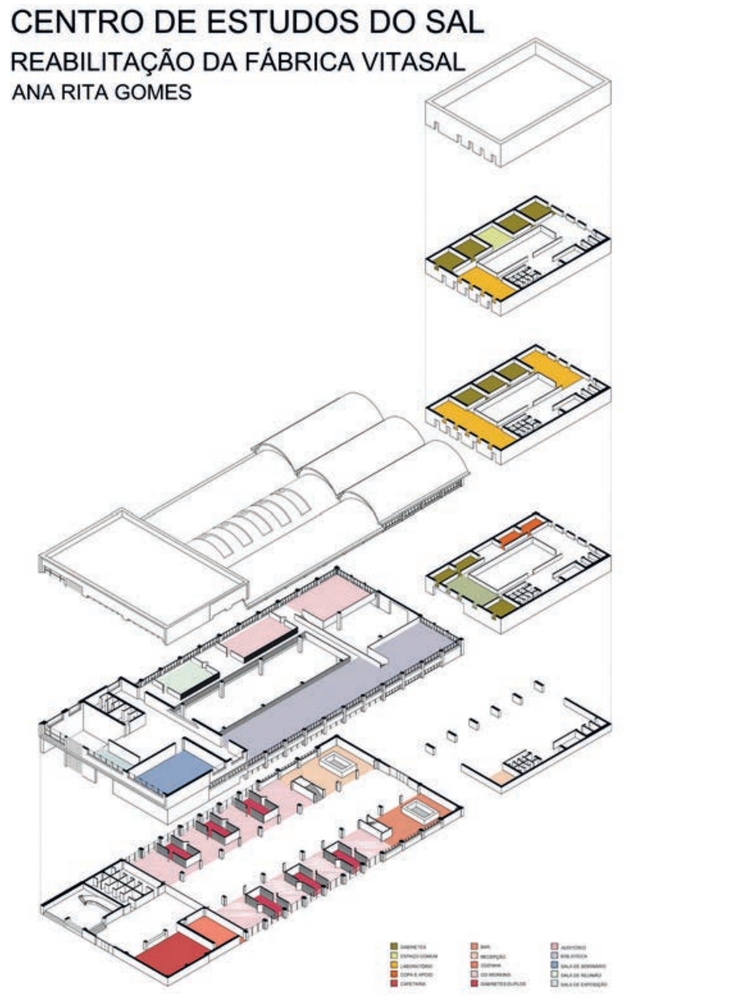

Fig. 5 Co-working and laboratories of the Centre for Salt Studies. Project by Rita Gomes.

even places to co-working. This educational facility became more communitarian and the city became also a learning space.
These urban approaches to the building renovation had also impact in the reconstruction criteria of the existing buildings, where students had to choose, either to keep it close to the original or to introduce a contemporary skin. (Fig. 5)

Photographic images as social mediators in architectural design: the dialogue with the community

The participatory process developed with the students of architecture and the community took place in two moments. One, in the beginning of the pedagogical experience, when students visited Vitasal, Canal de S. Roque and "Salinas" with Mr. João do Instrumento, a former worker of the salt pans, known as "marnoto". The experience was relevant to understand better this activity but also to understand the relation of the citizens with the transformations that occurred in the last decades with the collapse of this industry and also the recent new business that are activating the "Salinas". (Fig. 6)

The second activity was shared with the course of Anthropology, Culture and Architecture, when the students start to go from the urban issues to the programmatic ones. The interaction with social sciences approach is imperative to give students the concepts, the methodologies and the tools to dialogue with the communities and to integrate it in the design process.

In fact, in last decades, collaborations between architecture and social sciences have been thought as a way of rethink both

Fig. 6 Visit to Salinas with Mr. João do Instrumento, former "marnoto". Photo by Gonçalo Canto Moniz

disciplines and reconfigure their practices. In 1997, Neil Leach supports that architecture needs to take seriously cultural and social theory, traditionally outside of its domain, to self-critically revaluate and transform their own processes and history. On another way, anthropologists are reconfiguring their research methodologies through collaborations with architects (Estalella e Criado, 2016; Marcus, 2009).

Interested in the experimental reformulation of ethnographic research, George Marcus (2009) notes that graduate courses of anthropology are important places to the renewal of the discipline. Likewise, design studio courses in architectural schools are relevant

Fig. 7 Photo-elicitation session with students, users, workers and citizens. Photo by Sandra Xavier.

contexts to creatively work new design practices and methodologies and collaborations with social sciences could be a way to do that.
At architecture course of the University of Coimbra, design studio and anthropology units worked long time separately, but last year this situation changed and new challenges emerged for both. For design studio teacher, the aim was not to reproduce the traditional and instrumental relation with social sciences, asking them to give to architects information about the users and their necessities, but to reconfigure design process, not only through anthropology, but also in relation with stakeholders in a participatory endeavour. For the anthropology teacher, this collaboration with design studio represents an opportunity to experiment emergent ethnographic research methods and new forms to do anthropology. If ethnography is traditionally a solitary practice of research and writing, the course gave students some digital tools for collaborative work, like they used to do in design process (about this subject see also Otto e Smith 2013). Traditionally, ethnographic methods are used to study the present and, sometimes, the past of social and cultural groups, but not to collaborate with them in the production of the future (see again Otto e Smith 2013).

The meeting organized last year by the design studio teacher with the former users and workers of the Vitasal industrial complex and of the "Salinas" was an opportunity to change this. In this meeting, students talked with stakeholders about the past and the present of the industrial complex, but also about its future. They used some photographs of the complex to elicit information about past and present experiences and worldviews of the users and picked out other photos in internet to discuss with them the future the students imagined for the complex. (Fig. 7)

The students were introduced to this methodology by the professor of Sociology, Paulo Peixoto, who is member of the RMB project. Peixoto explained students that conducting photo-interviews is very different from just interviewing, as it evolves from a verbal to a visual-verbal relationship. Images, by comparison to words, evoke the deeper elements and feelings of people's consciousness. A methodological perspective that introduces a verbal visual relationship will provoke a deeper involvement of the interviewee and the interviewer. The verbal visual relationship makes the sensory experiences more complex and favours the effects of

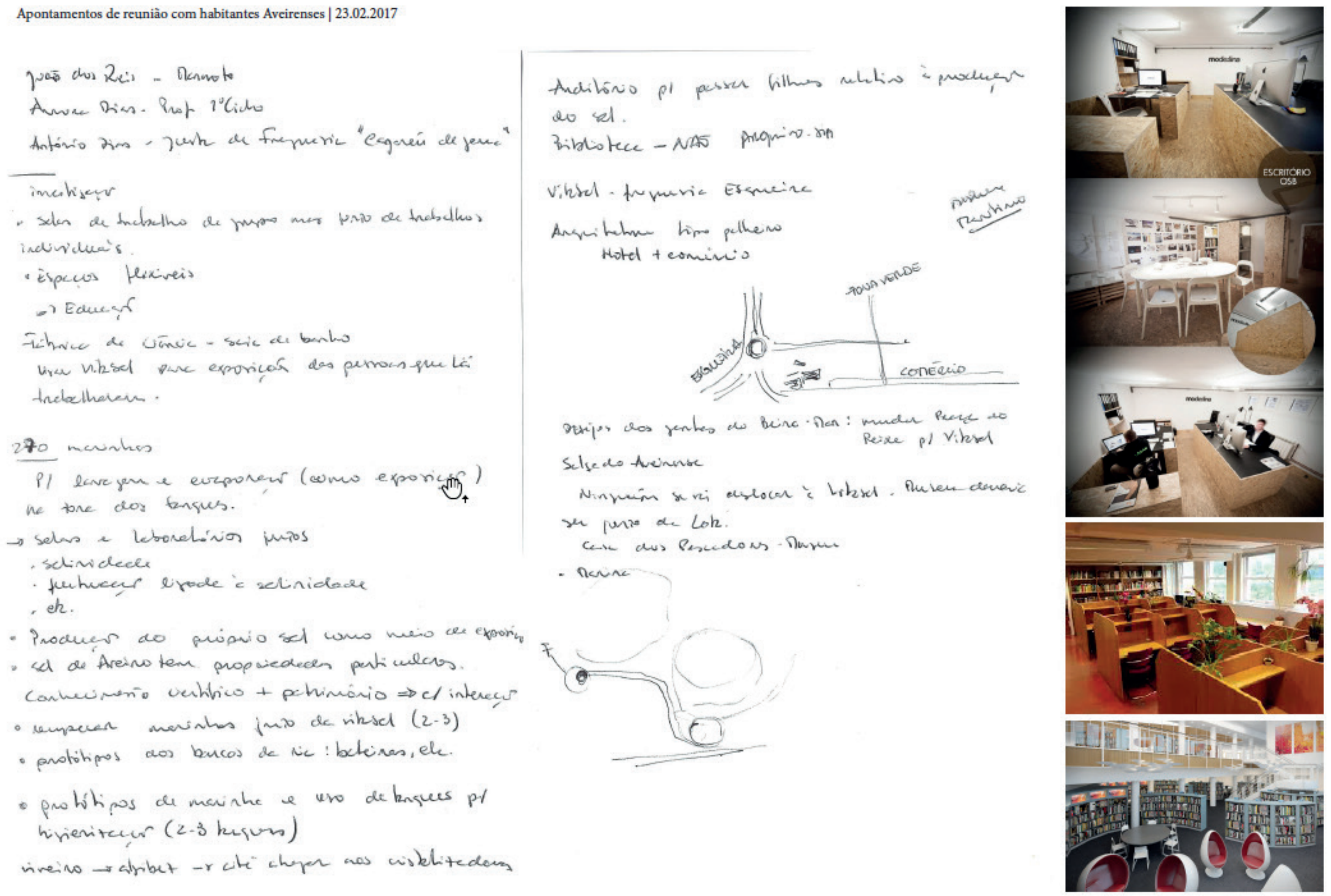

Fig. 8 Skecthbook with photos for elicitation and notes from the meeting. Notes by Jael Simões.

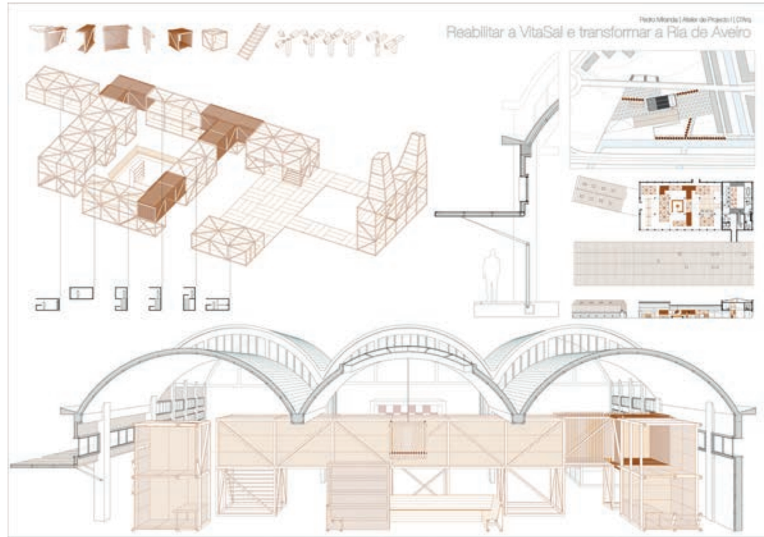

Fig. 9 Exhibition wood structure in Vitasal. Proposal by Pedro Miranda.

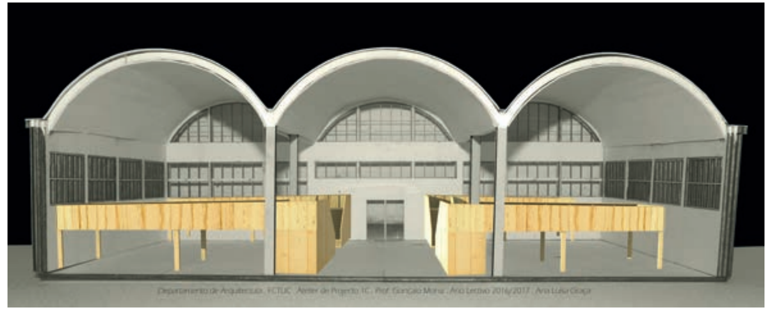

Fig.10 Working room modules in Vitasal. Proposal by Ana Luisa Graça.

contextualization, allowing a better fit of the descriptions in time and space (Harper, 2002). The temporality of the photos is always a crucial element of the photo-elicitation.

In fact, during the meeting, the former users and workers of the complex didn't look much to the photos, but listened attentively the students and talked profusely with them about their questions. The photos were only the starting point long history archived in their memories or the critic to the society that abandoned the salt and the Salinas to support the urban development or, more recently, the tourism. (Fig. 8)

After the meeting, the students tried to use this dialogue with stakeholders to define the programme of intervention in Vitasal building. It wasn't easy and it's never a direct connection between words and drawings. The main topic was the scepticism with the renovation of Vitasal, clarifying that it was not possible to bring the past back to the future. But, some underline the necessity to keep the memory of those heroic times. The students understood that Vitasal should remain and integrate either a flexible exhibition area about the "Salinas", a collaborative laboratory to do research about salt or a social and communitarian place to promote the relationships between "marnotos" and the new citizens of the Canal S. Roque. (Fig. 9, 10)

We could say that they used ethnography (the description and interpretation of the cultural meaning of things) and social science tools, as photo-elicitation, to do architecture. But we could also say that the dialogue with stakeholders about the future of the building, inspired in participatory processes, could also be used to do ethnography, to describe and interpret the cultures of people involved. Or in another words, the student tried to do architecture trough ethnography and ethnography through architecture.

In this pedagogical experience, it was difficult for students to articulate design studio with anthropology work. I asked students to write about the meeting and the experiences, memories, values and viewpoints of participants. From an anthropological point of view was missing social and physical proximity and a longer involvement with stakeholders to better interpret the culture meanings produced through design process. Nevertheless, this initial collaboration between design studio and anthropology unit was essential to rework processes, practices and methodologies of both disciplines and to rethink new forms of collaboration to develop, as Tim Ingold (2000) suggests, a building design through the practice of dwelling and sharing everyday life with stakeholders.

Conclusion

At Coimbra School of Architecture, we have been searching for the role that photographic images may have as mediating objects between past and future of buildings, between memory and invention, between architectural students and building stakeholders, as photographic images are both tools for ethnography and artefact production, allowing to articulate both a documentary and a projective design dimension.

A deeper understanding of the role that photographic images taken by students on a site visit, images of site and building construction collected in institutional archives, or images that local dwellers bring from family albums to the design process, may be incorporated in the architectural design through narrative constructions. This “visual methodology” or design tool, that could be described as a special mode of photo elicitation (Rose 2007), is still to be fully explored, but even so it has already demonstrated its impact on a more comprehensive design, attentive to projecting imagined possibilities from a material survey or ethnography.

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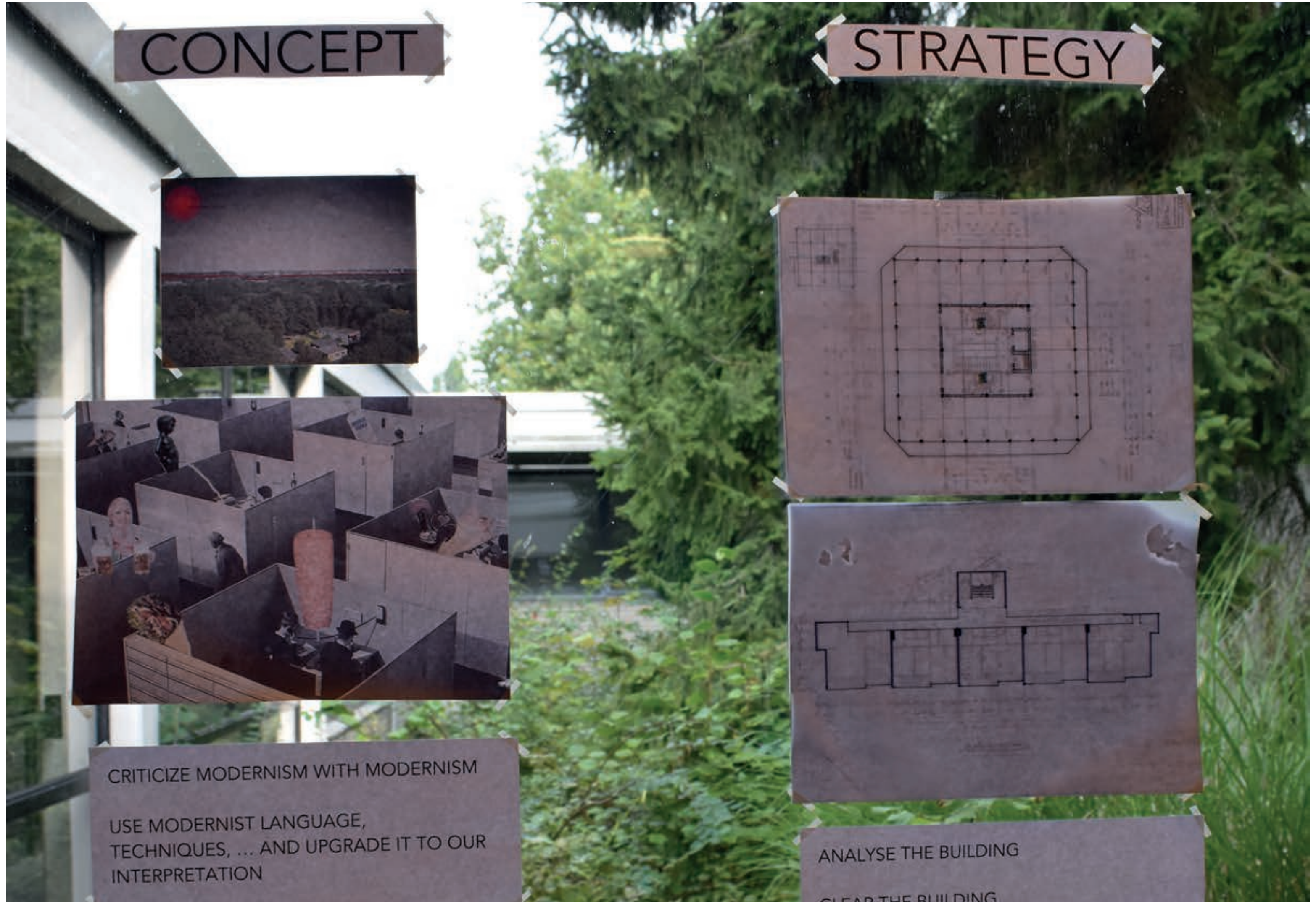


Reuse and education

The role of co-curricular activities in architectural education.The informal design studio

Abstract

This paper aims at reflecting about the role of co-curricular activities in Architectural Education, such as Informal Design Studios (IDS). IDS are learning experiences that happen out of the class and off campus and transcends curricular learning and conventional architectural design teaching, with the main purpose of encouraging positive engagement and motivation among students, collaborative work and openness to new thinking styles, thus creating the conditions for agentic learning to emerge (Bandura, 2008). Agentic learning is defined as self-directed actions aimed at students' personal growth and incremental development of their capacities and competences.
This paper attempts to place IDS within this definition and to identify various roles that this type of learning strategies might play in the "Re-use of modernist buildings - Design tools for sustainable transformations" (RMB) curriculum framework.
The paper is organized in three parts. The first one discusses the application of IDS learning strategy as a tool of architectural education. The second one proposes a framework to better leverage the potential of IDS within the RMB curricula framework and the third part evaluates the first IDS experience carried out as part of the RMB project. The paper concludes by outlining the main difficulties that involve the inclusion of IDS into the RMB curriculum framework.

Introduction

Architectural design studios (ADS) are considered to be the core component of architectural education: a learning environment, which is both an educational setting and a pedagogical model, where students are engaged in a process of finding solutions to assigned design problems, whether real or fictitious, following a practice-based models of education supported on instructor-to-student and student-to-student interaction. At ADS students have the opportunity to share tacit knowledge and experiences and develop critical thinking, which complements their academic formation.

ADS follow a relatively homogeneous framework that was originated in the late 19th century based on the apprenticeship learning model where students learnt to become architects through physical integration into the professional practice environment: a mix of engaging in the work of an architectural office, observing and being informally taught and trained by a master architect.

In recent years, there have been significant challenges in architectural education, as architecture schools are facing vocal pressure for change. Particularly significant is the need to prepare students as future practitioners to deal with the complexity and diversity of new problems involved in the (re)construction of contemporary urban territories and their built spaces, that are affecting their social, environmental and economic performance, including the adaptive reuse of buildings and sites. Also relevant is the changing context of architectural practice and market demand for architectural services, and advances in project procurement and delivery. This call for change indicates the need for the reorientation of architectural design education toward an engaging policy that contemplates both the social and the technical responsibility of architects.

This changing context pressures the various domains of architectural education, including the design studio pedagogical model. Educating students to become architects involves more than just inculcating theoretical, practical and experimental knowledge, awareness and fundamental design competences such as graphic, technical, verbal and writing skills, defined in the course documents as learning outcomes. Besides its multi-dimensional nature architectural education has a powerful 'hidden curriculum' that socializes and acculturates students into the values – ethic, motivational and aesthetic - and cultural practices of the discipline, which cannot be disregarded.

It is argued that the training of architecture students and future practitioners implies educational experiences that are challenging and enriching and that extend their academic abilities. This implies Agentic learning environments (Bandura, 1997), i.e, conditions capable to foster students' personal growth and incremental development of their capacities and competences towards architectural practice.

Formal education tools such as ADS do not seem per se to be flexible enough to respond to these new challenges. New learning strategies and methodologies that educators can engage are desired so that architectural education can evolve to remain relevant. Co-curricular activities, such as Informal Design Studios (IDS) due to their time-scale and other specificities seem to be an alternative tool to transfer and implement educational objectives into a learning practice, which proactively engages participants in collaborative processes.

IDS are defined as learning environments that promote learning relationships, interaction and exchange of information in short-term period. These are learning experiences that occur out of the class and off campus in an environment away from restrictions and formal processes and are attended on a voluntary basis. Informality transcends curricular learning and conventional ADS.

IDS are in line with living labs' framework by integrating inputs from practitioners and local stakeholders, together with specific community attributes, into the co-creation and co-production of solutions.

Within the IDS context, architecture students initiate actions that may drive their learning path and engagement with real-world problem solving as they progress through reflexive competencies. When students are reflecting, questioning, conjecturing, evaluating, and making connections between ideas, they are engaged and gain self-confidence.

The paper is organized in three parts. The first one discusses the application of IDS learning strategy as a tool of architectural education. An approximation between the notion of agentic learning, as proposed by Albert Bandura (1986, 1997) with David Kolb's (1984) Experiential Learning Style Theory and Donald Schön's (1991) concept of reflective practice is explored as theoretical support. David Kolb's experiential learning theory and Donald Schön's theory of action perspective complement each other and together raise important questions for study in this area, thus helping to explain and justify the IDS pedagogical model. The second part proposes a framework to better leverage the potential of IDS within the RMB curricula framework, by confronting students with real situations involving the adaptive reuse of post war buildings and sites. Adaptive reuse poses quite difficult challenges for designers and requires different skills and sensitivities than regular design from scratch; therefore different kinds of knowledge, design tools, and design processes are needed to cope with such projects. The third part evaluates the first IDS experience carried out within the RMB framework. The paper concludes by outlining the main difficulties that involve the inclusion of IDS into the RMB curriculum framework.

IDS learning strategy as a tool of architectural education

Recent scientific findings in the field of cognitive neuroscience are calling into question some of the learning methodologies commonly used to date, while providing clear and irrefutable evidence on how new learning dynamics that really transform the mind of human beings can be generated. Architectural education practice cannot distance itself from these findings.

Evidence reveals that students learn better when they get emotional. The master mechanism of human brain is emotion. Emotions reinforce memory. Memories are recorded in different ways and in different areas of human brain depending on whether or not there is an emotional context. Also curiosity has a great potential to make human brains more receptive to learning (Gruber et alt, 2014), as it alters the chemistry of human brains, causes the release of dopamine, activates the reward system, and enhance the ability to learn. Curious students learn more quickly and are able to recall more information. The quotient of curiosity is a recently introduced variable. Unlike the intelligence quotient, which is difficult to be trained, the quotient of curiosity can be developed. Such experimental findings cannot be ignored when designing architectural learning experiences.

Student engagement, described as the tendency to be behaviourally, emotionally, and cognitively involved in academic activities, is a key construct in learning motivation research (Lay, 2011). Emphasis is given to the need of providing students with learning environments that allow them experimenting and testing different solutions under uncertainty contexts and make decisions. Active learning in groups, peer relationships, and social skills are key components to engagement and motivation, which can add unique level of value to the overall educational experience.

Bandura (1997, 2008) examined more specifically the role of agency and motivation in learning, and coined the term Agentic learner to distinguish self-confidence and self-reflective students potentials. Accordingly students who are confident and reflective demonstrate abilities to experiment (and test) by generating alternative courses of action when initial success is not met; enhanced functioning through elevated levels of effort and persistence as well as ability to deal with a problem situation by influencing cognitive and emotional processes related to the situation.

Both Kolb (1984) and Schon (1991) argue that action and reflection are on the basis of learning and cannot be isolated from experience; it is part of a cycle. For Kolb (1984, p. 38) “Learning is the process whereby knowledge is created through the transformation of experience”: a cycle of experiencing, reflecting, thinking, and acting. Immediate or concrete experiences lead to observations and reflections. These reflections are then assimilated (absorbed and translated) into abstract concepts with implications for action, which the person can actively test and experiment with, which in turn enable the creation of new experiences. According to Kolb, knowledge is created, i.e., learning occurs, through a combination of grasping experience and then transforming it. The simple perception (or grasp of experience) is not sufficient for learning; something must be done with the experience. Experience is grasped either through comprehension or apprehension. Comprehension refers to conceptual interpretation and symbolic representation whereas apprehension refers to the awareness provide along the immediate experience. These two processes represent two modes of knowing and are most recently supported by research on the field of neurosciences.

Central to Schön’s understanding of architectural learning is the necessity to engage students in studio-based projects that simulated the complexities of real life projects and at same time foster reflection along the design process with the ‘expert’ thinking of their instructors. Schön divided reflection into two parts: reflection “in” and “on” action. Both include experience followed by reflection and the generation of hypotheses or experimental conclusions that allows students to observe and re-align their thinking to be applied to further experience. The more architecture students reflect on action, the better they develop expert tacit knowledge. The role of the instructor/educator is to provide interventions that help students develop skills of reflection on their work by applying “theories-in-use” (tacit Knowledge) and to learn to change it in ways more congruent with the values they adopt. Learning occurs as students acquire new theories-in-use and the competence to manage the learning process on their own including the detection and correction of error on design decisions.

Within the architectural design process reflection involves thinking about both the context (concrete experience) and the intervention (active experimentation). When students pass from thinking about their experiences to interpreting them, they enter into the realm of

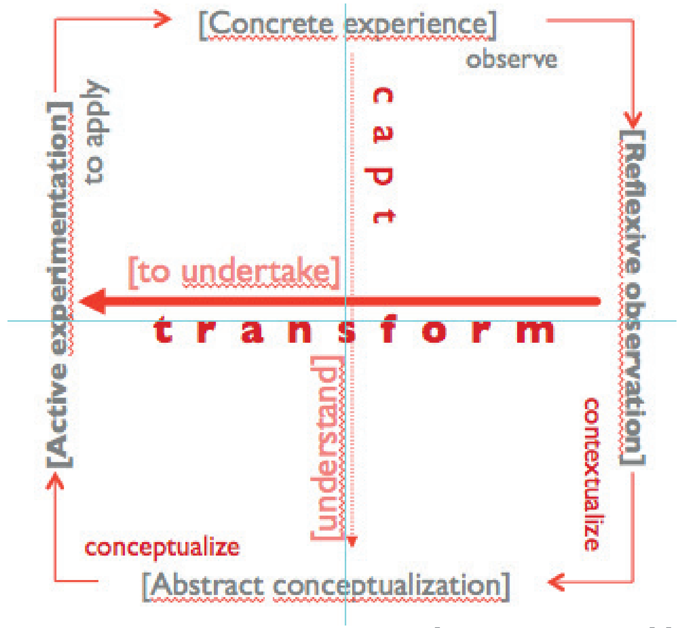


Fig. 1 Structural dimensions of [reflection in action] [Kolb conceptual model] cognitive psychology. After Kolb, D. (1984)

what Kolb termed 'conceptualization' stage. To conceptualize is to generate a hypothesis about the meaning of the experiences. In the active experimentation stage of the learning cycle students effectively 'test' the hypotheses they have adopted. The new experiences will either support or challenge these hypotheses. To learn from experiences it is not sufficient just to have the concrete and the active experiences. This will only take students into stage 1 of the cycle. Rather, any experience has the potential to yield learning, but only if students pass through all Kolb's stages by reflecting on their experiences, interpreting them and testing their interpretations.

IDS as part of the RMB curriculum framework

Within the RMB curriculum framework, IDS are outlined as periodic didactic experiments joining students and staff form the 5 schools of the RMB consortium. They are planned to last for 4-5 full-days and to involve between 25 and 40 students. Students are organized in groups, which are formed at random (from 5 to 8 students) with at least one student from each school. A dedicated website helps with student enrollment, the making up of groups and the spreading out of the supporting materials.

IDS are designed around a complex and provocative problem to challenge students’ understanding on post war buildings and to stimulate research on modern architecture and sustainable technologies. The acquisition of new knowledge about adaptive reuse and refurbishment, energy-efficiency and policy-making is a major goal. IDS learning experience is expected to develop their capacity to deal with this specific type of design problems and to reach solutions in a critical and upholding way. Live projects that engage with real development sites that involve functional, technical and social transformation, in collaboration with non-academic bodies, such as civic associations contribute to promote this strategy.

Students are not previously aware of the specific content of the project, as the objective is to confront them with a non-conventional architectural design exercise. Instructors are not exclusively allocated to each group, but attending all groups in a high flexible manner, contributing with ideas and advices derived from their expertise and professional experience. Open lectures with experts from different fields supply the discussion with various perspectives. This learning strategy is part of a constructive, participative and integrative process that would tear down conventional design methodologies towards a cross-disciplinary approach.

IDS start with a general presentation of the topic, including the site visit and ends whit an exhibit and presentation of the students’

PROCESS

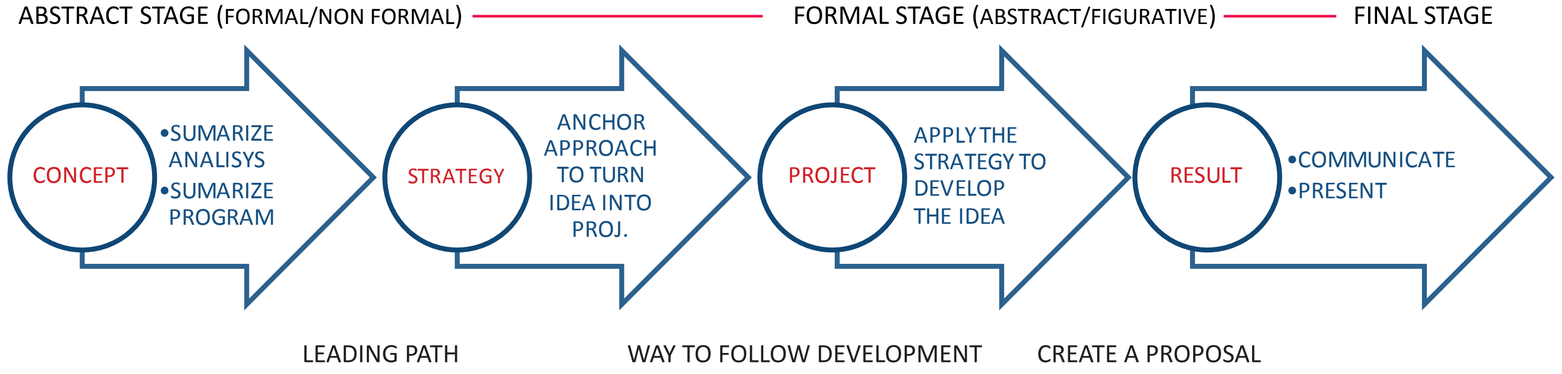
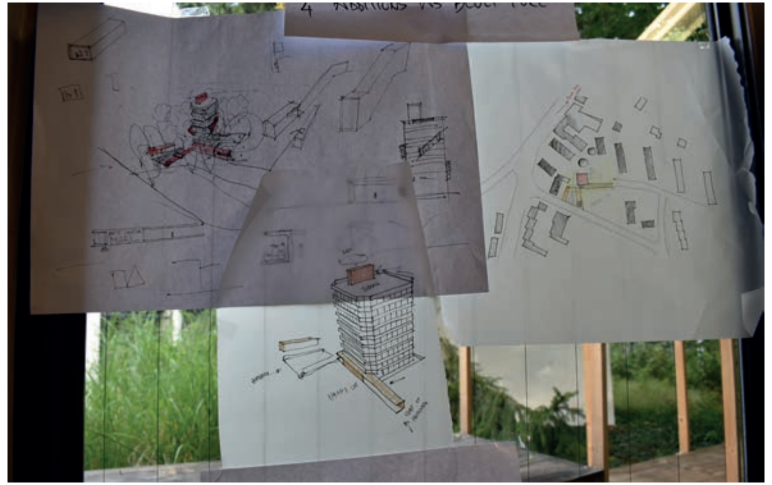


Fig. 2 IDS Learning Framework

proposals. Students' work follows 4 phases, which correspond to pedagogical goals: 1) CONCEPT (2nd day); 2) STRATEGY (3rd day); 3) PROPOSAL (4th day) and 4) RESULT (5th day). Each phase ends with a moment of presentation and collective discussion involving all the students and instructors, accordingly with figure 1.

After having contact with the real site of intervention and attending introductory lectures on the theme students are asked to formulate the problem in its multidimensional condition (theoretical, formal, technical, social) and generate hypotheses that announces the conceptual (abstract) paths to its resolution.
Once creating a conceptual statement to approach the problem, each team is challenge to propose a STRATEGY and tactics of intervention that allows them to support the architectural proposal. At this point, teams should evaluate and synthetize all information they have collected and communicate their approach. This implies a collective effort to establish a well-organized working method that incorporates the diversity of inputs within the group.



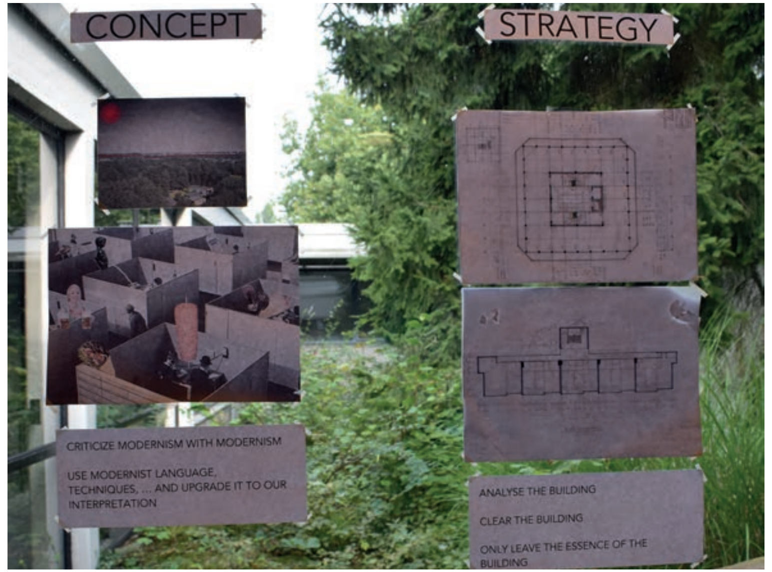


Fig. 3 Conceptual and Strategy team sketches, diagrams and models (RMB Workshop at Marl, 28th Aug-1st Sept 2017)

At the first two phases the role of instructors is critical. Students need to recognize and state the problem in order to identify a concept. They need to move beyond superficial elements and start to think particularly in terms of why and how. It is at this stage of the reflective cycle/spiral that students need to focus on the future, not just reliving the past. Once they have their own explanations they can move on to the next stage in the cycle, namely that of framing action by proposing a strategy to improve "healthy human habitats" in the reuse of modern buildings. There will probably be several different possibilities for action that they might take, and they have to choose, from their experience and knowledge, what they consider to be the most suitable action to take. It is the time to discuss both the project methods and the tools to be applied: technical drawings, models, etc. This gives the support to the next phase: the concrete experience of manipulating, i.e. making the PROJECT. At this phase students learn with each other's and with instructors' experience and critical view, in an environment of trust and complementarity, which contributes to develop specific competencies and expertize combined with a broad spectrum of critical knowledge and interpersonal skills.
The third critical session with instructors is also an important moment of the IDS. It is where proposals are validated at the light of what was promise and previous stated, and at the same time how well it is done. The discussion is moved to another dimension of how to express by drawing and models the fullness of each team ideas. That it is going to enlighten the FINAL PROPOSALS and create the basis of their communication.
IDS end with the confrontation of each team final proposal with a jury, but mostly with the community. The critical appreciation of

Fig. 4 Presentation and discussion (RMB Workshop at Marl)

the RESULTS promotes a valuable discussion between students, instructors and public, where anyone can express their thoughts, developing one environment for learning.

RMB experience: The Marl Evaluation

The first IDS organized in the framework of RMB - An experimental development of new residential and working Environments and typologies in Large-scale Housing project of the post-war era in Marl - took place in Marl, Germany from 28th August to 1st September 2017. It was focused on two different sites that were in a way functionally inappropriate for use or obsolete, with the risk of losing specific cultural elements and environments namely: an Office Tower at Bauturm currently used by Marl city council. In the near future the building will be vacant as the council services are moving to another site. The city council intends to reconvert it into housing; an Housing Estate at Hüls, owned by a housing association. It is in a poor condition with many vacant apartments in need of a large program of investment to keep them up to date at both the building and public space level).
The IDS involved a group of 28 students from Coimbra (8); IST, Lisbon (5); Antwerp (8) and Istambul (7) organized in five groups and 5 instructors. It was held in a former school building, where students were also accommodated.
The first day was occupied with visits to the intervention sites and open talks embracing the topic from various perspectives, including a lecture Recovery, Growth and Innovation in The Netherlands. Post-War Cultural Heritage and Todays Challenges addressed by Anita Blom.
The remaining days were dedicated to design work according to the 4 phases previously referred. A visit to Marl museum of sculpture (Skulpturen Park) and to Marl Hans Scharoun's school (1958) took place in the second and fourth day.

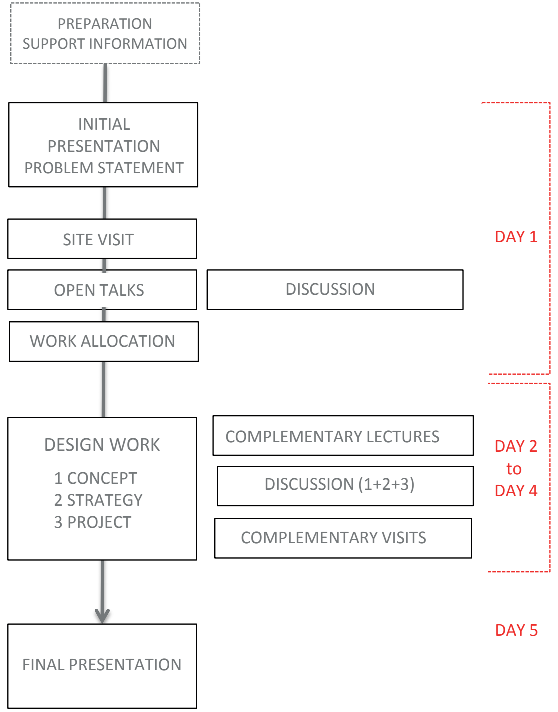


Fig. 5 RMB Workshop at Marl, 28th Aug-1st Sept 2017: timeline

After the IDS students were invited to evaluate their experience, describe what they learned from the IDS experience and how that knowledge was useful. The results of the post event survey show that students mainly report a positive experience. A high percentage

of students found themselves very satisfied with it (87%) as they considered that it offered an intermediate level of knowledge acquisition (75%).
The majority of the students agreed that one interesting feature of the IDS program was the fact that they were organized as small groups, as such, they shared both personal and scholarly experiences and instructors were at their disposition for intellectual discussion.
Considering the overall program, the majority of students consider it was very good or good (68%) and instructors were very knowledgeable or knowledgeable about the topic (68%), offering practical contributes (65% rank it very high or high) and involving appropriate activities (81% rank it very high or high). Open lectures contents were considered very significant (69%).
Particular emphasis was given to the role that creativity took in the exercise (75% listed as very high or high) as well as to the atmosphere created (67%, very good or good), team matching (68%, very good or good) and the team productivity (63%, very good or good).
Students also recognized the role of the IDS experience to enrich and extend their academic abilities, personal growth and capacities. What students learn from participating in the IDS appears primarily to be a function of the interaction between the self, the cognitive strategies, and the literacy skills necessary to navigate the IDS as a research process. Students not only learn more about how to do the academic and social tasks entailed in the IDS, they also view themselves changing as learners.

Conclusions: on the inclusion of IDS into the RMB curriculum framework

The inclusion of informal studios into the RMB+ curricula brings along certain difficulties that increases requirements for preparation and organisation, including extra financing to support students' travel and accommodation.
In terms of IDS preparation emphasis must be focused on documentation, as it is the basis for the study and analysis. The big challenge in the formal analysis of adaptive reuse is the need to consider both the building and the site with their original use and physical structure. Access to project data including site conditions, plans, sections, details and structural systems as well as images of the original use (when available) is critical. In addition, there is the process of transformation or change to consider as well. Adaptive reuse poses quite difficult challenges as changing the functional classification of a building introduces new regulatory conditions and may require rezoning approval. Basic documentation should also refer to the urban context so as to capture the project's urban role and new programmatic requirements.
Past experiences with this type of didactic experiments show that students had different levels of experience and interests and the short-time frame brings out a quite tense situation, through which students have to learn on how to collaborate effectively. IDS are based on group work and there is always the need to avoid negative influences on the group performance. To encourage learning between and among all participants and mitigate these problems, instructors are required to continuously act as facilitators.

Predominantly, serving as pedagogical tools, IDS format allows for an interdisciplinary approach as well as to generate knowledge through co-creation across disciplines and between academics and practice. By bringing together many different competences and expertise it provides new experiences for both students and instructors and may also provide a safe ground for different actors to meet. Moreover they offer a valuable learning opportunity: time-focused activity results in better embracement of the topic and also experience helps in faster learning and better remembering. The short timeframe for results also forces students to learn to collaborate more effectively. Informal studios provide students with an opportunity to get in touch with practice, not only via external informal studios instructors, but also when working on actual topics with real-life outcomes, as the reuse of modern buildings.
Although the shorter time scope of informal studios does not always allow for in-depth details of project elaboration to be gone into, IDS format allows testing the introduction of new topics into the standard curriculum, and appropriate pedagogical tools that enable students to succeed in broader disciplines
IDS deserve to become a part of standard tools in RMB+ curricula. In order to achieve this status, the standard curriculum must be adjusted to allow students to participate in informal studios without having to miss other curricular subjects. Therefore, the general questions for all instructors and lecturers remain how to pick up the right students and how to provide a balanced formulation of workshop assignments?

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facade2017

Nov. 24th // RESILIENCE

facade2017

Nov. 24th // RESILIENCE

Since 2000 (in the beginning 21st Century) climate change and globalisation have influenced the actual world and all societies tremendously and the have also affected the way we are building. Safety and security requirements are increasing and are consequently influencing the design of the building envelope. 'Resilience' describes the function and ability of buildings and their facades to to recover from or adjust easily to change; this can either be in a direct way to specific stresses forced by water, wind, fire, explosion or earthquake but also in an indirect way seen as a general ability of adaptivity to different changes. These issues will be addressed at the conference facade2017 from different academic and professional perspectives.

Hochschule Ostwestfalen-Lippe
University of Applied Sciences

Lucerne University of Applied Sciences and Arts
HOCHSCHULE LUZERN

european facade network

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SCHÜCO

8.30 **Registration**

9.00 **Welcoming & Introduction**
Prof. Ulrike Kerber (Vice President Communication)
Prof. Kathrin Volk (Vice Dean Dept. 1)
Prof. Dr. Uta Pottgiesser, University of Antwerp (Moderation)

Global Challenges

9.15 **Keynote lecture - Challenging Structures and Facades**
Daniel Meyer, Lüchinger + Meyer Bauingenieure AG; Zürich, Switzerland

10.00 **Prospective Challenges in Holistic Façade Design**
Daniel Arztmann, Schüco International / HS OWL; Bielefeld /Detmold, Germany

10.30 **Contextual Resilience - Case Study of Burj Alshaya Centre**
Taeyoung Kim, Korea National University of Arts; Seoul, South Korea

11.00 **Coffee break**

Existing Buildings / RMB Session

11.30 **Keynote Lecture - From Office to Housing. The GAKBuilding became 'de studio'.**
Wessel de Jonge - wessel de jonge architecten bna bv; Rotterdam

12.15 **Holistic Seismic Behavior and Design of Buildings**
Oguz C. Celik, Istanbul Technical University; Istanbul, Turkey

12.45 **Lunch break**

Light Facades / Responsive Facades

13.45 **Keynote lecture - International Trends**
Mikkel K. Kragh, University of Southern Denmark (SDU); Odense, Denmark

14.30 **Climate Responsive Facades and Sustainable Building Materials**
Sanjay Seth, TERI The Energy Research Institute; New Delhi, India

15.00 **Coffee break**

Future Architectural Concepts

15.30 **//**
Robert-Jan van Santen, VS-A Group; Lille, France

16.00 **Transparent Facades for Music Performance Spaces**
Spencer Culhane, Schüco New York; New York, USA

16.30 **Selected Student Posters and Final Discussion**

17.15 **End**

Notes

Daniel Meyer

Dipl. Bauingenieur ETH SIA SWB, Dr. Lüchinger+Meyer Bauingenieure AG; Zürich

Daniel Meyer, born 1962, is a graduated of the Federal Institute of Technology Zurich (ETHZ), Switzerland.

Professional work

Since 1988 he is as consulting engineer in responsible position with Wenaeser&Wolfens-berger Ltd, Zurich and Bollinger&Grohmann Ltd, Frankfurt. In 1995 he founded with
Dr. P. Lüchinger the consulting company Dr. Lüchinger+Meyer Ltd. He is a member of the executive and the management board. He realised a number of projects of housing, industry and bridge construction works in Switzerland as well as on European level.

Special attention is focussed on the conception of structures in team-work together with architects succeeding in numerous national and international design competitions. Special references concern the development of innovative structures such as glass structures.

Education

In addition to the professional work as structural engineer a special engagement is devoted to the formation of students. From 2003 to 2010 he was the head of the competence centre for glass and lightweight construction at the University of Applied Sciences of Lucerne. Since 2011 he is responsible for the architectural master course at the University of Applied Sciences of Zürich in the field of structures and façades.

Membership

Daniel Meyer is a member of the Swiss association of architects and engineers (SIA) and since 2009 an insider and vice president of the board of directors.

Fig. 1: rendering of the spiral, founders hall and historic buildings (courtesy of BIG)

Challenging structures and facades

D. Meyer, Ph. Willareth, A. Gianoli, R. Furrer (Dr. Lüchinger+Meyer Bauingenieure AG)

Abstract

The article, which reflects the close collaboration of the designers, engineers and researchers presents two projects with challenging structures and facades.

The museum “La Maison des Fondateurs” in Le Brassus, Switzerland will represent the watch making manufacture Audemars Piguet. Audemars Piguet stands for the finest quality, precision as well as innovation based on traditional watchmaking expertise and craftsmanship. The design is based on interlocking spirals formed by glass walls evolving out of the rough, natural landscape. The spirals provide a perfect linear museum path for the building program.
Despite the severe loading and weather conditions and inspired by the high values of Audemars Piguet, the project team designed the building to the limits of what is technically possible. The curved and very large insulated façade glass units, as well as the curved glass partition walls of the interlocking glass spiral are forming the load bearing structure. All vertical and horizontal loads are transferred by these glass components making solid columns and shear wall obsolete.

The new ITA or Arch-Tec-Lab building at the ETH Zürich will be built on top of an existing underground car parking on the ETH Zurich’s Hönggerberg Campus, resolutely resisting the temptation to use more land resources. The form it takes, dictated by what already exists on-site, the wavy form of the digitally fabricated roof and the open layout of the floor plan all set it apart from conventional research and work facilities. The supporting structure and building technology are exposed and constitute space-forming elements. This approach contributes to the overall technological aesthetic appeal of the building as a whole.

La Maison des Fondateurs

Introduction

During 2013 Audemars Piguet launched an invited competition for a watch museum in Le Brassus, Switzerland. The competition team headed by BIG – Bjarke Ingels Group developed the successful project proposal in an intense, interacting design process. The design team focused on creating a building for Audemars Piguet, which is reflecting the company's values, refereeing to the past and to the future as well as to strengthen the brand with an iconic, sculptural like building close to an architectural emblem. Many options and solutions have been investigated. Finally, the interlocking spiral has been created. The one-story tall spiral is located at the north side of the historical founders building and is directly linked to the new founder's hall, which is positioned between the existing buildings. (Fig. 1)

The geometrically very strong spiral is providing a perfect linear museum path along the company's history as well as watches, and shows a clear analogy to the mechanic of a mechanical watch. Workshops and workplaces of the company's best watchmakers are positioned along this museum path. The materials and structural elements are reduced to the essentials. Glass, brass and cast stone are the predominantly, visually used materials.

Structurally, the lightweight roof is supported only by glass elements for the vertical and horizontal loading. This dematerialized glass structure ensures full transparency throughout the building and façade. (Fig. 2)

Fig. 2: rendering of structural glass elements (courtesy of BIG)

The development from the competition project throughout to the execution phase has been subject to many challenges, such as structural robustness, enhanced durability as well as energy efficiency and sustainability.

Project Fundamentals and Design Process

The essential and most important parameter of the project is the shared vision to create the aspired load bearing all glass structure. This vision has been the base of the successful, interdisciplinary design process. A process, that has been exposed to conflicting parameters and focuses. But exactly the constant work on these parameters is the base of the current, successful execution. It is the execution of a carefully developed and enhanced competition project, preserving the original DNA of the design intend.

Due to the location in the Vallée de Joux with the particular, harsh micro climatic condition, the building is exposed to high snow loads above 5 kN/m2, even doubling locally, and very cold temperatures well below -20°C.

Fig. 3: rendering brass blind (courtesy of BIG)

Sustainability and energy efficiency are imperative design values. Audemars Piguet enhanced these values with a strong commitment to satisfy the Minergie label as minimum. Minergie is a very common Swiss label rating the energy efficiency but paying attention to the user comfort additionally.

These main design drivers illustrate the design challenges. The building structure, formed by the glass elements, has to carry severe loading, and be highly insulated glass walls with premium optical performance. Furthermore, solar control devices have to be implemented to prevent overheating during the warm seasons.

All these objectives are literally wrapped up by an absolute transparent, crisp all glass façade. Triple glazed units (IGUs) are forming the weather skin, providing the water tightness, low air permeability and the thermal insulation. The inner leaves of these triple glazed units are activated as loadbearing elements, proving the vertical and horizontal structural capacity. As an additional element, a brass curtain shades the façade passively but never interfering with eye vision and therefore maintaining the full visual transparency. This brass curtain, a three-dimensional net of individually shaped weaves, is hung above eye level in front of the upper area of the glazing, providing just enough solar protection for comfort and required energy efficiency. (Fig. 3)

The outlined design shows very well how the best solution was developed on these most important building parts and components, satisfying all major parameters. Iterative design steps, constant testing and improving and a dialogue of the designers and engineers based on expertise have been the key factors.

Material and surface qualities

The materialization, respectively the dematerialization is an important part of the project specific design language. The materialization aims for real, raw materials. Materials, that enhance in beauty by aging and building up a natural patina. Untreated brass has been chosen for the visual components such as sun shades and cladding parts, for example cover of roof edge, slabs etc. At the opening, these components will be shiny but darken in different grades due to the natural patina. This patina is a great material characteristic, reducing cleaning demands but also creating esthetic qualities.

The dematerialization depends very much on the glass surface qualities. Surface flaws, such as surface anisotropies and visual distortions, eliminate the aspired dematerialization and transparency. Instead of the visually desired "nothing", visual errors "kill" the transparency and lead to a surface spiked with visual errors. Technically, these surface flaws or errors belong to the characteristic of processed glass and are mostly subject to thermally introduced surface stresses. Furthermore, the typical total reflection of glass at a particular viewing angle and mirror effect of the applied low e-coating work against the transparency.

Therefore, the dematerialization and transparency are partially opposed by physical laws. Taking on the challenge to get as close as possible to the wanted appearance, the following parameters have been subject to a challenging development. Firstly, the g-value had to be optimized in accordance to the passive shading devices described above. A g-value of 23% proved to be the upper limit in order to avoid the overheating of the building. Esthetically, the low g-values has been a not negotiable value and had to be accepted, as the passive shading devices should not have been extended in the area. Despite this low value, the samples and the first manufactured units show a nice appearance.

The more challenging issue has been to tackle the surface errors. From an engineering point of view, the thermally introduced stresses are used to strengthen the glass. Fully toughened or heat strengthened glass provides a higher load bearing capacity. Furthermore, the risk of failure due to thermally introduced stresses during service is obsolete.

Optimizing the glass towards the annealed state (float condition) with the best possible surface condition requires a careful consideration of the loadbearing capacity under long term loading condition. Additionally, the risk of thermal breakage during service has been assessed carefully, taking into account the interface details, climatic exposure, the applied low e-coating, etc.

Fig. 4: First glass unit at works of Frener & Reifer in Brixen

The decision to use annealed glass on all layers in the triple glazing influenced the bending method fundamentally. Hot (roller) bending and lamination bending had to be eliminated as a processing option due to the introduced and, in case of the lamination bending, also required thermal stresses, respectively strengthening. Slump or gravity bending is the used bending method, ensuring the best possible annealed surface condition. The first assembled and inspected glass units prove to have an excellent appearance and are achieving the very much aspired and promised transparency. (Fig. 4)

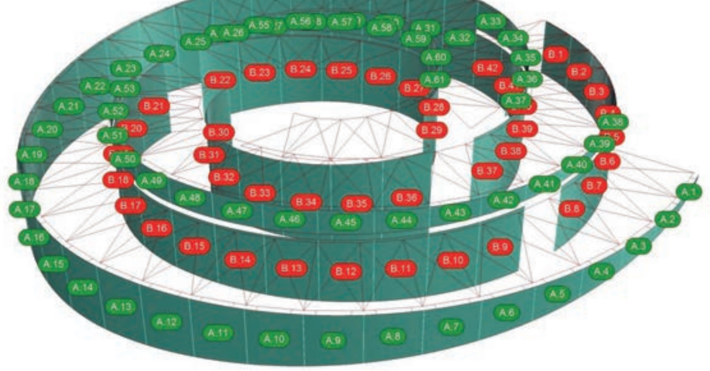


Fig. 5: Schematically view of the loadbearing glass element and roof structure

Thermal concept

The thermal concept of the façade and glazing is predominately defined by the Minegie criteria. The described exterior passive sun shades and the low g-value of 23% of the glazing is satisfying the energy demands in summer case and prevent overheating. The low u-value of 0.6 W/(m2 K) in conjunction with heaters below the glazing ensures the user comfort, avoiding any down drift during the cold seasons. The energy demands in the winter case are within the set limits. The large, glazed areas are compensated by the highly insulated green roofs. Additionally, photovoltaics on the adjacent existing building are contributing to the strict overall energy assessments and good rating.

Overall structural concept

The transparent design of the spiral did not allow placing columns or even walls inside the building. Therefore, it was decided to find a solution with load bearing glass walls. The façade as well as the interior separation walls would be used to transfer the vertical loads (dead load of the roof construction, snow load) and also the horizontal loads (wind load, seismic load). The horizontal loads have to be transferred through the rigid roof construction to the roof edge, from there as in-plane forces through the glass and eventually into the concrete foundation. (Fig. 5)

Individual glass pane

The concept for the individual glass panes was designed as simple as possible. At the outer façade, where the IGU is carrying the loads, the innermost layer of the IGU acts as the loadbearing layer. The loadbearing glass consists of a three times laminated 12mm annealed glass with a SGP interlayer. The glass is bordered at the top and bottom edge with a steel shoe, that is bonded to the glass. The shoe transfers horizontal in-pane loads to the vertical edge of the glass and from there diagonally through the glass to the bottom support. The vertical loads are being transferred from the roof bracket directly through the steel shoe into the glass. The connection between the bracket and the shoe is only pinned. This ensures that bending moments are not being transferred from the roof into the glass pane. The outer layers of the IGUs are only being supported at the bottom. These supports take the dead load and reduce the permanent stress on the edge sealing, which now only has to carry the wind loads.

The bearing concept of the inner glasses is exactly the same. Due to the larger forces in the centre of the spiral, the glass build-up increases to a maximum of five times 12mm annealed glass.

Design specialities

Geometry: The main part of the building consists of two spirals rotating in opposite direction, that interlock in the centre. The way it was designed, only four different glass radii exist. This reduces the expenses of the formwork for the slump bent glasses significantly. The shape of the glasses is, however, always unique. The upper edge of the façade follows the design of the roof edge. The roof edge was designed in consideration of a consistent overall geometry as well as proper drainage paths.

Durability: Since the façade is the thermal envelope as well as a structural element in one, the durability of it became more relevant than usual. It is very important that as little moisture as possible passes through the edge seal. Additionally, the climatic loads in the cavity of a bended IGU cause higher stresses on the edge seal due to the higher stiffness of the glass. Typical IGU's are being tested for its durability with artificial aging procedures.

Redundancy: The brittle material behaviour of the glass calls for a certain redundancy in the load bearing structure. Although the use of annealed glass in the laminated glass does provide quite a high residual carrying capacity, different load cases with damaged glass plies have been defined for the analysis. Glass panes with one or two damaged glass plies are being calculated as well as the failure of an entire element.

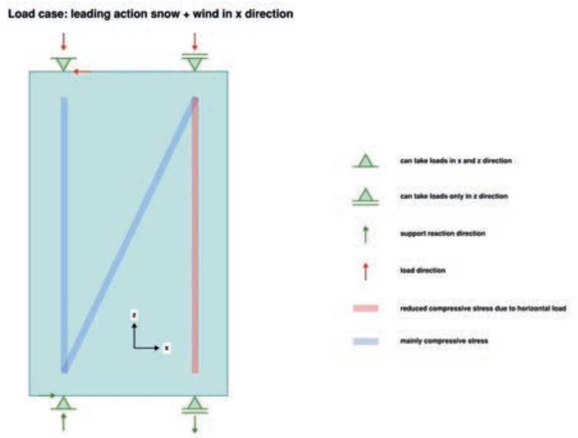


Fig. 6: Structural boundary condition of glass elements and supporting components

Testing: Many design relevant details and structures with structural glass are not standardized. The few reference projects with similar structures served as an indication during the design phases. Nonetheless, additional testing was unavoidable. The load transfer from the shoe into the glass had already been tested in the design phase. This gave a certain security for the planners to continue with the all-glass design. Further tests, including tests of the IGU and the five times laminated glass, are going to be carried out in the near future with the contractor.

Project progress

Currently, the project is in execution. Beside the manufacturing and assembly of the steel and glass element, the bespoke test regime is executed at the Façade and Metal Engineering Center at Lucerne University as well as other test houses. The test regime covers important points such as the extended life span of the triple glazing, load transfer of the concentrated point loads up to 400 kN as well as a full scale ultimate load test. The building is expected to be water tight by the end of autumn 2017

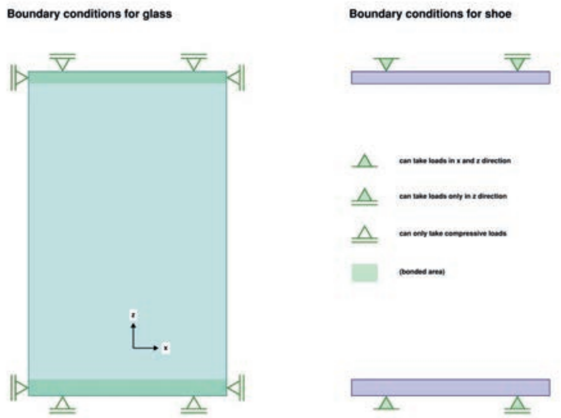


Fig. 7: Structural principles of load bearing glass elements

Acknowledgement and project partner
Client: Audemars Piguet, Le Brassus
Architecture: BIG - Bjarke Ingels Group, New York
Local Architect: CCHE, Lausanne
Structural Engineering: Lüchinger+Meyer, Zürich
Façade Engineering: Lüchinger+Meyer, Zürich /
Lüchinger+Meyer+Hermansen, Copenhagen
Specialist Façade Contractor: Frener & Reifer, Brixen

Fig. 8: Roof structure seen from the inside of the building.

ITA Building ETH Zürich

Introduction

The use of robotics in building opens up a whole new dimension of geometries for architecture. The ITA (Institute of Technology in Architecture) a at the ETH Zürich has carried out research into these possibilities for some time now - with remarkable results. With the planning for the timber roof of its new institute building, Prof. Fabio Gramazio and Prof. Matthias Kohler created a direct link with practical implementation and proved that their projects can really be built. The wide-span load-bearing structure consists of layered trusses arranged in 6 fields spanning 15 meters between box-type steel supports. (Fig. 8)

The project implements a roof structure in which all design, dimensioning and production processes were connected in a single interlinking digital chain. Each part of the whole affects the processes of the other partners.

The implementation presented new challenges both for the planners of the load-bearing structure and for all other parties involved in the process. Automation played a crucial role in determining the dimensions and quantities for the 168 differently shaped supports with a total of about 90,000 rafters and 800,000 nails in 100,000 joints. (Fig. 9)

Planning process

To generate a continuous digital chain, the individual disciplines had to be closely dovetailed, and it was essential to link them digitally. The most important requirement was a suitable definition of the demarcation points between the tasks involved.

The basis is provided by a 3D model in which the rafters are portrayed both as solid bodies and as a graph model with nodes and edges. For the structural calculations, the nodes and axes and their cross-section characteristics were recorded and then assigned support surfaces and loads. They were then transferred to the structural analysis program by means of an interface. The evaluation of the results was then carried out by an interface with Excel, where the cross section and connection calculations were carried out. The output from this process consisted of instructions for adjustments in the cross sections and the necessary number of nails per connection. After the adjustments were taken into account, the sequence was then repeated. After the completion of the dimension and quantity design process, the data were then prepared for production.

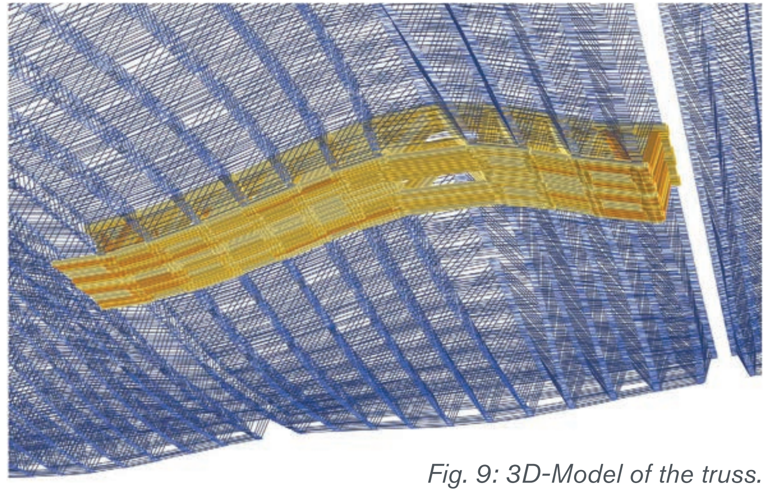


Fig. 9: 3D-Model of the truss.

Layers
The trussed beams are produced lying on their side in sections with a width of 1.15 meters. This means that the rafters can be laid on each other along their broad side and nailed in place. In this process, the rafters are collected from the store by robots in a fully automated process and cut to the right length in the joinery station. The layer structure of the 15 meter long beams consists of groups of three interlocking layers of chord rafters and one layer of diagonal braces which are laid alternatively to form a stack of 23 rafters. The chord rafters overlap each other at the joints.

Nail patterns
Due to the production of the layers in a lying position, the nails are always knocked in from one side, and they overlap each other within the layer. This means that they are affected by the nails in the lower and adjacent layers because the minimum distances between nails must be complied with. The offset distances between the rafters in the layers must also be taken into account, so a regular nail pattern is not possible. Due to a specially developed algorithm created by the company ROB Technologies, it was possible to insert the necessary number of nails taking these interactive factors into account. If the node geometry did not offer sufficient space for nails to be inserted in accordance with the standards, this was remedied by structural measures such as widening the cross-section of the rafters. (Fig. 10)

1:1 support tests
As the trussed beam design described did not comply with the standardized conditions in every respect, a complete trussed beam was constructed before the dimensional planning was finalized, and it was tested in a load and stress test. By contrast with the actual horizontal load, the vertical load is transferred to the nodes by cylinders via load distribution joists. Attaining the expected breakage load enabled the structural analysis model and the selected verification method to be confirmed. Expansion measurements were carried out on selected rafters to monitor the flow of forces through the individual rafters. In addition, the insight gained in the construction of the trussed beam was then used in the production process. (Fig. 11)

Summary
The close interaction between the planning disciplines right through to the production process created a very interesting cooperation process. The digital chain, as a central communication element, was the fundamental requirement which enabled the high data volume to be processed.

The automation of the structural calculations gave the design a greater degree of freedom and enabled variants to be examined quickly.

Fig. 10: Nail Pattern

Fig. 11: Execution of support tests

The layer-based structure of the trussed sections made for simple working processes which could be implemented in a fully automatic process and which required no extra components for the nodes. For the planner of the load-bearing structure, the selection of suitable joining and fastening elements was a decisive topic. The use of nails was a very universal and flexible solution, although it represented a major challenge, especially in the geometrical arrangement of the nails. Nevertheless, this design created a very ductile load-bearing structure which can redirect loads and therefore has a high level of redundancy. The consistently applied digital chain shows the innovative character of the project and demonstrates how complex geometrical configurations can be elegantly dealt with.

Conclusion
The two presented projects show that the developing of interesting and innovative architecture is based on a persistent and constant dialogue between architects, engineers and researchers. Much in the spirit of Le Corbusier that effective co-operation enlightens the art of construction.

Acknowledgement and project partner
Client: ETH Zurich
Overall architectural planning: Prof. Sacha Menz, Guido Züger, ETH Zurich
Timber roof: Prof. Fabio Gramazio, Prof. Matthias Kohler, ETH Zurich
Structural Engineering: Lüchinger+Meyer, Zürich
Sole contractor: HRS Real Estate AG, Zurich

Notes

Daniel Arztmann

Head of Building Physics International Projects, Schüco International KG; Bielefeld, Germany

Daniel Arztmann studied Architecture at the Hochschule für angewandte Wissenschaften und Künste in Holzminden (HAWK)-with a focus to metal construction and facades. After his Diploma in 2003 he worked as a Project Engineer for customized solutions for international markets at the Schüco Int. KG.

In 2010 he obtained his M.Eng. in Facade Design and Construction from OWL, University of Applied Sciences in Detmold. As a result he became Head of Research and Development for Emerging Markets at Schüco International KG until 2011 and continued to specialize in building physics and construction for international projects in the global engineering department.

Since 2010 he is teaching in the façade master program in Detmold and since 2016 in the new MIAD program. His focus here is in detailing and construction.

The dissertation will deal with different relevant topics of future facade design related to interior comfort, building physics and effects to the exterior in different climates.

The PhD researcher has longtime practical experience in façade consultancy for international architects and cladding companies but also an affinity to scientific methods of theoretical building physics. Due to this, the different topics will be analyzed, evaluated and explained according to scientific standards and will result additionally in an output of practical relevance to the façade market. This output can be a new designed façade component to avoid current existing issues (e.g. Shadow Box), design recommendations for improved design principles (e.g. zero energy principles for tropical climates) but also guidelines for the reasonable implementation of requirements out of international standards and regulations (e.g. BS / document L / SAP 2012), just to name a few.

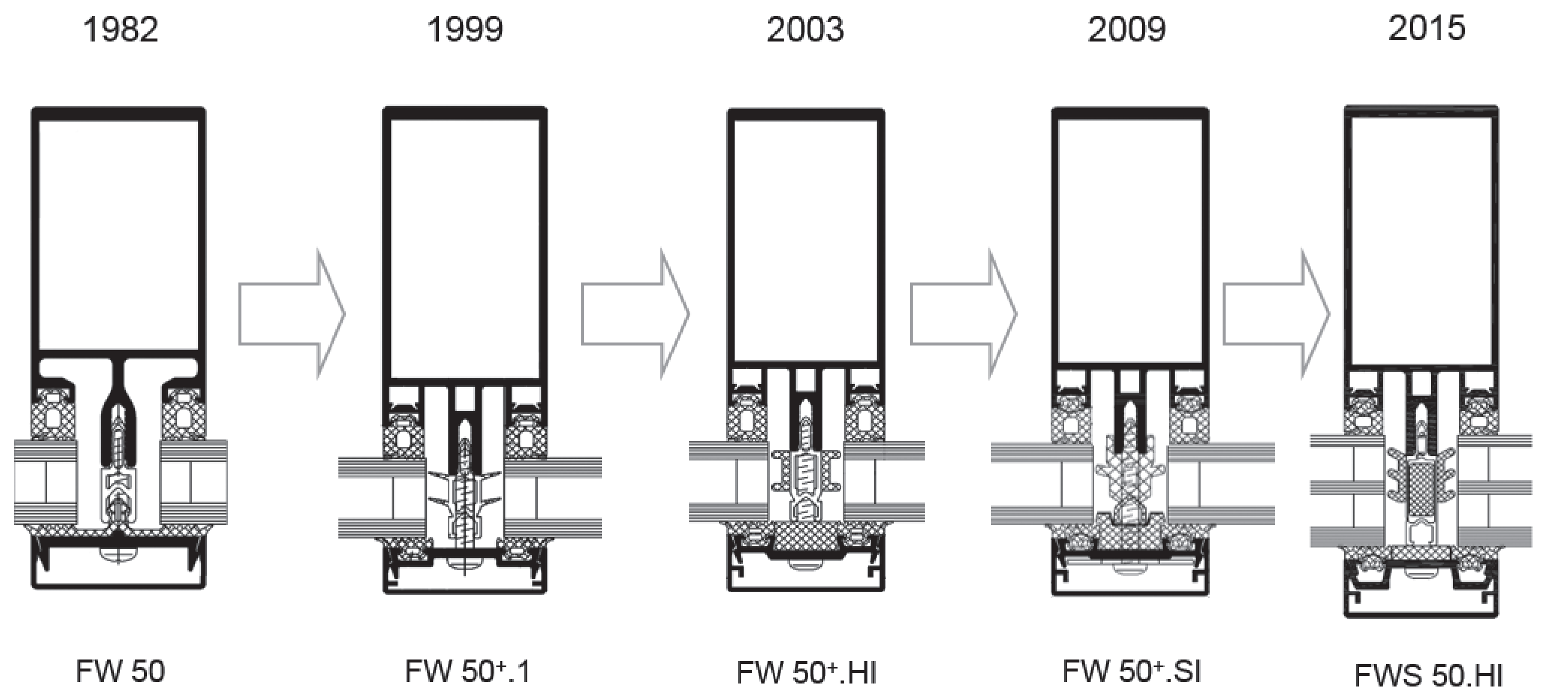


Fig. 1: Improvement of thermal properties over the last decades (Schüco International KG, 2017)

Climate Change, Globalization and Digitalization and their Impacts on Prospective Façade Design

Abstract

The façade industry reacted to the necessity to reduce the CO2 emissions and with this the extent of global warming. It considered energy efficiency as one of the main driver in façade design during the last years with the result that the thermal properties of the building envelope are currently at its reasonable technical limit. Now, it is the time for a new holistic façade design approach to react to climate change and its already noticeable effects. Good design efforts are visible in industry and science that deal with windows and facades resilient to torrential rain, hurricanes and seismic activities

Climate Change // Globalization // Digitalization // CO2 Emissions // Product Design // Exchangeability // Mitigation // Digital Simulation

Introduction

Climate change, globalization and digitalization, these three keywords shape our present political and scientific discussions and are often named in one breath. All of these phrases describe a prospective prediction with variable consequences and an uncertain future. Due to this, the political and scientific world is separated into those who are afraid of the unknown consequences and those who are willing to take the challenge and who face the future with confidence.

The building industries perspective on these keywords is a different one. While globalization and digitalization offer new opportunities in terms of product design and sales, it is the climate change that challenges the build environment and mainly influences the requirements on new building components. The building envelope has a particular importance in this situation as it is the component that acts as separation between inside and outside climate and is exposed to the direct impacts of the climate change.

Impacts of the climate change on the building envelope

The climate change is a fact. This is the conclusion of the fifth status report of the Intergovernmental Panel on Climate Change (IPCC) from September 2014 (Chalmers, 2017). Human activities and their CO2 emissions are with a 90% guarantee responsible for it. Climate change and their impacts are already recognizable anywhere on our planet. The main impacts on the building envelope are:

Heat and drought
According to projections, heat and drought will increase, even in areas in the moderate climate zone. To be resilient against this, façade components must be built of materials that withstand high temperatures. Furthermore, the necessity for an effective sun protection design will increase to lower the external heat gains of the buildings and with this the consumption of cooling energy. Buildings must be designed to minimize the intra-urban heat island effect by heat absorbing facades.

Torrential rain
Weather events with torrential rainfall will increase in the moderate and tropical climate zone. This can cause short-term flooding which must be considered during the design of building areas near to the ground level (base area, entrances, light shafts, etc.). In the areas higher above the ground, the facades must be designed to meet the increased requirements according to driving rain and it must be ensured that all temporary openings are closed during the event.

Fig. 2: Bombay after heavy monsoon rainfalls (mumbaimag, 2017)

Materials that are not water repellent should be protected against driving rain also considering that torrential rain often occurs with turbulent winds.

Heavy thunderstorms
Current studies show an increased amount of heavy thunderstorms in North America and some parts of Europe like South West Germany (Rauch, 2017). Due to torrential rainfalls that come along with heavy winds and often hail, they can cause huge damages to buildings and their facades.

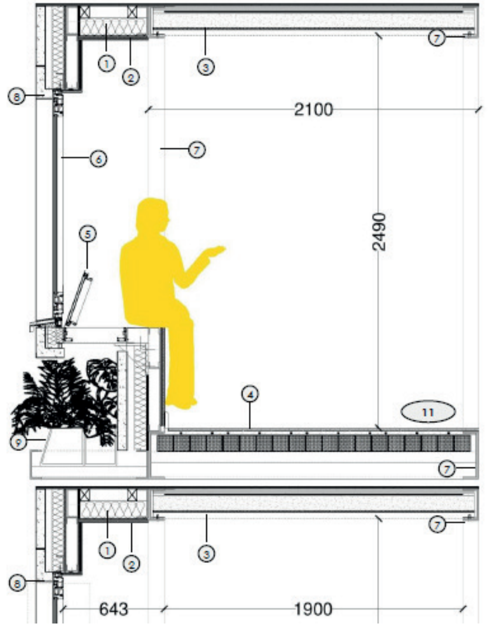


Fig. 3: Reinterpretation monsoon window (Vedula, 2017)

Management of climate change and its noticeable effects

The building envelope on one hand has huge potentials to influence the intensity and velocity of climate change, on the other hand it must be designed to withstand its noticeable effects that are mentioned above. Due to this, a structured analysis is very important to find the requirements, current and prosperous façade design must meet. The insurance company Munich Re defines several components of the management of natural disasters (Höppe, 2017) that can also be applied for the management of the climate change and its noticeable effects. Applied to the façade business it results in the following influencing factors:

As a long term factor the mitigation of the climate change is very important which means the influence on its intensity and velocity. It is a fact that 32 percent of the worldwide final energy consumption and 19 percent of the greenhouse gas emissions can be attributed to the building sector (Chalmers, 2017). This should be drastically reduced by improving the energy efficiency of the building envelope and with this the energy consumption and CO2 emission in the building sector. One example for this in façade design is the constant improvement of the thermal properties of all façade components over the last decade. This results in modern energy efficient building envelopes with heat transmission coefficients lower than 0.8 W/m²K for the entire envelope including cold bridges. (Fig. 1)

A second component of risk management is the management of exposition. An example for this is the use of the correct building components depending on climate specific requirements. A façade system that is designed for the fabrication and use in Central Europe can cause huge challenges if installed in a building in tropical climate. Reasons for this can be the different requirements on the thermal properties of the façade, location specific weather events (e.g. monsoon), different worker capabilities and insufficient equipped workshops, just to name a few. Due to this, some globally experienced companies in the façade business develop product series that are especially designed for the needs of specific target markets. A holistic analyzation of the target market with considering all the above mentioned topics and much more is an indispensable step before starting the product development (Fig. 2, 3, 4).

Fig. 4: Development of market specific facade systems (Schüco International KG, 2017)

Another midterm factor is the minimization of the vulnerability of the building envelope. For this, it is important to know all requirements for the building envelope and to consider them carefully during a holistic design approach supported by possibilities of modern computation. A careful analyzation of the envelope defined by the architect is important. Due to this, the specifications and the façade geometry must be carefully checked, depending on the complexity of the geometry with the help of modern software tools, before starting with the concept design.

After the preliminary design stage is finished, modern simulation tools offer the possibility to check, if all necessary requirements are met. With finite element tools it is possible to analyze the façade according to thermal and acoustical properties and its structural behavior. Predictions are possible for wind and air tightness, punctual structural impacts from flying parts and effects out of seismic activities (Fig. 6,7).

As all of these simulations are doable in an early planning stage, necessary alterations of the façade design are possible without big effort or expenses. After the fine-tuning in the façade development stage is finished, the articles can be produced and prototypes manufactured with the knowledge that the façade will pass all further tests for sure. The final check of the new façade is done via laboratory tests with a physical mockup (Fig. 8) at the end of the development process and all tested system properties are documented in a product pass (Fig. 9).

A further method that also minimizes the vulnerability of buildings would be the adjustment and implementation of stricter regulations

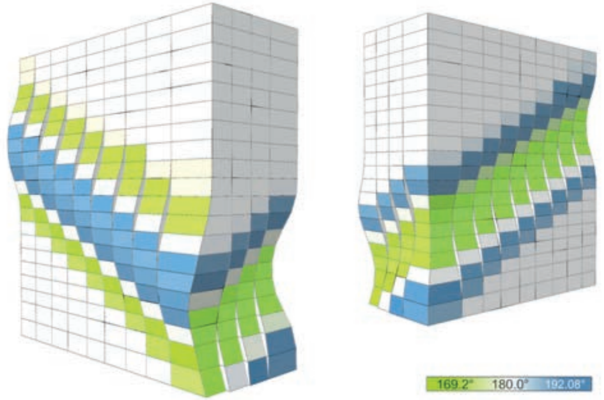


Fig. 5: Analysis of the envelopes geometry with Grasshopper and Rhino (Schüco International KG, 2017)

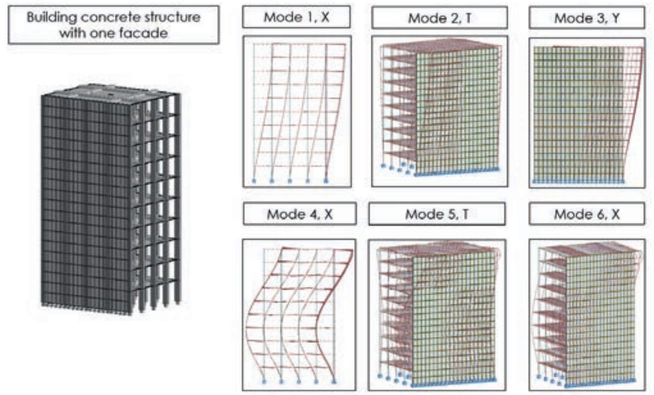


Fig: 6: Seismic simulation of a building with façade (Aoun, 2016)

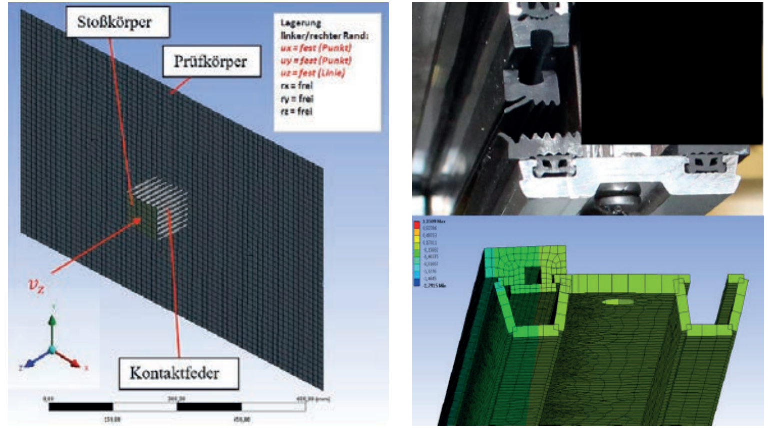


Fig. 7: Simulation of pendulum impact test on a glass balustrade (Riechmann, 2017)

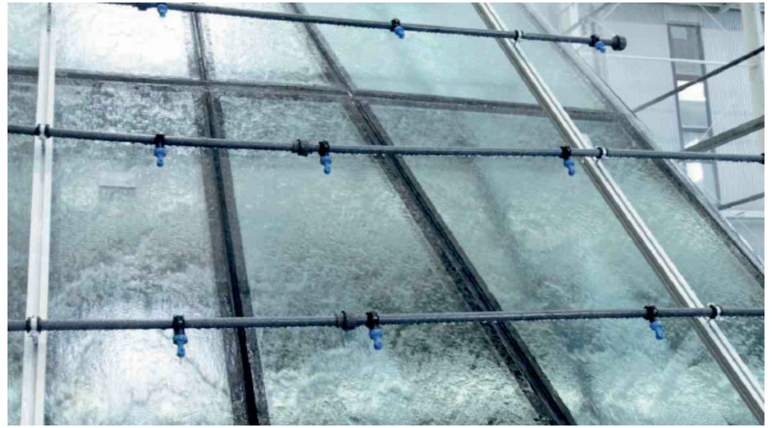
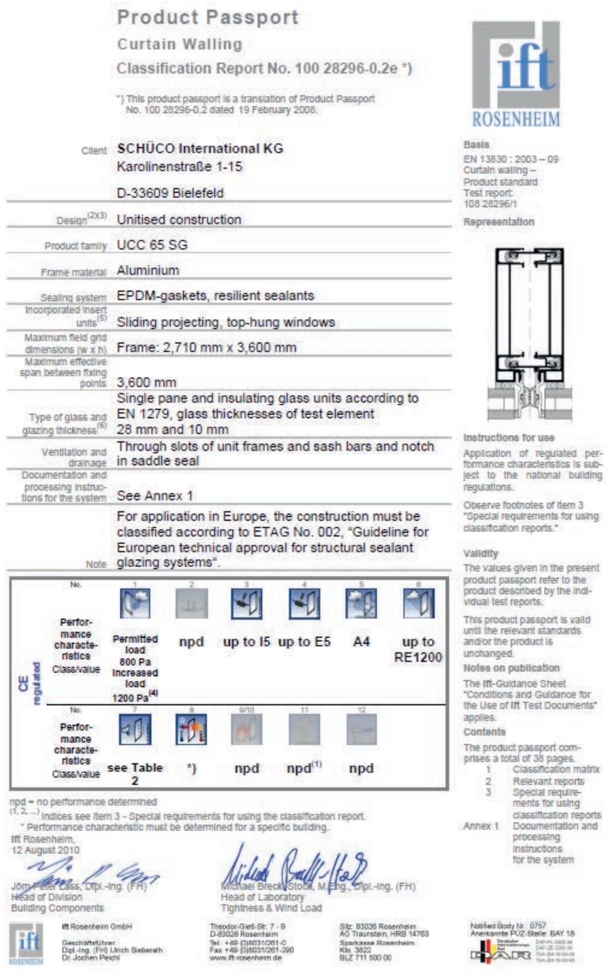


Fig. 8: A physical mockup is tested acc. to driving rain in the laboratory (Schüco International KG, 2017)



Product Passport
Curtain Walling
Classification Report No. 100 28296-0.2e *)

*) This product passport is a translation of Product Passport No. 100 28296-0.2 dated 19 February 2008.

ift ROSENHEIM

Client	SCHÜCO International KG Karolinenstraße 1-15 D-33609 Bielefeld
Design(2)(3)	Unitised construction
Product family	UCC 65 SG
Frame material	Aluminium
Sealing system	EPDM-gaskets, resilient sealants
Incorporated insert units(5)	Sliding projecting, top-hung windows
Maximum field grid dimensions (w x h)	Frame: 2,710 mm x 3,600 mm
Maximum effective span between fixing points	3,600 mm
Type of glass and glazing thickness(6)	Single pane and insulating glass units according to EN 1279, glass thicknesses of test element 28 mm and 10 mm
Ventilation and drainage	Through slots of unit frames and sash bars and notch in saddle seal
Documentation and processing instructions for the system	See Annex 1
Note	For application in Europe, the construction must be classified according to ETAG No. 002, "Guideline for European technical approval for structural sealant glazing systems".

CE regulated

No.	1	2	3	4	5	6
Performance characteristics Class/value	Permitted load 800 Pa increased load 1200 Pa(4)	npd	up to I5	up to E5	A4	up to RE1200

No.	7	8	9/10	11	12
Performance characteristics Class/value	see Table 2	*)	npd	npd(1)	npd

npd = no performance determined
(1, 2, ...) Indices see item 3 - Special requirements for using the classification report.
* Performance characteristic must be determined for a specific building.

ift Rosenheim,
12 August 2010

Jörn Peter Lass, Dipl.-Ing. (FH)
Head of Division
Building Components

Michael Brecht-Stock, M.Eng., Dipl.-Ing. (FH)
Head of Laboratory
Tightness & Wind Load

Basis
EN 13830 : 2003 – 09
Curtain walling – Product standard
Test report: 108 28296/1

Representation

Instructions for use
Application of regulated performance characteristics is subject to the national building regulations.

Observe footnotes of item 3 "Special requirements for using classification reports."

Validity
The values given in the present product passport refer to the product described by the individual test reports.

This product passport is valid until the relevant standards and/or the product is unchanged.

Notes on publication
The ift-Guidance Sheet "Conditions and Guidance for the Use of ift Test Documents" applies.

Contents
The product passport comprises a total of 38 pages.
1 Classification matrix
2 Relevant reports
3 Special requirements for using classification reports
Annex 1 Documentation and processing instructions for the system

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Notified Body Nr.: 0757
Anerkannte PÜZ-Stelle: BAY 18

0307 / 433

Fig. 9: All tested product qualities are documented in a product pass (Schüco International KG, 2017)

and standards according to climate change and its effects. Current weather events must be recorded, its specialties analyzed and compared with the requirements stipulated in the appropriate regulations. If there are divergences, adjustments are indispensable! Acute management of catastrophes can be seen as the last possibility to react on the noticeable effects of the climate change. Early alert, evacuation and emergency are some of the short-term methods that should be considered in building design to reduce the effects of a natural disaster. For this, modern technology and sensors must be developed that recognize the initiation of a catastrophe as early as possible. In a second step, there must be an automation that introduces appropriate measures. An example for such an appropriate measure are robust shutters that come down automatically in front of a glazed façade to protect it against flying parts in case of a hurricane.

Repair work and reconstruction

If a building was affected by an extreme weather event and if parts of the building envelope were demolished, it is another character of a resilient building envelope that demolished parts can be replaced easily so that a fast reconstruction of the building is possible. This must be considered already in the design process of the façade. The different components of the building envelope must be categorized according to their importance for the stability of the façade. Structural components are very important and must be designed with a specific robustness to withstand extreme events. All other components must be easy to maintain or to exchange what influences the necessity for accessibility and a careful design of all component interfaces (Fig. 10).

Fig. 10: Exchangeability of components (Arztmann, 2011)

Conclusion

The climate change is in progress and its impacts in the form of extreme weather conditions are already noticeable. Global players in the façade industry take already action and develop new energy efficient products that lead to a mitigation of the climate change. Furthermore, they use a holistic design approach with the help of digital simulation tools to develop a new product generation that is resilient against all impacts.

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Notes

Taeyoung Kim

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Taeyoung Kim studied architecture at Seoul National University (BSC, MSC). Taeyoung worked as an architect for KIOHUN (1996-2002) before joining the Design PhD programme of the Bartlett School of Architecture, UCL in 2002. She worked in Gensler as a Senior Associate (2004-2013), leading numerous architectural and masterplan projects in Europe, the Middle East and South Asia while running Atelier 7 as a co-tutor in Greenwich University (2008-2011) and participating with academic juries and critics in London and Paris.

Appointed an Assistant Professor at the K'ARTS in 2014, Taeyoung is currently coordinating the advanced design studios of the RIBA-validated architectural programme and running one of the studios with a focus on social architecture and urban informality. She is a co-founder of Urban Topology, a design and research practice where she continues her interest in the design of cooperative housing and art/cultural projects for private and public clients.

Fig. 1

Contextual Resilience

Case Study of Burj Alshaya Centre

Abstract

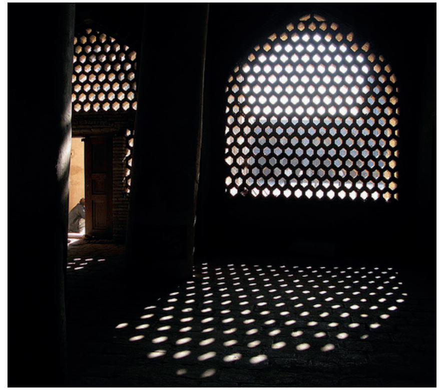
Burj Alshaya Centre, designed by Gensler, is a mixed-use development in Kuwait City comprising an office tower, hotel tower, and podium. To achieve a singular identity for the complex of distinct components, the concept of 'Mashrabiya' was taken and interpreted to a unifying envelope in a diagonal pattern with reference to traditional Arabic latticework. The paper examines the design process and tools that developed the envelope into facade, fins, canopy and roof in accordance with differing functions, orientations and configurations. It proposes the diagonal geometry of the envelope to be a framework enabling both consistency and differentiation, thus achieving contextual resilience.

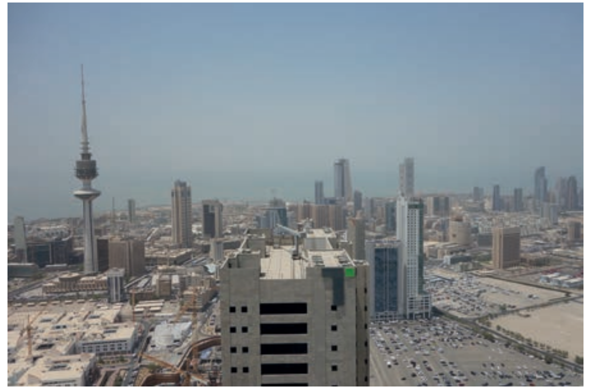
Mashrabiya // Contextual Resilience // Identity // Brief Complexity // Facade Geometry

Introduction

Mashrabiya is one of the most resilient facade elements and most powerful reference to traditional architecture in the region. Originating from wood balustrades on balconies where water jars were kept for cooling, it sometimes referred to wood latticework used on windows of a room projected above a street or courtyard. Some usage points to partition walls between rooms allowing lights and air to flow. To women, it was a screen for a window through which they could see the world without being seen. While their functions were multi-layered, its environmental role was consistent. The cultural implications varied depending on the setting.

The term, Mashrabiya has been used in a variety of contexts with varying interpretations for the last few hundred years. Its contemporary interpretations are much more diverse and cannot be





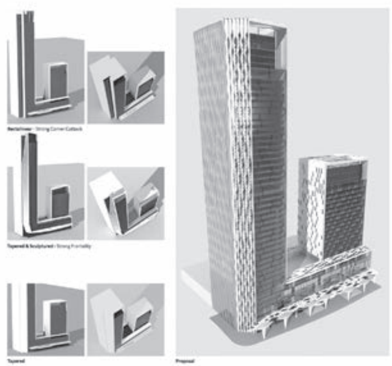


Fig. 2-4

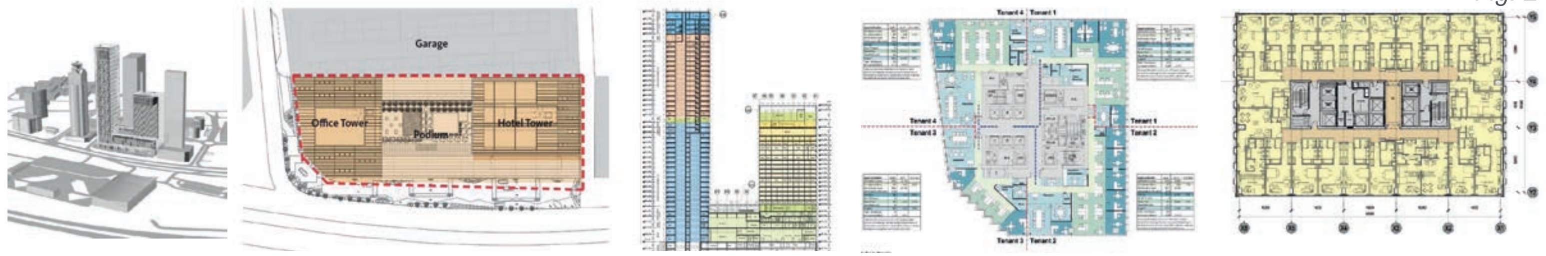


Fig. 5

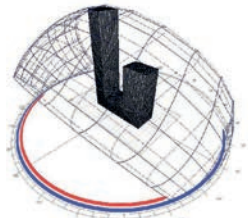


Fig. 6-7

defined as a single product or category. It may be a mere borrowing of a traditional screen pattern or a focus on its environmental function. The materials also differ, ranging from wood, terra-cotta to prefabricated concrete or metal panels.

The authentic interpretations of Mashrabiya are argued about amongst historians, theoreticians, and architects. But there is no doubt that the public's collective memory still plays a critical role in accepting a specific outcome, forming the cultural continuity in urban development. However, an owner's vision makes a greater impact in a private project like Burj Alshaya, which is the case study of this paper. The owner projected Mashrabiya in the sense of belonging to his culture and wished to re-interpret it in his project.[1]

The Mashrabiya is proposed as a main facade that unifies the distinct components into a singular identity for Burj Alshaya Centre in Kuwait. The paper examines its resilient adaptation to functional, environmental, and cultural contexts, highlighting the Mashrabiya geometry as that which enables the contextual resilience in the design process.

Brief Complexity

Functional Brief

Burj Alshaya Centre is a mixed-use development with an overall area of 143,965 m^2 in Kuwait City. It comprises an office tower, a hotel tower, and a podium. The complex includes a 50-floor office tower, a separate tower for the Four Seasons Hotel and the podium providing amenities for both the office and the hotel. Gensler were the lead design architectural firm, integrating input from the client, the operator, and the local architect, and the consultants into the design from concept to the DD stage.

A multi-level podium fills the plot boundary with an overall area of 30,839 m^2, including three major entrances to the hotel, the ballroom, and office tower. It accommodates all public functions associated with the hotel above ground, including the entrance lobby and tea lounge, all day dining, meeting rooms, a ballroom, a spa, a fitness centre, indoor and outdoor swimming pools as well as supporting kitchen areas, hotel administration offices, mechanical plant rooms, a retail mall, and BOH in the basement floors.

The Hotel Tower has an overall area of 41,824 m^2, containing guest rooms, suites of various sizes as per the Four Season's room mix, service apartments and specialty restaurants located on the roof. The hotel floors include 238 modules to allow for 250 keys. The office tower, with an overall area of 71,302 m^2, accommodates the Alshaya offices, the rental office floors, and MEP spaces[2].

The project brief has two types of complexity. At grade, the facade creates a sense of a main address for the office and a grand arrival area for the hotel. The strong presence of the tower is also here, exhibited in a continuation of the tower facade. On the other hand, as the vertical progression unfolds, special functions occupy rooftop or penthouse floors as destinations, exploiting the advantages created by the height. While the airy, bright outdoor qualities are desirable for good views, they are only possible when also providing protection from winds and heat. The desire for more openings should be balanced with the needs for better controls.

Environmental Brief
The site has a strong east-west axis which drives the idea of the towers at opposite ends connected by the podium. The towers' east and west facades are exposed to a significant amount of direct sunlight, requiring a protecting envelope like Mashrabiya. For the South facade, the environmental study is to address strategic decisions about the appropriate shading arrangement from the following options:

1. Cooling lead
2. CIBSE Guide A Comfort Criteria
3. ASHRAE 55-2004 Thermal Comfort Criteria

The highest-performing shading systems allow the office zone to pass ASHRAE comfort criteria. Athough the typical southern zone passes CIBSE comfort criteria, the western zone of the office tower do not meet these criteria. In an open plan office scenario, the reduced internal gains mean that the required cooling loads are much less than in the initial study. As the contribution of solar gain contributes to the total heat gain significantly, the use of shading devises gives greater percentage reductions in cooling over the basic case. The report concludes that savings of almost 20% can be achieved with the introduction of the most extreme shading options.

Alongside the west facade of the Office tower, horizontal surfaces are where the heat gains are most problematic. But the brief requires the utilization of the roof surfaces of the podium and the towers to provide semi-outdoor experiences with spectacular views for proposed special programs[3].

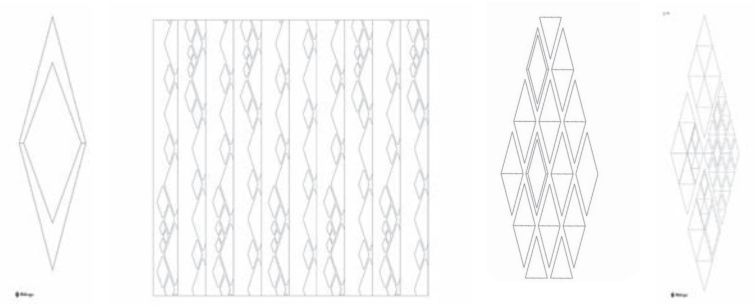


Fig. 8

Cultural Brief
The architectural vision for the complex was to create a contemporary Mashrabiya, following the client's aspirations and cultural sensitivity. The composition of the complex, including the position and orientation of the towers are driven by the efficiency and configuration of the site. The design is to "wrap" both podium and towers in an envelope, the Mashrabiya. Its aim is to create a unique and recognizable building form without affecting the compact and efficient floor plates. Whilst the consistent use of the material and geometry unifies the whole development, its local variations, responding to internal requirements, rationalise and enrich the experience of the Mashrabiya. Overall, it creates unique characteristics for the whole complex, distinguishing itself from its surroundings with a grand gesture and local sensitivity[4].

Contextual Resilience

Facade Geometry
The complexity increases where the functional, environmental, and cultural briefs intersect. The environmental conditions vary according to topological or topographic relationships and thus their combinations with the functional brief leads to a greater complexity in the following ways:

- Office tower east/west vs. Hotel tower east/west
- Podium roof terrace vs. Tower roof terrace
- Entrance canopy vs. Podium canopy
- Roof top expressions

An office is desirable with floor-to-floor glazing to allow natural light but, on the contrary, exposure to heat gain requires shading to reduce cooling loads. The roof top terrace is most sought after due to the panoramic views but is less occupiable as its temperature and wind pressure is higher than on lower floors. The articulation of the top of the tower is often emphasized as an expression of the owner, irrespective of its internal uses. To accommodate this complexity, the consideration of resilience had to be taken in the design of Mashrabiya.

The notion of resilience has been developed during the past 50 years mostly in the psychological, medical fields to study how individuals or communities cope with adverse conditions by the use of internal and external resources. Lately in architecture, the notion of resilience has been used in facade design to sustain performance in harsh weather conditions or unpredictable climatic changes in the long term. Though the environmental resilience of a facade guarantees a certain lifespan, other factors, including functional changes or market trends tend to affect the actual lifespan of a building despite its structural or environmental performance. For this reason, a facade design process needs to have contextual resilience as a complex field where at least functional, environmental, and cultural factors compete and negotiate. This paper particularly focuses on the resilience of the geometry of the Mashrabyia, investigating how it responded to the contrasting internal and external conditions and needs, adapting itself to the resulting variations.

Vertical Mashrabiya
The base geometry of Mashrabiya is set up in a dia-grid. Reminiscent of traditional Arabic patterns, the dia-grid is interpreted into three dimensions with variations in accordance with the amount of opening or light required in the detailed brief. The vertical Mashrabiya has a unitised panel unit alternating over a two-story height and fixed in a rectilinear grid. To allow light and views, a diamond-shape opening is cut in the center of the two-story panel. It undulates from a side view, projecting the most at the top and bottom points of the diamond. The overall effect is an alternating pattern of dia-grids flowing with the verticality of the tower. In the office tower, the diamond opening is larger, becoming vertical fins to introduce more light inside. The dia-grid is integrated into a rectilinear unit both in the planar and sectional profiles.

Horizontal Mashrabiya
The vertical Mashrabiya continues in its horizontal form, forming a canopy for the entrance courtyard at grade and a canopy for the pool terrace on the podium roof. It also wraps the tower roof with composite insulated panels. The horizontal Mashrabiya in the canopies has a unit panel in a diamond shape, both in planar and sectional profiles. The unit size changes in a fractal pattern, creating an atmosphere of cast light and shadows in a gradual progression. The overall complexity of the pattern comes from the dramatic experience of light, glare, and reflections. It welcomes visitors and celebrates arrivals at the destination along the vertical journey from

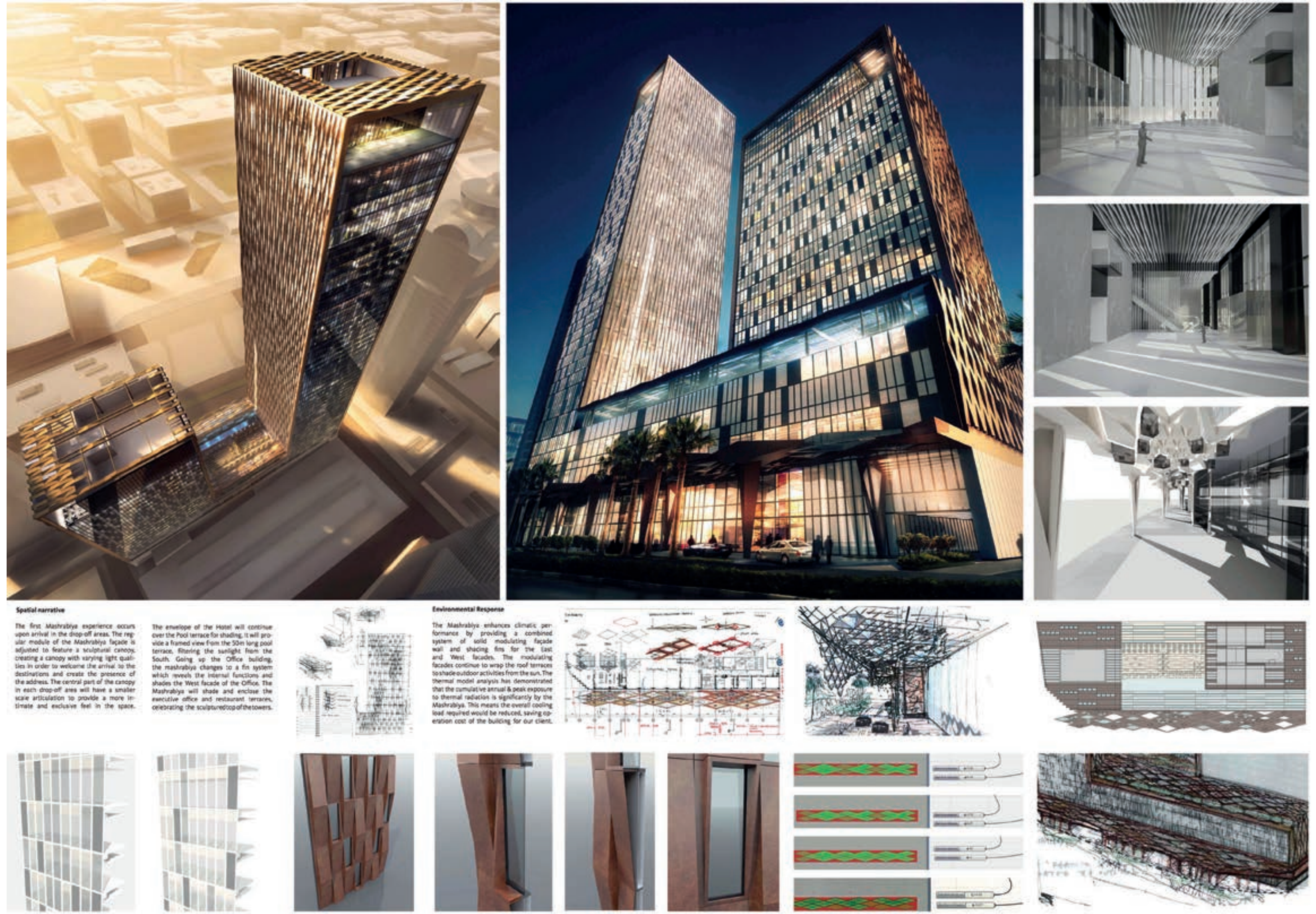
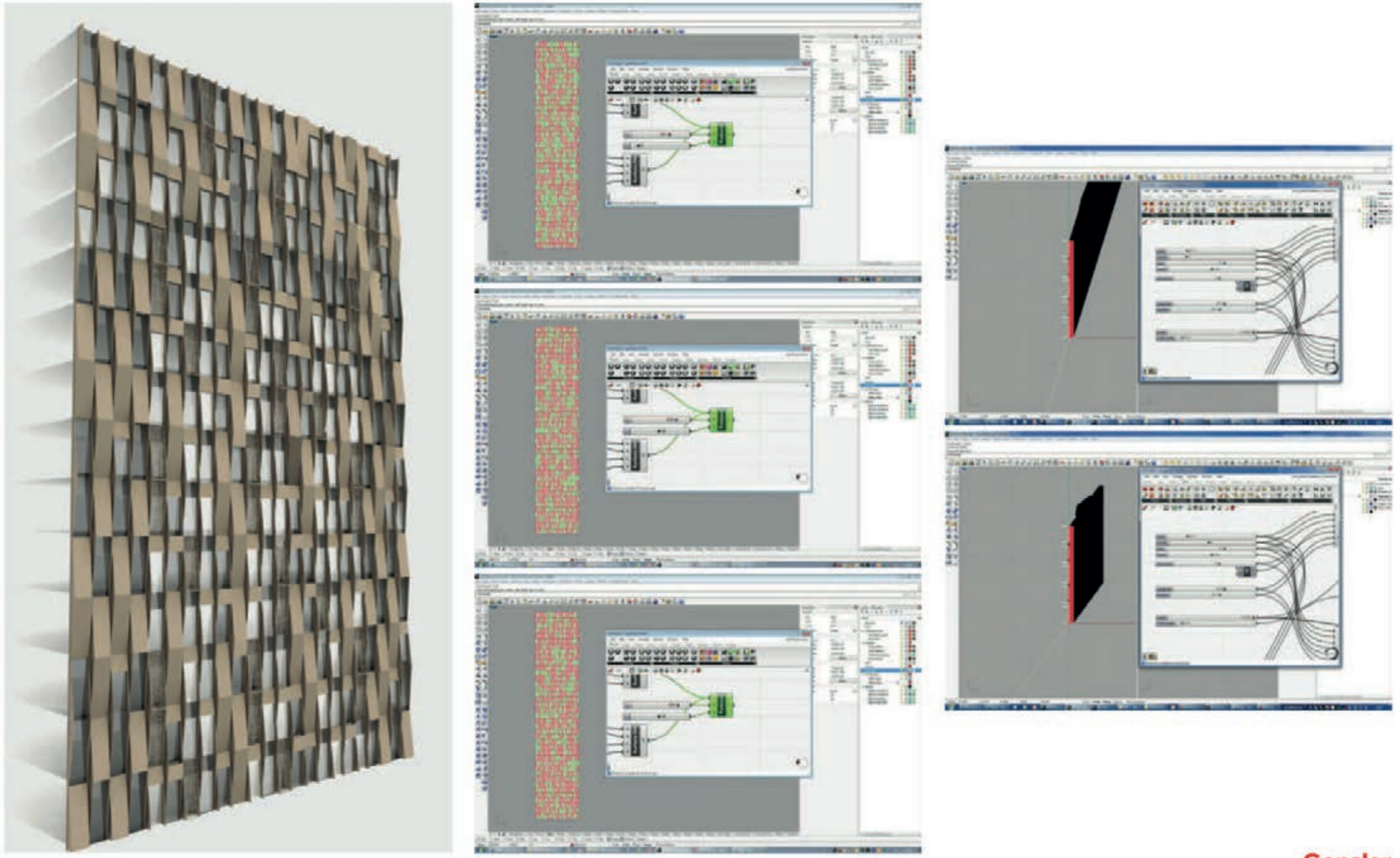


Fig. 9

digitaLAB

Alshaya Centre - Kuwait City
Gensler, London.

Facade and Canopy Study



Gensler

Fig. 10

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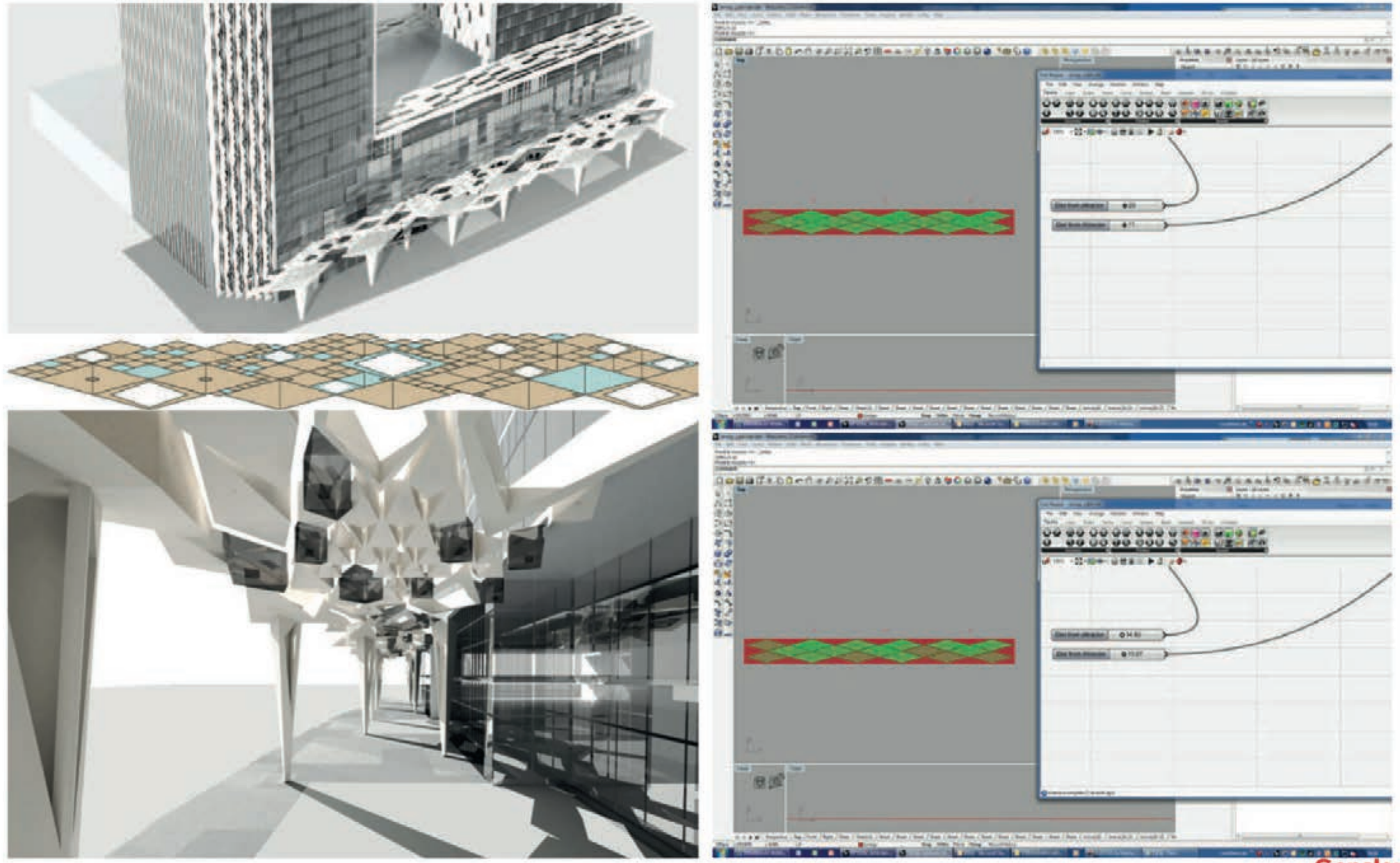
Alshaya Centre - Kuwait City
Gensler, London.

Facade and Canopy Study



Gensler

Fig. 11

Fig. 12

grade level to the top floors of the towers. The Mashrabiya roof of the tower roof is to be insulated to provide an enclosure for internal activities and protection from the elements.

Spatial Narrative

The first Mashrabiya experience occurs upon arrival in the drop-off areas. The regular module of the Mashrabiya facade is adjusted to feature a sculptural canopy. The central part of the canopy in each drop-off area has a smaller scale articulation to provide a more intimate and exclusive feeling in the space. The envelope of the Hotel continues over the pool terrace for shading. It provides a framed view from the 50 meter long pool terrace, filtering the sunlight from the south. It wraps the office building, shifting to a shading fin system which reveals the internal functions, and shades the west facade of the office tower. The Mashrabiya shades and encloses the executive office and restaurant terraces, celebrating the sculptured top of the towers[5].

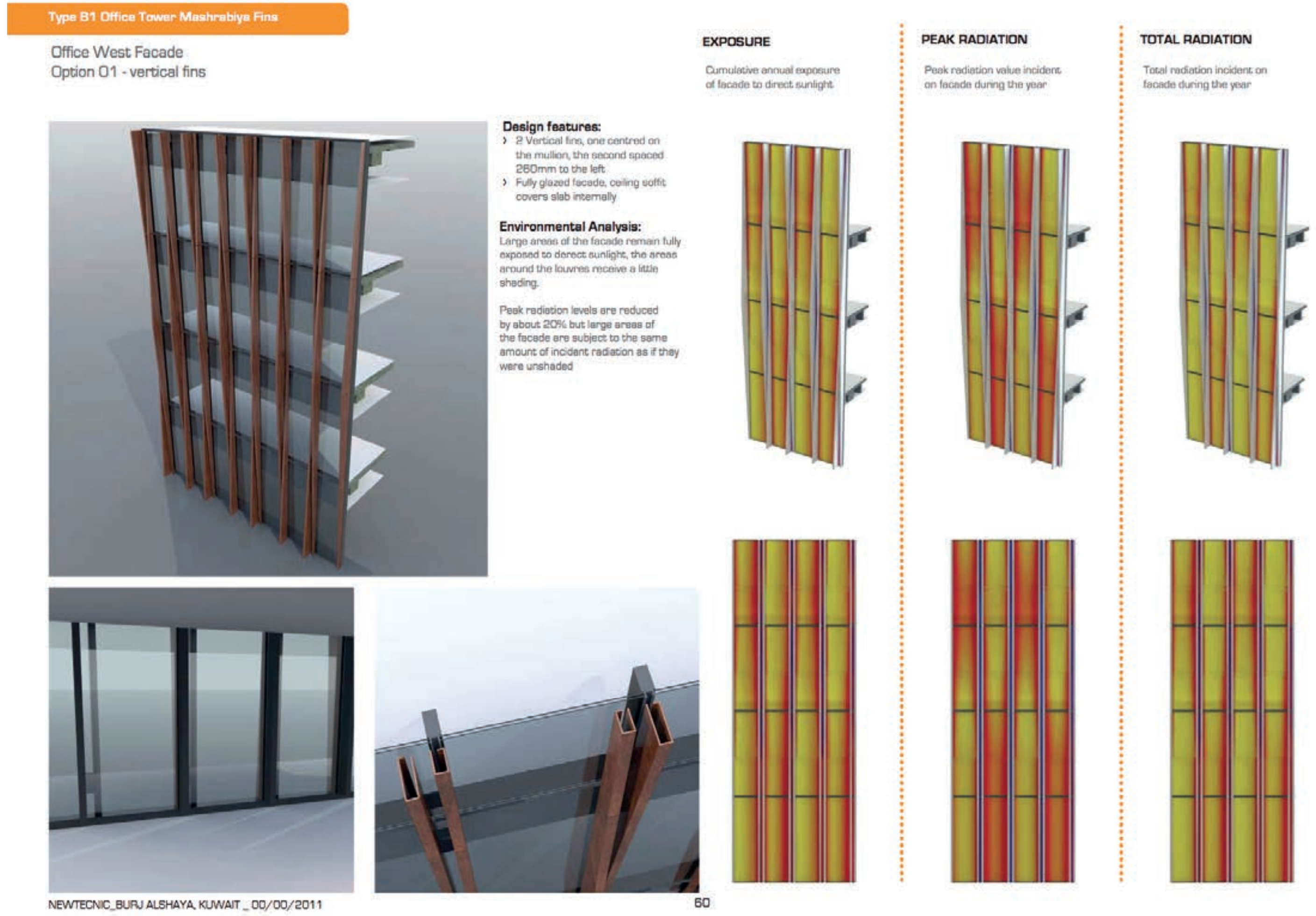
Traditional Mashrabiya typically refers to the elevated first floor perimeter zone finished with a timber screen facade for a see-through purpose to the street below. Older precedents show that they accommodated a ventilated air zone to keep water jars cool. Once applied only to the first floor, now the Mashrabiya takes a 50 storey tower into account for future peripheral living.

However, it is not just an environmental performance that makes it possible to occupy a space which used to be uninhabited. It is another level of cultural meanings, obtained in the spatial narrative told by design. The arrival experience, spectacular water experiences, and the top panoramic views become newly associated with Mashrabiya. It is re-defined as a contemporary feature and enclosure in a semi-outdoor setting with controlled seeing and being seen functions.

Construction Mock-ups

There are factors that pose risks before construction. Mock-ups were made to review how the design intent would be realized, depending on manufacturers' skills. With this aim, the items were

Fig. 13


Type B1 Office Tower Mashrabiya Fins
Office West Facade
Option 01 - vertical fins
Design features:
› 2 Vertical fins, one centred on the mullion, the second spaced 260mm to the left
› Fully glazed facade, ceiling soffit covers slab internally
Environmental Analysis:
Large areas of the facade remain fully exposed to derect sunlight, the areas around the louvres receive a little shading.
Peak radiation levels are reduced by about 20% but large areas of the facade are subject to the same amount of incident radiation as if they were unshaded
EXPOSURE
Cumulative annual exposure of facade to direct sunlight
PEAK RADIATION
Peak radiation value incident on facade during the year
TOTAL RADIATION
Total radiation incident on facade during the year
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60

Fig. 14

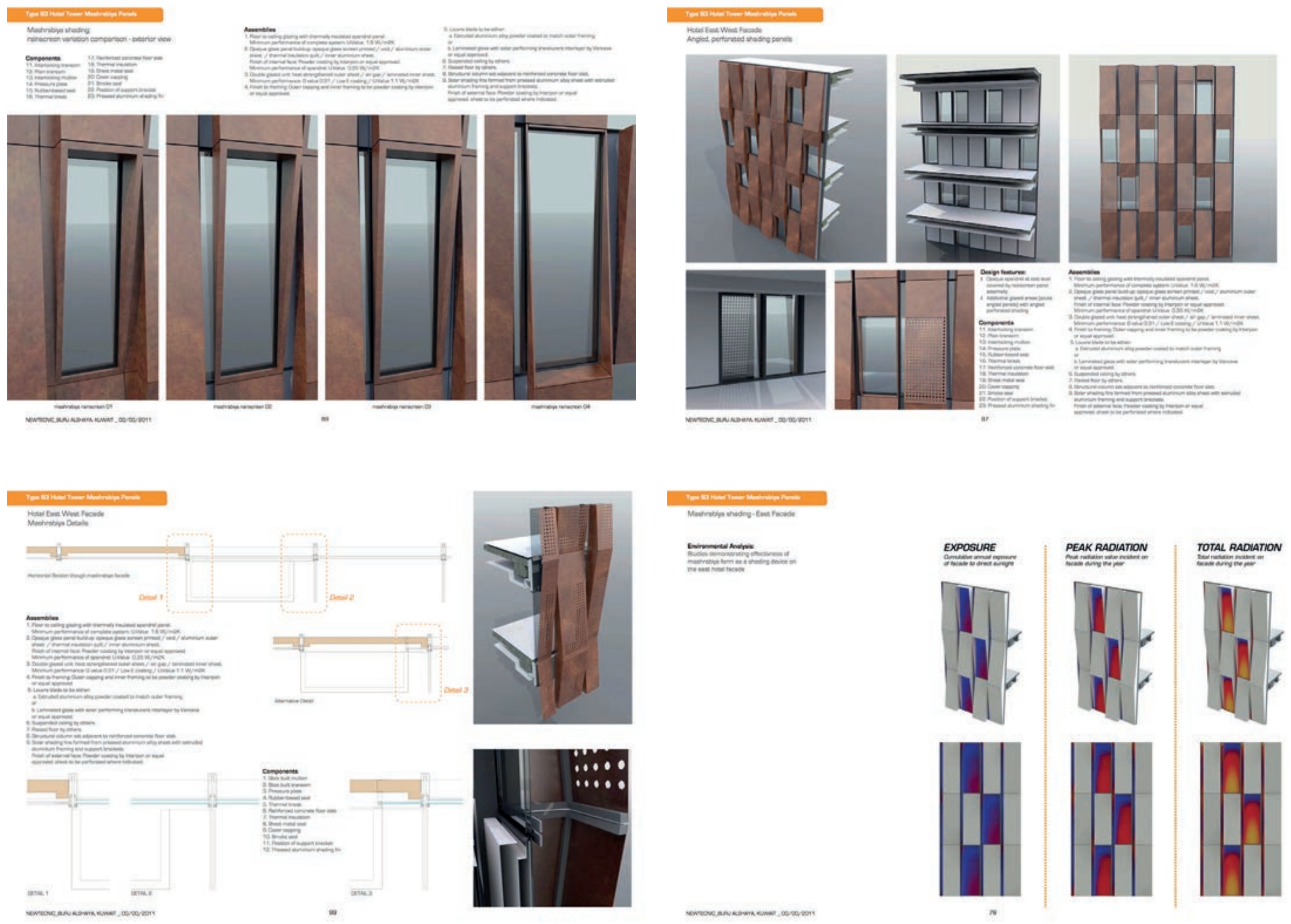


Fig. 15

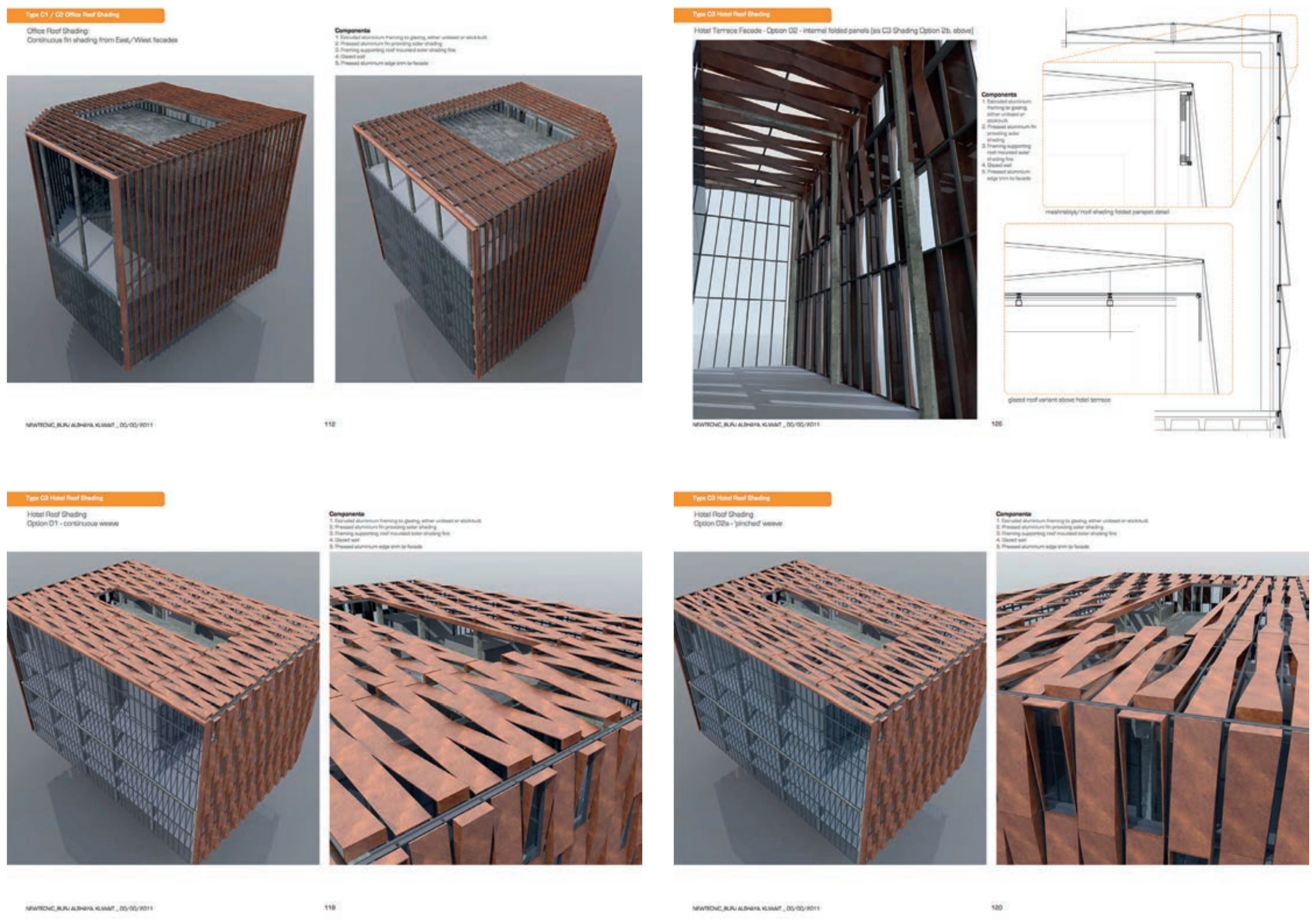
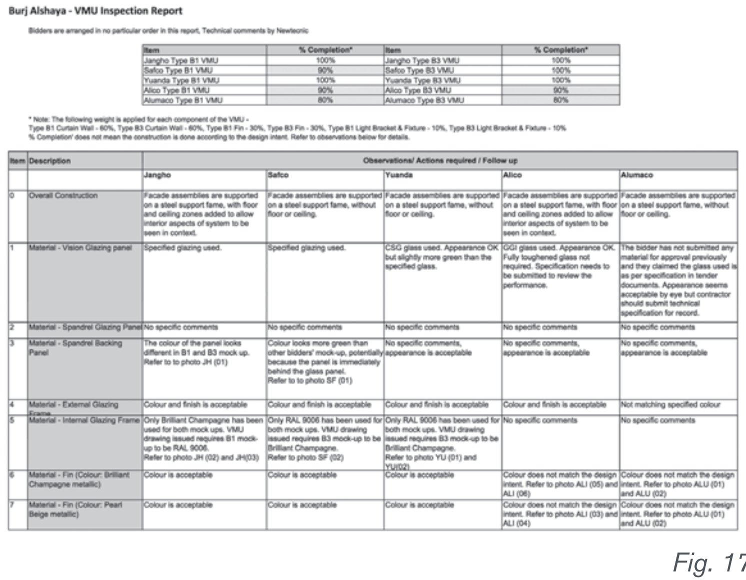


Fig. 16



Burj Alshaya - VMU Inspection Report

Bidders are arranged in no particular order in this report, Technical comments by Newtecnic

Item	% Completion*	Item	% Completion*
Jangho Type B1 VMU	100%	Jangho Type B3 VMU	100%
Safco Type B1 VMU	90%	Safco Type B3 VMU	100%
Yuanda Type B1 VMU	100%	Yuanda Type B3 VMU	100%
Alico Type B1 VMU	90%	Alico Type B3 VMU	90%
Alumaco Type B1 VMU	80%	Alumaco Type B3 VMU	80%

* Note: The following weight is applied for each component of the VMU -
Type B1 Curtain Wall - 60%, Type B3 Curtain Wall - 60%, Type B1 Fin - 30%, Type B3 Fin - 30%, Type B1 Light Bracket & Fixture - 10%, Type B3 Light Bracket & Fixture - 10%
% Completion' does not mean the construction is done according to the design intent. Refer to observations below for details.

Item	Description	Observations/ Actions required / Follow up				
		Jangho	Safco	Yuanda	Alico	Alumaco
0	Overall Construction	Facade assemblies are supported on a steel support fame, with floor and ceiling zones added to allow interior aspects of system to be seen in context.	Facade assemblies are supported on a steel support fame, without floor or ceiling.	Facade assemblies are supported on a steel support fame, without floor or ceiling.	Facade assemblies are supported on a steel support fame, with floor and ceiling zones added to allow interior aspects of system to be seen in context.	Facade assemblies are supported on a steel support fame, without floor or ceiling.
1	Material - Vision Glazing panel	Specified glazing used.	Specified glazing used.	CSG glass used. Appearance OK but slightly more green than the specified glass.	CGI glass used. Appearance OK. Fully toughened glass not required. Specification needs to be submitted to review the performance.	The bidder has not submitted any material for approval previously and they claimed the glass used is as per specification in tender documents. Appearance seems acceptable by eye but contractor should submit technical specification for record.
2	Material - Spandrel Glazing Panel	No specific comments	No specific comments	No specific comments	No specific comments	No specific comments
3	Material - Spandrel Backing Panel	The colour of the panel looks different in B1 and B3 mock up. Refer to to photo JH (01)	Colour looks more green than other bidders' mock-up, potentially because the panel is immediately behind the glass panel. Refer to to photo SF (01)	No specific comments, appearance is acceptable	No specific comments, appearance is acceptable	No specific comments, appearance is acceptable
4	Material - External Glazing Frame	Colour and finish is acceptable	Colour and finish is acceptable	Colour and finish is acceptable	Colour and finish is acceptable	Not matching specified colour
5	Material - Internal Glazing Frame	Only Brilliant Champagne has been used for both mock ups. VMU drawing issued requires B1 mock-up to be RAL 9006. Refer to photo JH (02) and JH(03)	Only RAL 9006 has been used for both mock ups. VMU drawing issued requires B3 mock-up to be Brilliant Champagne. Refer to photo SF (02)	Only RAL 9006 has been used for both mock ups. VMU drawing issued requires B3 mock-up to be Brilliant Champagne. Refer to photo YU (01) and YU(02)	No specific comments	No specific comments
6	Material - Fin (Colour: Brilliant Champagne metallic)	Colour is acceptable	Colour is acceptable	Colour is acceptable	Colour does not match the design intent. Refer to photo ALI (05) and ALI (06)	Colour does not match the design intent. Refer to photo ALU (01) and ALU (02)
7	Material - Fin (Colour: Pearl Beige metallic)	Colour is acceptable	Colour is acceptable	Colour is acceptable	Colour does not match the design intent. Refer to photo ALI (03) and ALI (04)	Colour does not match the design intent. Refer to photo ALU (01) and ALU (02)

Fig. 17

Fig. 18-19

Fig. 20-22

Fig. 23-25

Fig. 26-28

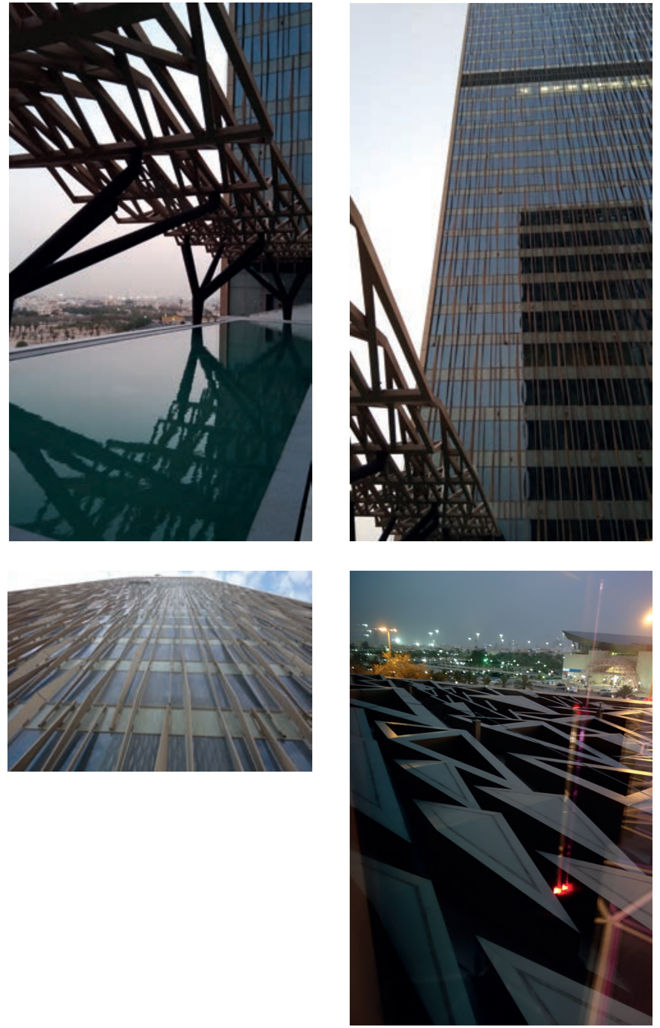


Fig. 29-32

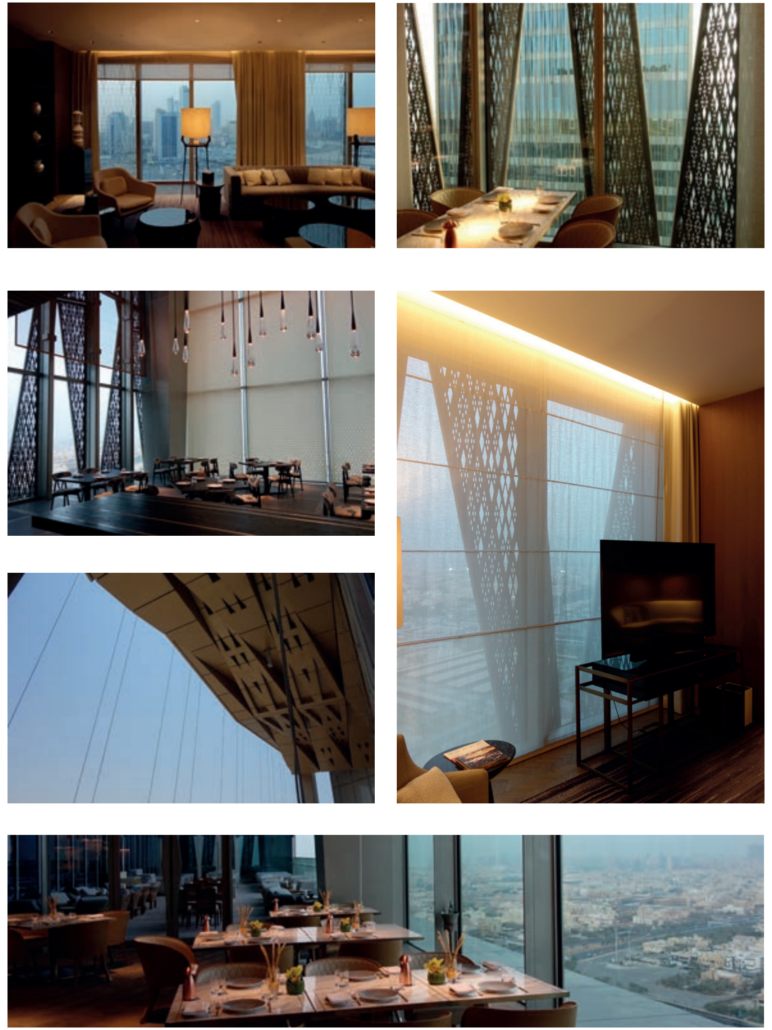


Fig. 33-38

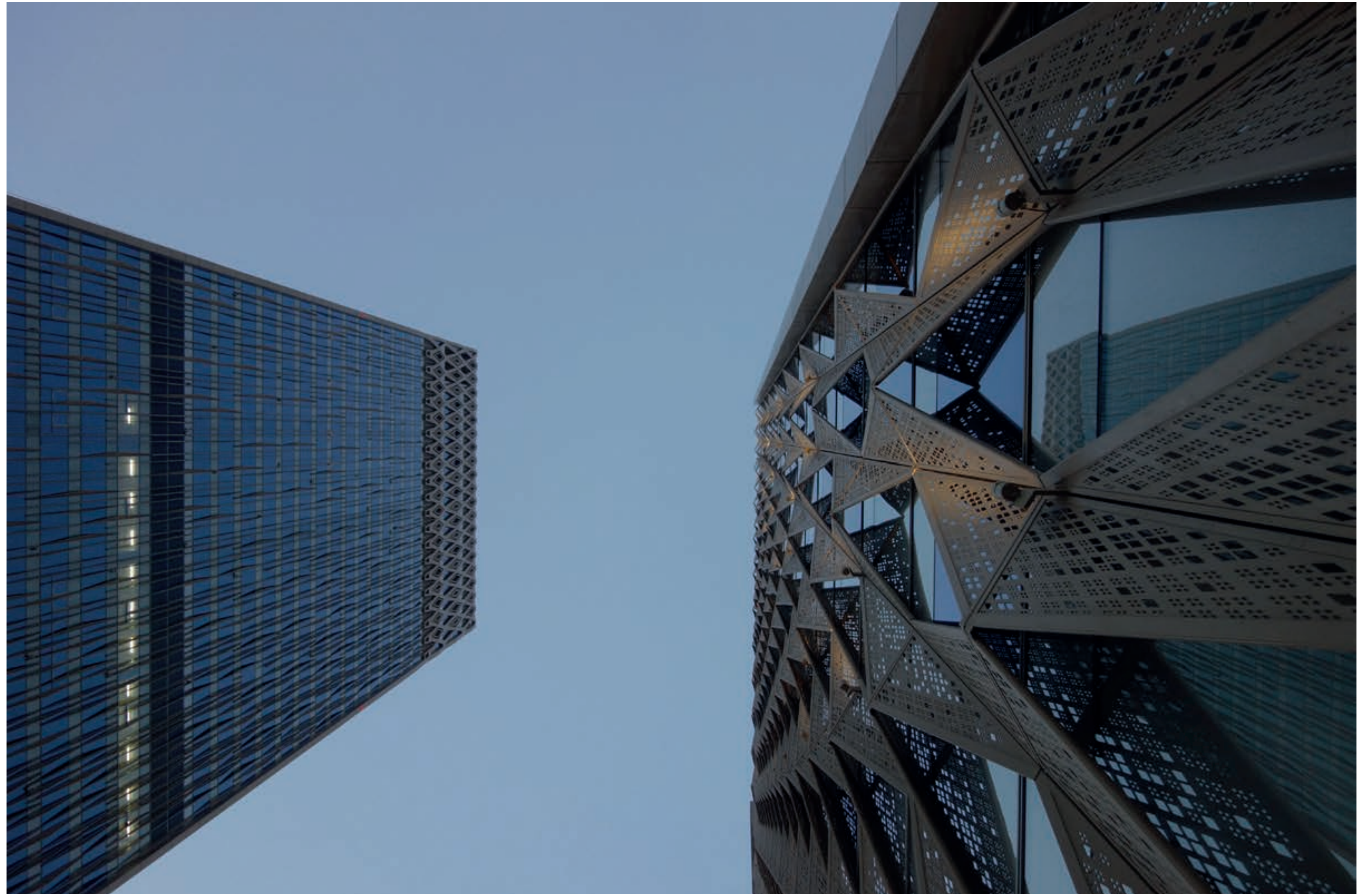


Fig. 39

set for an inspection before decision-making[6]. Contextual resilience needed to be expanded in the future with consideration of the following:

Constructability
Materials
Colour & Finish
Unitised Frame system
Bracket to primary structure system
Bracket to light fixture system
System - Fins.

Conclusion

The paper examined the design of Mashrabiya as a main facade component of Burj Alshaya Center in Kuwait. It defined the resilience of its geometry as a capacity to adapt to dynamic conditions. Brief complexity evolved in the design process. The conditions are environmentally articulated with open/closed enclosures, height progressions, horizontal or vertical positions and orientations – or functional – for work, living, and leisure. But the dynamism arises in the design when the particular local contexts demand varied combinations of both sides. They got more complicated as the cultural sensitivity was taken into considerations as another factor. The paper argues that the notion of resilience is to be expanded to contextual factors, and the facade geometry plays a key role in achieving contextual resilience in the design process.
The next step is to position the notion of resilience in the context of construction and respond to the changes that occur due to technological limitations, constructability issues in the local market and the current cultural tastes and market trends, which were discussed in the paper as forces that challenged the contextual resilience of the facade, set in the design process.

Mashrabiya is a reference to regional architectural traditions that have survived the last few hundred years. Its loose definition enabled various interpretations to respond to the changing cultural sensitivities of each era. There are some strict arguments about what makes the applied Mashrabiya authentic among its precedents such as its functional role or environmental performance with an aim to differentiate them from what may be called fake or pseudo-Mashrabiya.

Although the re-interpretation of Mashrabiya is welcomed with innovations, such as high tech facade systems or materials or its new functional status as a re-programmed occupiable space, the question of the identity still remains open for those facades to which the term refers. It is agreed that environmental and functional roles are essential, making Mashrabiya authentic, but it is its cultural resilience that makes it acceptable as Mashrabiya, other than a sustainable screen system or inhabitable double skin facade. Therefore, rethinking the facade resilience is crucial to making it more inclusive of cultural, environmental, and functional contexts and re-defining contemporary Mashrabiya.

Client	Alshaya Property Development Co. W.L.L.
Hotel Operator	Four Seasons
Lead Architect	Gensler (pre-concept to DD 100%)
Local Architect	KEO (submissions/negotiations w/ the regional authorities, tender and construction drawing packages)
Interior	Yabu Pushelberg
Landscape	Gensler
Facade	Newtecnic
Structure	KEO
MEP	KEO
Hospitality Tech.	Spartan Comms
Kitchen	Sirico
Misc.	BMU, VT, Wind consultants

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Gensler, Burj Alshaya - VMU Inspection Report (2013)

Newtecnic, Design Team Meeting Report 01, 03, 07 (2011)

Newtecnic, Design Development Report (2012)

Images

IMG1	*Mashrabiya example; https://karianna11.wordpress.com/2010/11/16/daylight-design-of-buildings/*
IMG2	*Kuwait City (Photo Credit. Gensler)*
IMG3	*Gensler SD Report, Architectural Character*
IMG4,5	*Gensler GDEA board 1*
IMG6	*Gensler SD Report, Executive Summary*
IMG7	*Gensler Burj Alshaya Booklet, Diamond Patterns*
IMG8	*Gensler GDEA board 2*
IMG9,10	*Gensler digitaLAB facade & canopy study*
IMG11	*Gensler DD Report, Canopy Renders*
IMG12	*Gensler DD Report, Pool Canopy Renders*
IMG13,14	*Gensler DD Report, Aerial Views*
IMG15	*Newtecnic Report, West Office Facade*
IMG16	*Newtecnic Report, Hotel Facade*
IMG17	*Newtecnic Report, Hotel Facade*
IMG18	*Newtecnic Report, Hotel Facade*
IMG19	*Newtecnic Report, Environmental Analysis*
IMG20	*Newtecnic Report, Office Roof Shading*
IMG21	*Newtecnic Report, Hotel Terrace Facade*
IMG22	*Newtecnic Report, Hotel Roof Shading*
IMG23	*Newtecnic Report, Hotel Roof Shading*
IMG24,25	*Gensler VMU Inspection photos*
IMG26	*Gensler VMU Inspection Report*
IMG27	*South Facade Construction (Photo Credit. Gensler)*
IMG28	*Office East Facade Construction (Photo Credit. Gensler)*
IMG29,30	*Office East Facade Construction (Photo Credit. Gensler)*
IMG31	*Hotel East Facade Completion (Photo Credit. Gensler)*
IMG32	*Hotel West Facade Completion (Photo Credit. Gensler)*
IMG33~35	*Podium Canopy Construction (Photo Credit. Gensler)*
IMG36	*Podium Canopy Completion (Photo Credit. Gensler)*
IMG37	*Podium Canopy & Office Facade Construction (Photo Credit. Gensler)*
IMG38	*Office Lobby Completion (Photo Credit. Gensler)*
IMG39	*Canopy Completion (Photo Credit. Gensler)*
IMG40,41	*Guest Room Completion (Photo Credit. Gensler)*
IMG42,43	*Specialty Restaurant Completion (Photo Credit. Gensler*
IMG44,45	*Tower Terrace Roof Completion (Photo Credit. Gensler)*
IMG46,47	*Two Towers Completion (Photo Credit. Gensler)*

Notes

Wessel de Jonge

wessel de jonge architecten bna bv; Rotterdam, Netherlands

Wessel de Jonge (1957) graduated in architecture from TU Delft, the Netherlands. As a partner in Wessel de Jonge Architects in Rotterdam, his portfolio includes the restorations of the Netherlands Pavilion at the Venice Biennale by Gerrit Rietveld of 1953 and of the former Sanatorium 'Zonnestraal' in Hilversum by Duiker & Bijvoet of 1926-31, as well as the rehabilitation of the Van Nelle Factory in Rotterdam by Brinkman & Van der Vlugt of 1926-30. Recent projects include the restoration and adaptive reuse of Aldo van Eyck's 1960 Orphanage in Amsterdam. He is also a partner in the design team for the ongoing revitalisation of the 1938 Olympic Stadium in Helsinki.

In 1990 Wessel de Jonge was the Founding Secretary of DOCOMOMO International, and in 1994 he started the DOCOMOMO International Specialist Committee on Technology. He has published extensively and lectured internationally on various aspects of Modern Movement heritage. Since 2015 he is full professor in Heritage & Design at the Faculty of Architecture and the Built Environment at TU Delft. Wessel de Jonge will speak about the re-use of the GAK-Office Building (Gemeenschappelijk Administratie Kantoor) built in 1959 from the architect Ben Merkelbach in Amsterdam. The building has been modified into housing providing small starter-appartements ('de studio').

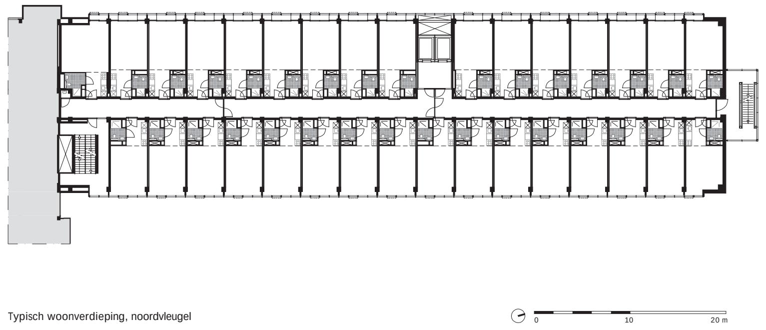
Fig. 1: The GAK building 1969 seen from the parking (image: www.gahetna.nlphotographer unknow / Anefo)

From Office to Housing. The GAK-Building became 'de studio'

The Amsterdam district of Bos en Lommer is undergoing a true metamorphosis that addresses a growing socio-economic dynamism in an innovative residential and working area. Centrally located in this area, the office building of the Gemeenschappelijk Administratie Kantoor (GAK) was built from 1957-59 after a design of the architect Ben Merkelbach, who was the city-architect of Amsterdam from 1956-61. Clad with green coloured glazing the building was nicknamed “The Aquarium" from the very beginning.

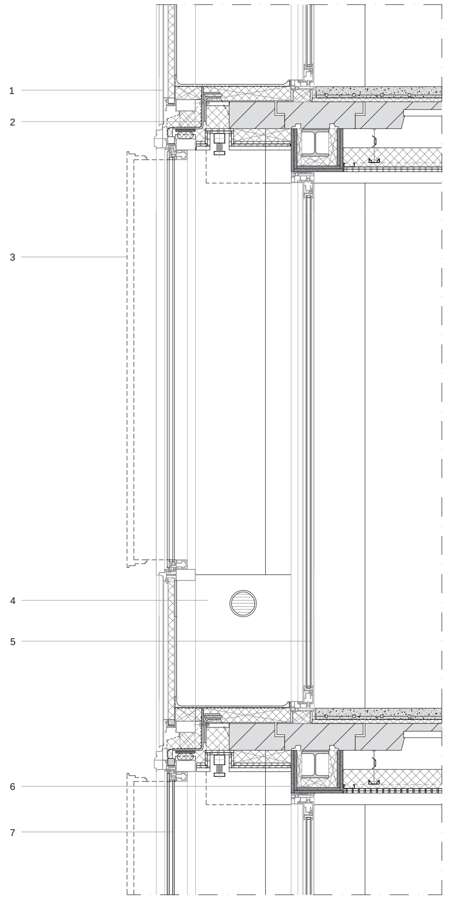
This huge office building of nearly 40.000 m^2 along the A 10 highway hosted 3.000 people. Employees were divided into departmental "villages" of 12 to 28 staff to ensure the human scale in the large building. With a dimension of 155 m length and 47 m height the building has 11 floors and is divided into two wings, separated by a projecting central section. Being ultramodern at that time, the GAK building was equipped with escalators, air-conditioning, cold-heat storage in the groundwater and a curtain-wall with green double glazing. The GAK office was an early example of a fully air-conditioned building in the country. Only the windows in the canteens and the ground floor could be opened.

GAK gebouw, Amsterdam



Typisch woonverdieping, noordvleugel

GAK gebouw, Amsterdam



1 aluminium gevelsysteem - 2 bestaande stalen constructie - 3 PAF-ramen, uitzetbaar tot 135mm - 4 geisoleerde ventilatiebox - 5 aluminium schuifpuisysteem met HR++ beglazing - 6 stalen constructie, brandwerend afgewerkt - 7 dubbele beglazing, groen Parsol

Gevelfragment verticaal, westgevel

Fig. 2/3/4: New elevation, typical apartment floor and detail of the new double facade installed to improve sound insulation and comfort.

Despite its original innovative character, the building suffered from vacancy since 2005 and became a blind spot in the neighbourhood. After various feasibility-studies which our office has conducted for various programs for property developer AM and Housing Corporation Stadgenoot, the functional program that was finally adopted involved residential studios for starters while the two lowest floors are hosting businesses and a lounge area. Some of the apartments are offered in the student rental sector. With moderate purchase prices, the concept of compact living at a location within the A10 ring road has proved successful. The apartments of about 28 m2 are accessed through a spacious entrance hall with service desk, laundrette, coffee outlet and other common facilities. The lifts, halls and hallways feature daylight and a distinctive color scheme that increases recognisability. A challenge was to cope with the extreme requirements for noise protection which resulted in a new double facade construction.

The ground floor and basement are redeveloped into multifunctional premises, the interior of which is designed by Zecc architects commissioned by The Amsterdam Company. These areas play an important role as a meeting space of the complex. The livelihood is further enhanced by interacting with the renovated city park with the original sculpture pavilion of the architect Enrico Hartsuyker, which is also used by The Studio's residents. Due to the combined facilities and the green environment, the new residential community developed into a “vertical neighbourhood” in a short time.

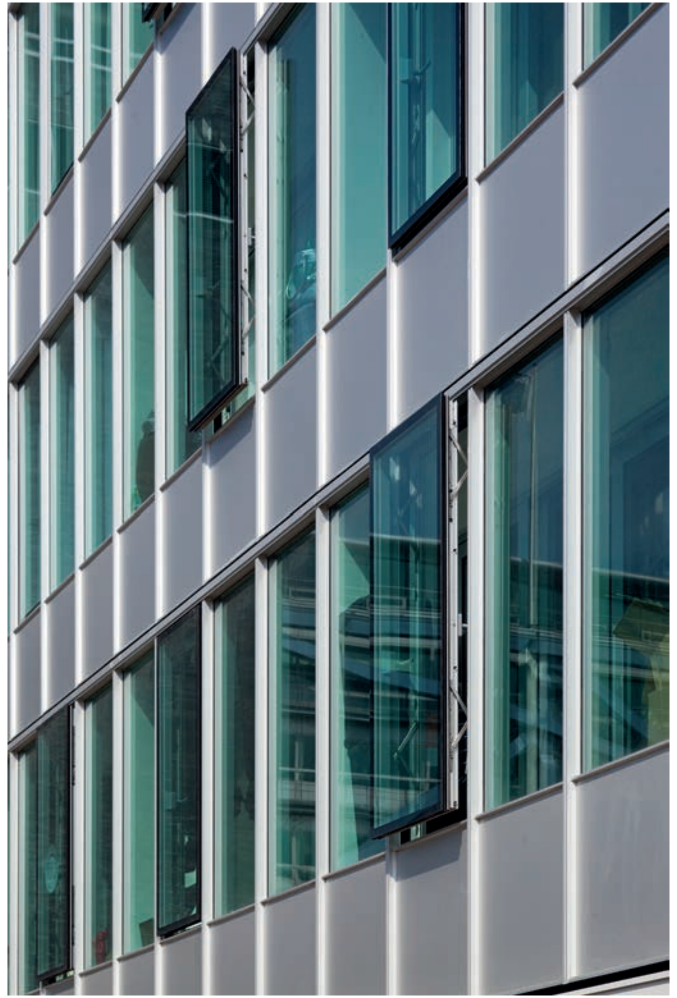


Fig. 5: The new double facade is referring to the original facade in colour and materiality.

Notes

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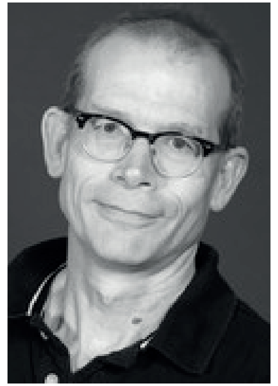


Michel Melenhorst studied at Delft Technical University and the Politecnico di Milano. Melenhorst worked as an architect for the offices of Wiel Arets (1991-1995) and Rem Koolhaas OMA (1995-1999) before starting his own office M in 1999. 2005 He became a partner in DAAD Architects till he made the switch in 2012 to Detmold Germany to hold the chair for Contextual Design, building transformation, reuse and cultural heritage at the Hochschule Ostwestfalen Lippe/ University of Applied Sciences, since 2012.

Till 2012 Michel Melenhorst was in the editorial Board of the web platform ´the Netherland will change´, a professional platform for knowledge exchange and a database with best practices on new and experimental developments in spatial planning and architecture.

Besides the Detmold school Michel Melenhorst has an extensive experience in teaching and lecturing at i.e. TU Delft, KTH Stockholm, Design Academy Eindhoven, the Pontificia University in Quito Ecuador the La Salle University in Bogota Colombia, Hafencity University Hamburg, Aarhus School of Architecture and at the Academy of Architecture Groningen and most recently at the University of Antwerp and the K´Arts - National University of the Arts in Seoul.

Michel Melenhorst is member of Docomomo international and is active in Docomomo Deutschland workgroup education. At the HS OWL he is coordinating the Master Architecture, is speaker for the research group ConstructionLab and is a member of the UrbanLab.

Fig. 1: Monseigneur Schrijnenhuis

Dirk Roosenburg and Fritz Peutz, seismic-resistant building in the 1930s in Heerlen, the Netherlands

The influence of architectural personality on decisions regarding resilient façade constructions of Dirk Roosenburg's Oranje Nassau Mines Office Building and Fritz Peutz´s Monseigneur Schrijnen Retreat House.

Abstract

Coal mining in Dutch Limburg eroded a widespread area with a labyrinth of subterranean shafts and tunnels. Instability and unexpected movements in the subsoil caused by collapsing cavities are affecting building foundations to this day. Similar problems are occurring in the north of the Netherlands due to the exploitation of natural gas. Almost 90 years ago, in the city of Heerlen, two modernist architects, Roosenburg and Peutz, dealt with this seismic movement of the subsoil in the design of their buildings. Although their goals were the same – to find resilient solutions for building on unstable foundations - the measures they took to achieve these goals were very different.

Roosenburg started his career in the office of Berlage. The open floor plan and the steel structure of Berlage's Holland House in London formed a permanent inspiration for Roosenburg. The finely meshed, structural segmentation, in a simple overall volume that he used for the 1931 Oranje Nassau building, holds a clear reference to the Holland House.

Fritz Peutz´s retreat for catholic nuns, only two kilometres away from the Oranje Nassau building, is an icon of Dutch expressive modernism. It takes up the Dudok heritage: a suprematist composition, expressing the building´s programme and connecting it with the surrounding landscape. To realise his architectonic intentions on a site that was expected to incline two meters, Peutz had to solve a contradiction between an architectural wish - massive intersecting volumes - and the constructive need for a lightweight, adjustable construction.

The paper describes the precautions that Roosenburg and Peutz took, in both their façade design and the primary construction, to make their buildings resilient to expected deformations. It highlights the constructive differences and similarities between them, used to solve comparable problems but based on two different architectural languages. Moreover, it illustrates how the solutions found to tackle the threats of cracks and other severe building damage proved helpful in appropriately restoring the two buildings. With these two ´old examples´, the paper will give some inspiring directions for our contemporary building practice in how to establish resilient building structures through an intelligent fusion of architecture and engineering.

Historic resilient façade construction // regional contextual modernism

Introduction
In recent years, the Netherlands has seen a renewed surge of interest in building in areas with unstable subsoil conditions. Decades of gas extraction in the north of the country have destabilised the subsoil, and minor earthquakes and subsidence are almost commonplace. The consequences are considerable: cracking and other damage to thousands of buildings, homes being declared uninhabitable, legal claims, and much human suffering. The disruptive effects of gas extraction on the soil conditions and ground strength were initially not deemed to necessitate constructional measures. However, a design has now been prepared for the Dutch Practical Directive (NPR), which standardizes what needs to be considered in certain areas. (1) From around 1900 to 1970, large-scale coal mining took place in the south of the Netherlands. The South Limburg subsoil is eroded with a labyrinth of subterranean shafts and tunnels. Not long after the mining industry started to boom, it became clear that mining galleries, fault lines, changing rock formations and subsoil layers – with or without load bearing capacity – were having a significant influence on building practice in Limburg. Where possible, architects and constructors took account of this in the structural design and architectural choices for their buildings.

Based on a description of the structural and architectural characteristics of two buildings from the late 1920s and early 1930s – the Monseigneur Schrijnen Retreat House by the architect Frits Peutz (hereinafter: the Retreat House), and the Oranje Naussau Mines Office Building by Dirk Roosenburg (hereinafter: the Oranje Nassau building) – it becomes clear how the programme, location, personal preferences of the architects, building technique and

Fig. 2: Oranje Naussau Headquarters

materials, as well as a healthy dose of experimentation determined how these two architects tackled comparable constructive challenges in a way that was entirely their own. (Fig. 1, 2)

The architects Roosenburg and Peutz
We can discern several interesting similarities in the careers of Roosenburg and Peutz. They both studied at the Technical University in Delft, and started their studies as civil engineers but ended up as architects. Roosenburg and Peutz both started working as independent architects after a short stint in employment. They were both known for their meticulousness and accuracy regarding design and execution. Obviously, they were not completely the same: Roosenburg can be characterised as a pragmatic functionalist, and Peutz as a spatial functionalist. Whereas Roosenburg was cosmopolitan, a citizen of the world, erudite, and not religious,

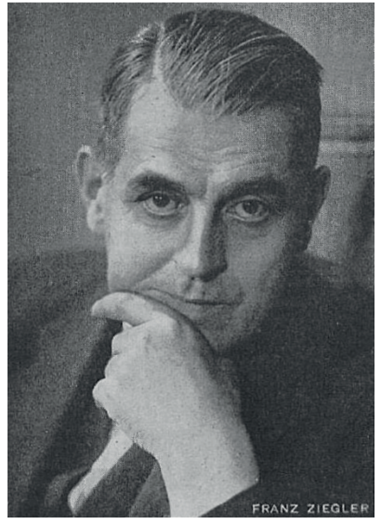


Fig. 3: Dirk Roosenburg

Fig. 4: Frits Peutz

Peutz's roots were in the provincial town of Uithuizen in the northern Netherlands, from where his parents sent him for his secondary school education to Rolduc in southern Limburg – a bulwark of conservative Catholicism. Peutz was a thinker, a deeply religious man with a strong philosophical bent. (Fig. 3, 4)

Roosenburg and the Oranje Nassau building
Many will have heard of Roosenburg as the grandfather of Rem Koolhaas. Koolhaas praises his grandfather for his professional skills, wisdom and charm, but does not regard him as a source of inspiration for his work. Roosenburg was highly pragmatic, and although very well-read and bestowed with many talents, he eschewed grand theories in his architecture.

Dorine van Hoogstraten characterises Roosenburg thus: “From an artistic point of view, his work was generally not extravagant or avant-garde because that was not his way of looking at things. For Roosenburg, quality was about the combination of constructive, functional and artistic aspects. He can certainly be considered modern when it comes to being forward-looking and innovative. He focused on contemporary types of buildings such as airfield buildings, offices and advanced hydraulic engineering works, and on innovative construction methods. He built for hypermodern companies such as KLM, Philips and Shell. He had little affinity with designers such as Granpré Molière, considering his work to be sentimental and troublingly retrogressive. At the same time, however, he considered architecture to be more than a lifeless and literal translation of the client's set of requirements. He set great store by expression and symbolism.” (2)

Apart from being an architect, Roosenburg was an excellent constructor and a competent networker who managed to connect with the biggest clients in the country from the outset of his carrier. He was a functionalist of the highest order who, however, was not overly constricted by style. He knew how to extricate the concept of style from functionality, and could thus work effectively in various circumstances and with a wide variety of clients.

After a short spell with the architect Luijck, Roosenburg's career as an architect began at the office of the renowned H.P. Berlage. From 1914 to 1918, his activities included working as a project manager for Berlage's Holland House, an office for the firm Müller & Co in London. This design was strongly inspired by the American

Fig. 5 inspiration Berlage the Holland House in London

Fig. 6: Oranje Naussau

school of architects, which included Sullivan. A steel frame allowed for a floor plan with a flexible layout, the façade has strongly vertical bands, the overall scheme is modest, with ornamentation and more luxurious materials being purposely applied in the entrance and stairwell. Roosenburg was a great admirer of Berlage; the sober scheme and flexible floor plan that he learned about there came to be recurring elements in his own oeuvre, not least in the Oranje Nassau design (3). (Fig. 5, 6)

In an article that Roosenburg wrote about the Oranje Nassau building in 1932 for the architecture magazine Bouwkundig Weekblad, he explains what he considered to be the main challenges of this assignment: “A maximum of programmatic flexibility to allow for future changes in use, and to erect a building on subsoil that is highly flexible, unstable and unpredictable” (4). He continues, “I did not find it at all easy to adjust to the opposite of all my experience of building. Fortunately, I received support from people who were familiar with the mining area, but people who have seen everything cracking and creaking around them start to realize that many efforts to prevent this have thus far been in vain.” (5) The mine engineers advised him not to oppose the movements but ′to go with the constructive flow′. In response, Roosenburg developed a construction principle that he compared to the segmented body of a caterpillar: “An elongated body composed of mutually moveable sections supported by multiple short legs. The caterpillar's lesson was observed. Flexible material, consisting of small segments, for the superstructure; minimum own weight; foundations with each segment on its own supports, which can move entirely freely of each other, possibly allowing mutual movement in horizontal and vertical directions.” (6) (Fig. 7, 8)

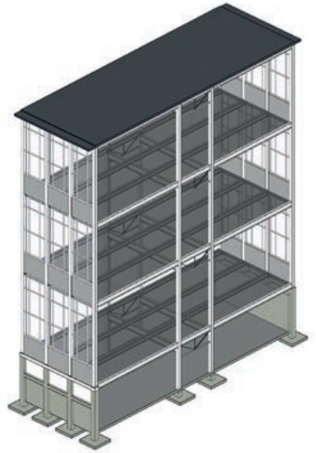


Fig. 7: The caterpillar principle

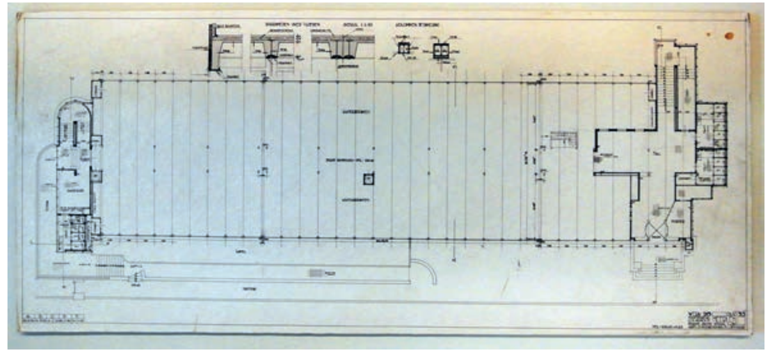


Fig. 8: Typical Floorplan

The main structure of the building consists of a steel frame with a bay distance in the façade of 0.9m. From the two façades to the central corridor the span is 6.30m, the corridor itself is 1.8m wide and is flanked by columns at a centre-to-centre distance of 2.7m. This gives rise to a simple rectangular building volume with stairwells and entrances at the head ends. The building has two expansions. As in the admired Holland House, the floor plans are flexibly configured. (Fig. 9, 10)

To make it possible for the "caterpillar segments" to move, all the connections between the casings, between the casings and the main structure and between partition walls, floor and supporting structure are in the form of sliding connections. Weight was kept to a minimum in many parts of the construction; the floors are made of pumice concrete where possible, and hollow terracotta elements are used for parapets. Insulating cork sheeting was applied to the cavity, over which the thin steel plate cladding was attached. The steel columns are founded on individual concrete bases, with the basement being placed as a separate construction between the steel columns and bases. All the bearings are executed with riveted connections, and the connecting holes are oval to be able to accommodate sliding movements. In case of strong deformation and damage to the riveted connections, extra safety bearings are provided for the steel beams. Particular care was given not only to the connections and the lightness of the materials; implementation was also characterised by extreme precision: All the iron parts were sandblasted and covered with a red lead primer. On site, a check was carried out for mechanical damage to the red lead primer, and new primer applied if necessary. Linen cloths soaked in red lead were applied between all connections between iron parts. (Fig. 11, 12, 13)

Fig. 9/10: open floorplans

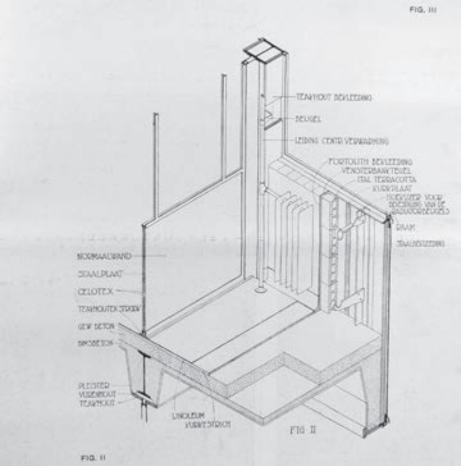


Fig. 11: section floor/partition/façade

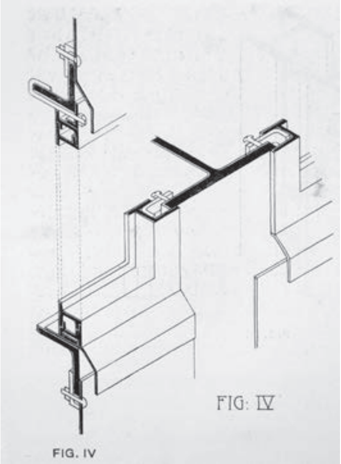


Fig. 12: window fixture

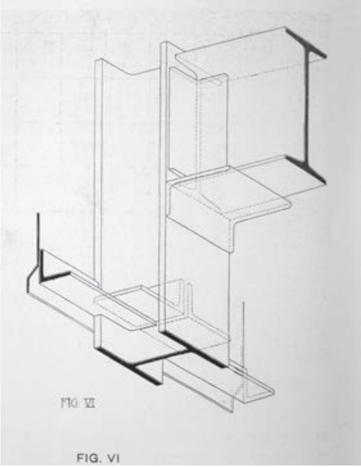


Fig. 13: additional support for beams

Fig. 14: Molenberg with the Retraite 1920/1940/2005

Peutz and the Retreat House

The Retreat House for nuns commissioned by the Catholic Monseigneur Schrijnenstichting foundation was to be erected on top of the Molenberg hill in Heerlen, a location that afforded a stunning view of the mining region, but which was also precisely above a fault line in the subsoil, where strong, irregular, unexpected and highly local subsidence could be expected. The conservative Catholic community had always had its buildings constructed in a traditional manner, i.e. in brick or natural stone. It was quite something for the clients to decide to work with a ´modern´ architect like Peutz. What probably convinced them in the end is that Peutz took religious matters very seriously, and that he was not only a very experienced architect regarding constructions, but was also a seeker who was fascinated by eternal questions of time and space. (Fig. 14)

“We can only grasp space by imparting the perception of time to the concept of space, but conversely, we only approach the concept of time through the spatial perceptions of movement and rest (7), and “The plasticity of the building does not serve first and foremost to accommodate the functional components but should be seen as a composition that responds to the environment, which engages in connections with landscape and building, but is also a complete composition in itself.” (8) Typical statements by Peutz as a spatial functionalist. Although he is often seen as an architect in the expressive school of Dudok, his work was both more functional and more ´spiritual´. He was a great admirer of Duiker; the circular staircase in the Retreat House is a clear architectural quote referring to Duiker's Zonnestraal sanatorium, but functionalism had different connotations for Peutz. Geert Bekaert wrote the following about the Retreat House: With its clarity, tautness and honesty, it does not only manifest an "international style" in its specific situation in the landscape. It internalises and personalises the style as if it had been invented there on the spot. (6)

The Retreat House reveals many of Peutz´s architectural fascinations, such as the pulsing spatial sequences of movement and the special connection between building and landscape. With the Retreat

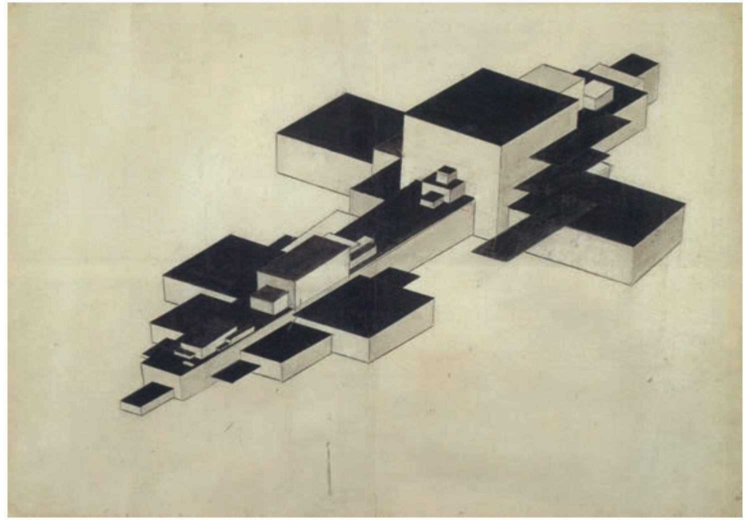


Fig. 15: building and ornament ilia Chashnik, supremolet 1927

Fig. 16: Peutz Retraite

Fig. 17/18: spatial sequence in the Retraite, entrance, stairs, hall, ´veranda´

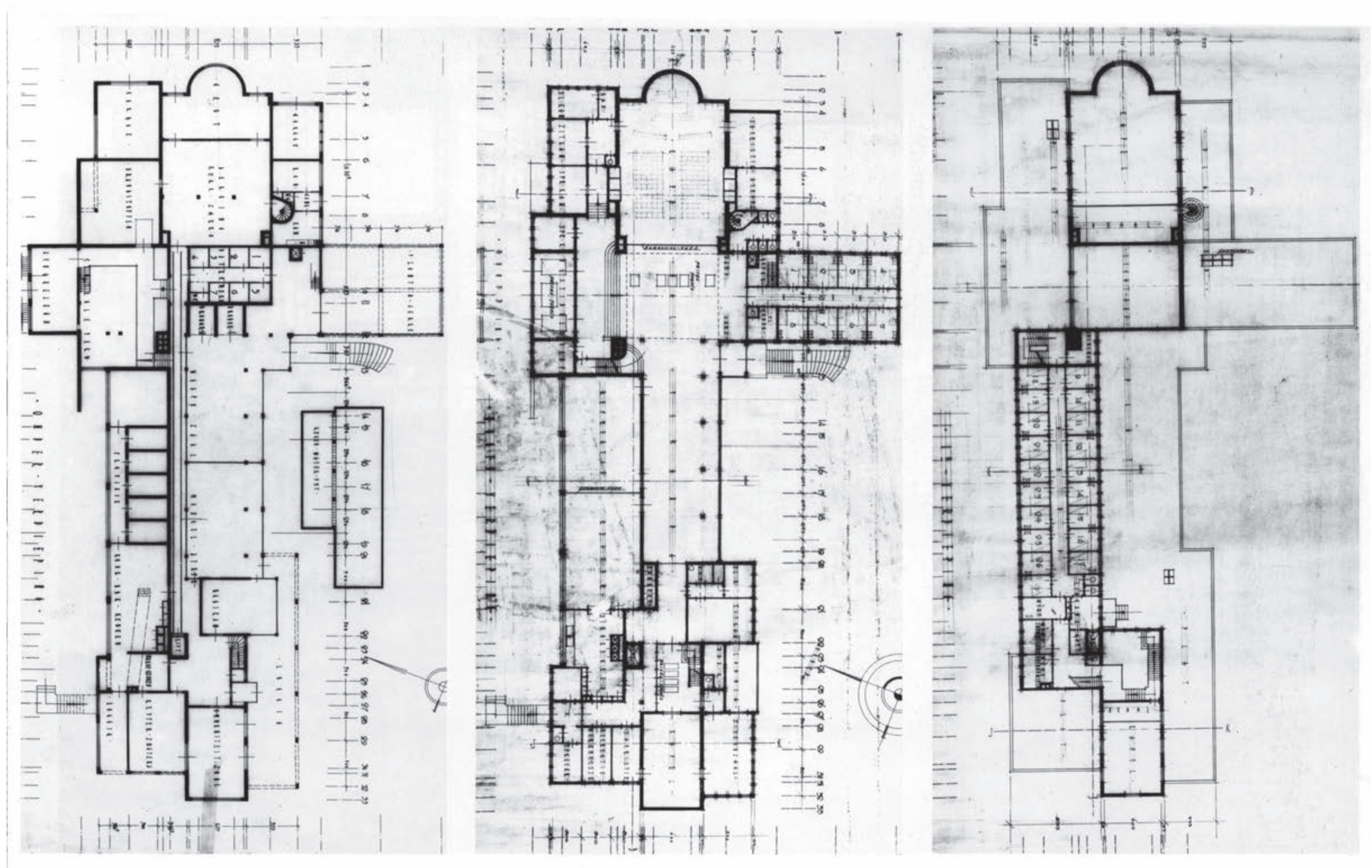


Fig. 19: Retraite floorplans

House, Peutz also takes an important step regarding the theme ´building and ornament´: the plasticity of the building as a whole becomes ornament. (Fig. 15, 16, 17, 18, 19)

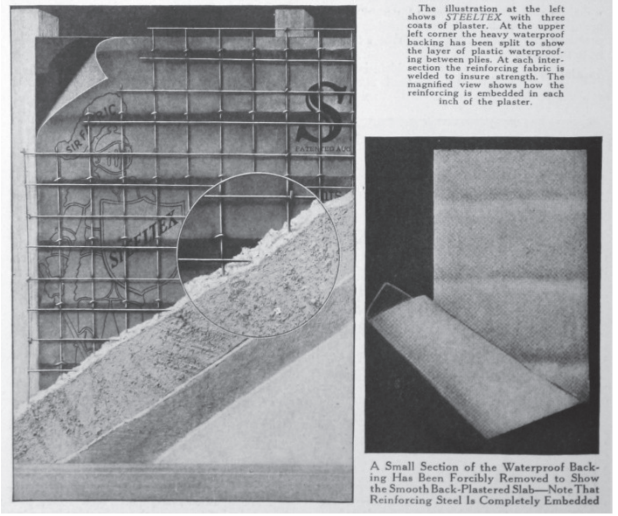
To fulfil his architectural wishes in this inspiring but unstable setting, with all its foundational problems, Peutz soon became aware that a solid structure for a building of the size of 22,000m2 would be impossible. Even a concrete skeleton with brickwork cladding would be too heavy and rigid. An enormous subsidence of as much as 2m was expected over a prolonged period, which, as Peutz put it, would not go down like the floor of a lift. After consulting with the Limburg mine engineers, Peutz eventually opted for a steel structure with light built-in components and lightweight but tough and strong cladding. All the parts from which the sculpture of the building was constructed spatially and functionally were divided into sections and founded separately; even the individual columns were adjustable horizontally and vertically at the column base. In the event of local subsidence, the columns can each be jacked and positioned independently of each other. To prevent cracking, the built-in walls and inner cavity walls stand unconnected on the concrete floors and do not have fixed connections to the steel frame. (Fig. 20)

The cladding was effected with a system imported from the US known as Steeltex. Steeltex is a network composed of 5x5cm grids of steel bars, with a backing of bituminized paper onto which plaster can be directly applied. The network is affixed to the main structure using a secondary steel structure and comprises extra supporting sections at façade openings. Sufficient expansions were applied so that movement in the steel frame would not lead to cracking

Fig. 20: steel structure Retraite

in the façade. Peutz used the linear patterns of the expansions in the façade to show that although the Retreat House consisted of solid volumes regarding composition, the outer walls of these volumes themselves were not solid. Peutz's craftmanship and the ensuing long, relatively problem-free existence of the building and construction are apparent from his description of the materials and constructions that he used. After many tests and specimens, Peutz was able to vary the directions for use of the product in such a way that an optimum solution was found for the local conditions, allowing a robust façade to be constructed. Peutz describes this process in the architecture magazine Bouwkundig Weekblad in 1934:

“The Americans stipulated the following for plastering the Steeltex:
1st layer: cement mortar 1: 1 3/4 with cow hair or hay, no lime, no



The illustration at the left shows *STEELTEX* with three coats of plaster. At the upper left corner the heavy waterproof backing has been split to show the layer of plastic waterproofing between plies. At each intersection the reinforcing fabric is welded to insure strength. The magnified view shows how the reinforcing is embedded in each inch of the plaster.

A Small Section of the Waterproof Backing Has Been Forcibly Removed to Show the Smooth Back-Plastered Slab—Note That Reinforcing Steel Is Completely Embedded

Fig. 21: Page 6 from: Better wall for better homes, national steel fabric corporation-Pittsburgh 1927

waterproof additives.
2nd layer: after the first layer is air-dried, after at least 26 hours, cement mortar 1:2 1/3, with an addition of lime only if there will be a coloured third layer and if necessary, with waterproof additives.
3rd layer: cement mortar 1:2 1/4, with a maximum of 10% whitewash or "Edelputz".

Our tests forced us to deviate from these directions. The second layer proved not to adhere well to the first layer. The plasterwork also developed wind cracks. We obtained good results with:
1st layer: 1 part cement to 3 parts sand.
2nd layer: before the first layer is air dry, apply 1 part cement to 3 parts sand and 1/4 lime, flatten and roughen.
3rd layer: after air-drying of the 2nd Montenovo plastering, flatten and

Fig. 22: Detail of damage to Stucco and STEELTEX Wire Lath

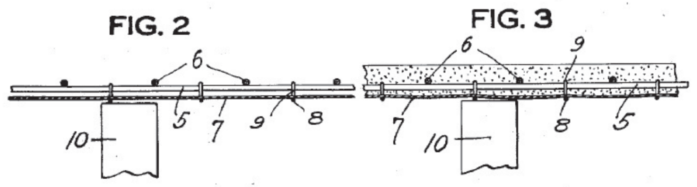


Fig. 23: from patent application 1597507 Steeltex, 1926

comb tool after 24 hours.

If the weather was wet and cold, we used Cockeril cement, and Enci when it was dry and hot. Pit sand yielded better results than river sand but we did not dare to use pit sand when there was a chance of frost.” (9) (Fig. 21, 22, 23)

Peutz set to work with great precision on each and every part of his building, and experimented a lot with low-tech solutions for the Retreat House. Particularly remarkable here are the use of a grey water circuit, the insertion of special prism glass building blocks in the floors to allow light to filter deep into the basement, and a sophisticated ventilation system with suspended ceilings and chimney pipes that brought about natural air circulation flows. (10) (Fig. 24, 25)

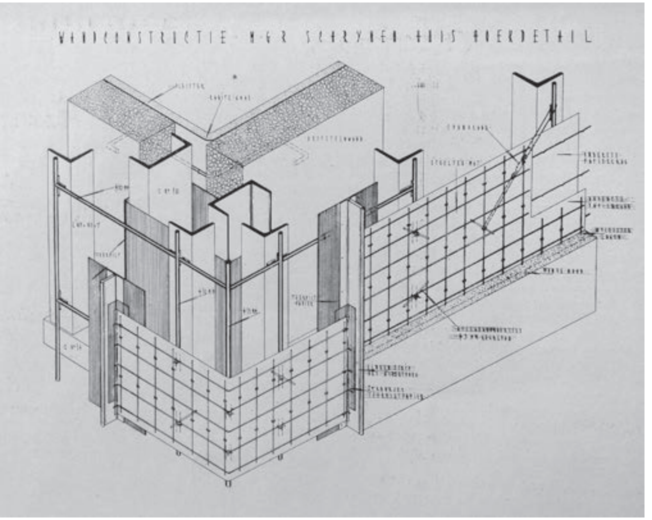


Fig. 24: corner façade detail Retraite

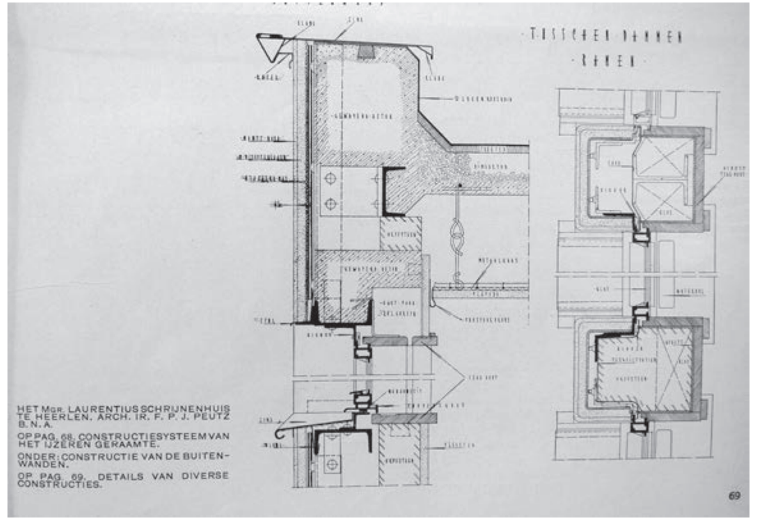


Fig. 25: Window and Fascia detail Retraite

From then on

Over the years, Peutz´s and Roosenburg's buildings changed ownership and function several times. In the 1960s, the Retreat House became a theological college, and in the 1990s, an office building with the architectural firm AGS as its main user. In 2003, AGS restored the Retreat House, winning the national public award for restoration. After the mines closed, the Oranje Nassau building, known until then as the "NV Mij tot Exploitatie van Limburgsche Steenkoolmijnen genaamd Oranje Nassau Mijnen" was also closed. The building was fully restored in 1995-1996 by architects firm Jo Coenen & Co Architecten, after which it was occupied by the Rijks Geologische Dienst (Geological Survey of the Netherlands). The building currently houses offices, storage space and despatch space for the dreaded assessment notices from the Dutch Tax and Customs Administration. The iron sidings were painted again in their original green colour for the restoration. (Fig. 26)

Both buildings, after having been in service for 85 years, are still in a very good state of repair. In both restoration works, the original building substance was retained to a remarkable extent. In both the Oranje Nassau building and the Retreat House, all the casings could easily be removed, cleaned and reused thanks to the sliding flexible connections. The occurrence of rust was minimal due to good working details and protection, and the thin outer cladding on the façade has also stood the test of time. The care Peutz took regarding implementation, varying the composition of the mortar applied according to the weather conditions, was undoubtedly a contributing factor in this. Moreover, the division of the sidings and the additional support underneath the sidings prevented cracks and fractures from occurring. The cladding of the Oranje Nassau building, too, has remained free of any significant damage for almost 100 years now due to the good working details, with sufficient tolerance, overlap and ventilation. (Fig. 27, 28)

Fig. 26: Oranje-Nassau after the restauration with its original green colour

Fig. 27/28: easy removal of window frames in the Retraite

The ´freedom of movement´ in the main structure and the flexibility of the connections between the inner layout, outer wall and main structure did indeed accommodate major subsidence and shocks, thus preventing damage. (The movement in the expansion joints in the Oranje Nassau building had already reached 3cm after only a few years!). Furthermore, the built-in units of inner walls and ceilings, which were applied separately, ensured that both buildings were multifunctional. The restoration of both the Retreat House and the Oranje Nassau building involved the implementation of remarkable energy concepts. A sophisticated functional layout that excluded work areas in sun-facing rooms made it unnecessary to apply additional outside sun protection or heat-absorbing glass. This means the façades remained virtually unchanged. The Oranje Nassau building and the Retreat House now both accommodate computer data centres, with computers that produce so much residual heat that it can be used for heating and cooling purposes. For the Oranje Nassau building, this meant that that the original single-glazing could be retained, while in the Retreat House, a relatively thin double-glazing was sufficient in the original casings. Thanks to this innovative climate concept, parapets and closed parts of the façade did not need fill-insulation for the restoration.

Conclusion

There are standards and directives governing the conditions for erecting new constructions in areas facing significant subsidence and seismic movements. Like many other standards and directives,

Fig. 29/30: Retraite before and after restauration

they are not without risk; simply following these conditions to the letter, often while taking into account an extremely short economic life-cycle of 40 years for new buildings, leads to uniform solutions with no leeway for creative, innovative designs that are inspired by their context.

These buildings by Roosenburg and Peutz show that there is another way of doing things; a strong architectural signature ensues in buildings that rise above mediocrity and are appreciated for their original character. The constructive insight of these two architects made them aware of the gaps in their knowledge and the need to fill these gaps with specialized knowledge; in this case, from the mine engineers who were more familiar than any with the situation regarding the local soil conditions, and the do's and don'ts of building in that particular area. And finally, they both possessed true architectural mastery, not only in the architectural design of their buildings but also regarding their knowledge of material properties and working details, which were essential to realize their architectural dreams in these specific, challenging locations. It is more than just a nice bonus that this shows that it is also possible to build for the long-term using simple, inexpensive materials such as cement, iron and glass. The innovative, experimental pleasure in working with the architectural constructive challenges that is evident from these buildings, and also the uncompromising awareness of quality in the work of Peutz and Roosenburg, aimed at an optimum and long-lasting functioning of their buildings, form an inspiration for our current building practice 85 years on. (Fig. 29, 30)

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Notes

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Oguz C. Celik's research interests lie mainly in various topics of structural and earthquake engineering. His current research has focused on analysis, design, and development of seismic energy dissipation members that could be used in new and seismically vulnerable structures. He has both research and application experience on seismic assessment and retrofit of existing buildings and bridges. Following the past devastating earthquakes in Turkey, he was in charge of design and retrofit of numerous damaged private and government buildings. Professor Celik's projects are funded by research institutions as well as by the construction industry. He made reconnaissance visits to earthquake stricken areas in Turkey and Italy. He teaches courses on statics, strength of materials, structural analysis, reinforced concrete structures, steel structures, and earthquake resistant building design. He has authored/co-authored 160+ journal papers, books, conference papers, and seminars. Oguz C. Celik delivered invited talks in USA, Japan, South Korea, China, and Turkey. Recently, he co-chaired ICBEST Istanbul and co-authored the conference proceedings titled "Interdisciplinary Perspectives for Future Building Envelopes". He is the member of many national and international professional institutions. In addition, he is in the editorial board of Journal of Steel Structures (Springer), guest edited two special issues in other journals, and is an active reviewer of many international journals.

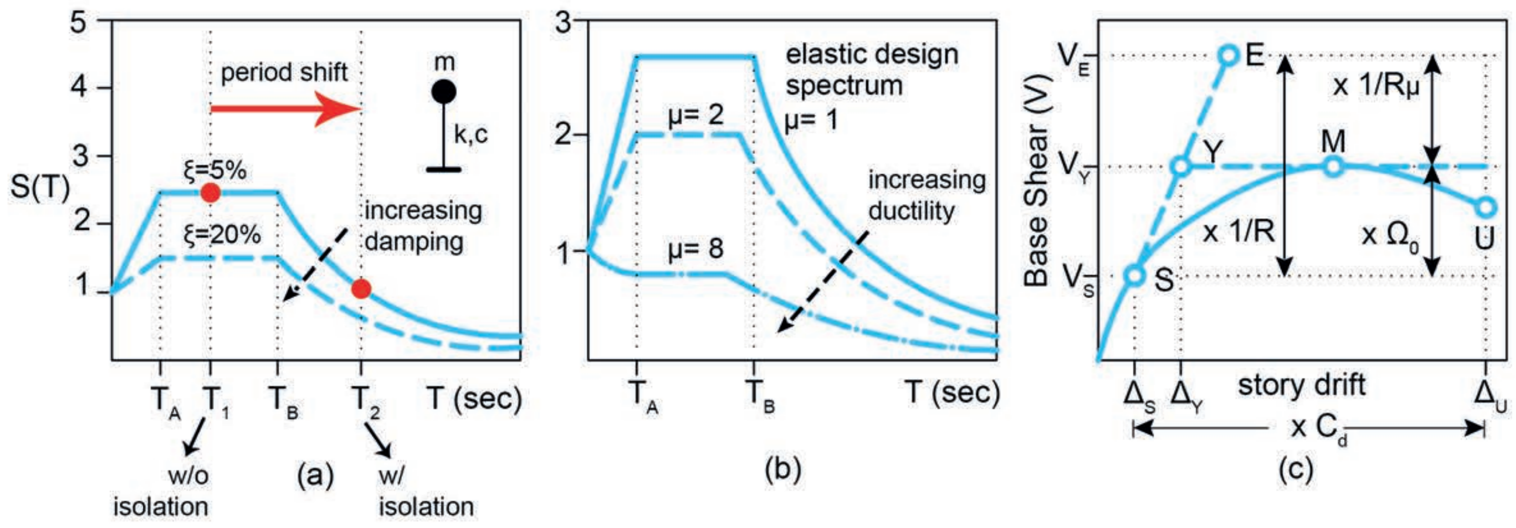

Fig. 1: Sample design spectrum curves a) Effect of damping b) Effect of ductility c) Base shear versus story drift curve and seismic performance factors

Holistic Seismic Behavior and Design of Buildings

Abstract

Some significant issues regarding the seismic behavior and design of buildings are given in brief. Load and resistance factor design (LRFD) is introduced and safety factors including the earthquake/seismic effects are discussed. Analysis methods as proposed in most seismic codes are mentioned. Special consideration is given to the design earthquake and performance objectives in seismic design. Theory of seismic resilience and recovery models are summarized. From the past earthquake reconnaissance investigations, types and reasons of seismic damages to building-like structures are listed and sample images from facade failures are provided. Ways of limiting nonstructural damages especially in facade systems are explained with the help of structural codes. Finally, existing seismic testing procedures for facade members are given.

Structural Design // Earthquake // Building Performance // Facade // Drifts // Testing // Resilience

Introduction

A thorough understanding of structural behavior is key and a firm foundation to enhance design skills of architects and engineers. Also, it has always been an issue to assess the real capacity of designed buildings against mostly known and unknown (largely variable) loadings. Fortunately, building design codes (both national and international) have much evolved over the course of time to deal with these dilemmas as correct as possible. Load carrying systems are composed of interconnected members that are supported in such a way that they are able to resist gravity loads from their own weight and other external loads. Principal loads can be classified as dead loads, live loads (floor, roof), snow loads, wind loads, earthquake (seismic) loads, rain, icing, temperature effects, water and earth pressure etc. Earthquake loads have a significant impact on structures and must be taken into special consideration in areas of major seismic activity such as the West Coast of the USA, Chile, Turkey, Italy, Japan, New Zealand etc. During earthquakes, seismic movements of the ground transmit accelerations to structure's every single structural and architectural member. It has always been a challenge in design phases how to combine these loads reasonably. During their lifetime, many structures will experience most of the loads listed above. Most of the modern building codes such as newly released ASCE 7-16 (Minimum Design Loads and Associated Criteria for Buildings and Other Structures) suggest load combination equations (a.k.a. load combos) for both ASD (Allowable Strength Design) and LRFD (Load and Resistance Factor Design) as introduced in ANSI/AISC 360-16 (2016).

Currently, LRFD procedure is usually followed not only in this code but also in many countries' codes. In this procedure, the design strength/capacity of each structural component equals or exceeds the required strength/demand determined on the basis of LRFD load combinations. Thus, design should be performed in accordance with Eq.1.

$$R_u \leq \emptyset R_n$$

where R_u is required strength obtained using LRFD load combinations, R_n is nominal strength, $\emptyset$ is resistance factor, $\emptyset R_n$ is design strength. Every member (including the facade components) of the structure to be designed should satisfy this equation in order to have a safe system. This is called as the strength approach in structural design. A load factor of 1.0 is generally taken into account for earthquake (E) loading. Other load factors are usually greater than 1.0 (due to relatively less probability of occurrence) and may vary in every national building code.

Buildings and their components should be well analyzed in a holistic way under the assumed load combinations. Modern building codes present three options for the dynamic analysis of structures: Linear time history analysis, response spectrum analysis, and nonlinear (inelastic) time history analysis. In dynamic analysis, linear elastic response is investigated for the entire response time history. Response spectrum analysis eliminates the time variable from the solution and again assumes linear elastic conditions although nonlinearity is taken into account with some behavior factors defined for each type of structural system. Lastly, nonlinear time history analysis accounts for post yield behavior of structures taking the time as variable. It has always been suggested so far that inelastic dynamic analysis is required for reliable seismic response prediction and design for buildings. On the contrary, there are still problems in lacking practicality in this process, Hart and Wong (2000).

With this basic information, this paper summarizes some significant/fundamental points of seismic design of buildings and their components. A holistic design approach for structural and nonstructural portions is proposed.

Design Earthquake

Most earthquake codes (e.g. ASCE 7-16, IBC (2015), Specification for Buildings to be Built in Seismic Zones (2007)) specify the spectral acceleration values for a maximum considered earthquake (MCE) with a 2475-year recurrence interval which is corresponding to a 2% probability of being exceeded (PE) in 50 years. Design basis earthquake (DBE) is described as two thirds of these values and corresponds to a 475-year recurrence interval (10% PE in 50 years). MCE is used especially for hospitals, schools (i.e. buildings with higher importance factor of I=1.5,1.4) while DBE is used for ordinary buildings such as residential buildings (i.e. I=1.0). In nuclear power plants and defense related facilities, a very low risk level of 1% PE in 100 years with a 9950-year recurrence interval can be used in design. (Fig. 1)

Typical elastic and inelastic design spectra for a single degree of freedom (SDOF) system are given in Figures 1a,b. These curves can be used in the equivalent force procedure which is widely followed in many low to mid-rise buildings having simple structural plan layouts.

Performance Objectives in Seismic Design

In general, a code-designed structure should be able to resist:

- A minor level of earthquake ground motion (GM) without damage
- A moderate level of GM without structural damage but possibly experience some nonstructural (i.e. architectural) damage
- A major level of GM having an intensity equal to the strongest, either experienced or forecast for the building site, without collapse, but possibly with some structural as well as nonstructural damage, Bruneau et al. (2011). (Table 1)

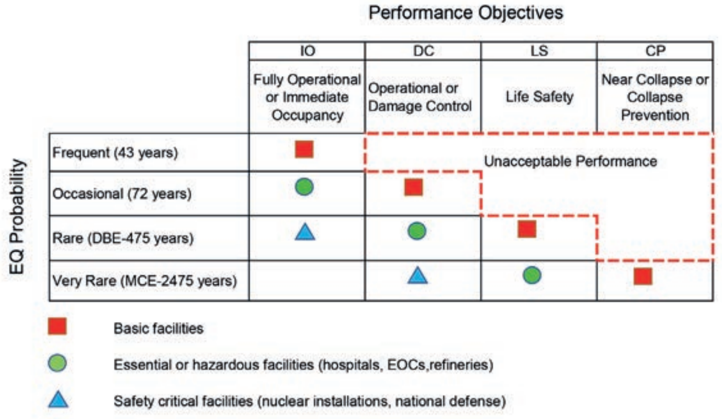

Table 1. Seismic Performance Objectives

Equivalent Force Procedure

Equivalent static force analysis is an assumed approximate method to simulate lateral earthquake loads for simple buildings. Basically, this method provides the engineer with a rough estimation of total horizontal force (i.e. base shear) on a structure following the basic equation of motion as given in Eq.2, Dowrick (2009).

$$V = ma$$

in which m is the mass of the structure and a is the seismic horizontal acceleration which could be in the range of 0.05g to 0.40g. A simpler way of this equation can be written as:

$$V = CW$$

where C is seismic response coefficient, W is the effective seismic weight that includes all dead loads (all permanent components and equipment), 25~30% of floor live loads, a portion (e.g.20%) of the snow load. C is a function of several factors such as effective ground acceleration (seismic zone) coefficient (A_0), building importance factor (I), spectrum coefficient ($S(T)$), and seismic load reduction factor (R). Note that, among them, R is of great importance for obtaining a better ductile seismic response and is dependent on the structural system type used (e.g. R=2.0 for masonry buildings, R=8 for both in-situ ductile RC and steel moment frames). Note that higher values of R factors are preferred since it results in a lower seismic load for the design of building. However, special emphasis should be paid on detailing issues to enhance performance during earthquakes.

For the distribution of horizontal loads along the height of the building, additional assumptions are made. Again, for simple, low to medium-rise buildings, the current lateral seismic force distributions in building codes are generally based on first mode dynamic solution of lumped multiple-degree-of-freedom (MDOF) elastic systems. For example, vibration mode shapes for a three-story building are illustrated in Figure 2. Therefore, a first mode deflected shape of the system as shown in Figure 2c is taken into consideration. This solution yields approximately an inverted triangular distribution for lateral earthquake forces resulting in larger story shear forces in the lower stories. (Fig. 2)

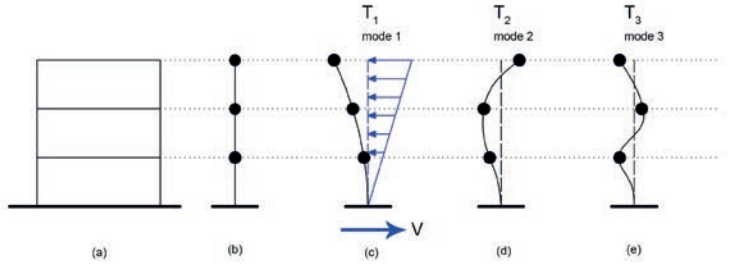

Fig. 2: Mode shapes for a three-story building a) Real building b) Idealized building c) 1st Mode and corresponding lateral loading d) 2nd Mode e) 3rd Mode

Seismic Resilience

Seismic resilience is characterized by reduced probability of system failure, reduced consequences due to failure, a reduced time to system restoration. Resilience (R_s , normalized shaded area as shown in Figure 3) is defined as a function indicating the capability to sustain a level of functionality (or performance) of a building or facade over a time (e.g. a life span). Change in functionality from seismic events is characterized by a drop and gradual recovery. Loss of functionality can be gradual or sudden following a strong earthquake, Cimellaro et al. (2009), Renschler et al.(2010).

It is possible to quantitatively define resilience. For example, fragility functions can be used for quantification. In functionality ($Q(t)$ in Figure 3) curves, different recovery paths such as linear recovery (average prepared community), trigonometric recovery (not well prepared community with lack or limited organization), and exponential recovery (well prepared community) can be considered. As an example for exponential recovery, such recovery occurred after the 2001 Nisqually earthquake. Calculation of seismic resilience through functionality losses makes use of the fragility functions that

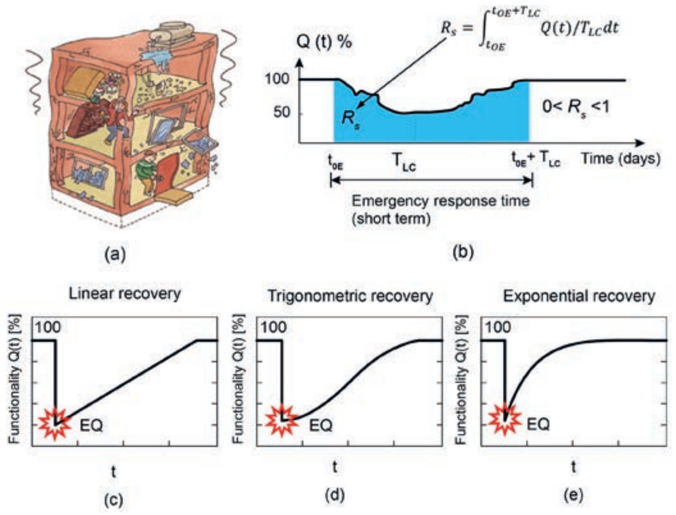

Fig. 3: Functional change versus time curves a) Shaken building b) Definition of resilience c,d,e) Recovery models

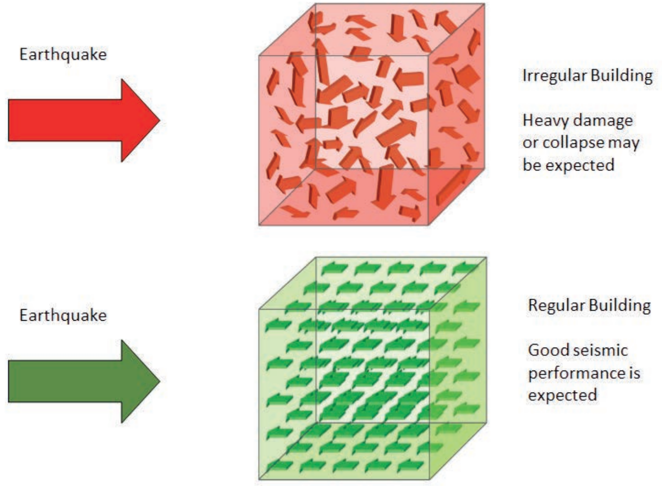

Fig. 4: Schematic explanation of irregular versus regular system behavior under seismic loads (adapted from Prof.Akira Wada's presentation)

show the reliability of the system to be analyzed. These functions represent the probability that response of a system (or structure) exceeds a given performance threshold. Response and response threshold are functions of the structural properties, ground motion intensity, and the time.

To achieve a high resilience, the community needs to be prepared and less vulnerable. Integrated façade engineering issues are discussed by Takeuchi (2017). Yalaz et al. (2016) investigated and classified observed damages and failures for a lifetime (15~20 years) in a set of existing low-rise and high-rise commercial buildings in Istanbul.

Seismic Damages To Buildings During Earthquakes

There are many lessons to be learned from past devastating earthquakes. These mistakes should be avoided in future new building or retrofit designs. Many buildings (poorly engineered or non-engineered) experienced heavy structural and nonstructural damages or totally collapsed during the past earthquakes. Widely observed structural damages are:

- Poor material properties (both concrete and reinforcing bars (rebars))
- Irregular structural systems (in plan layout (types A1, A2, A3) and elevation (types B1, B2, B3) as introduced in Seismic Code of Turkey)

Fig. 5. Various types of seismic damages to building structures: a) Nonstructural damage to a RC building in the 2016 Amatrice, Italy EQ b) Partial collapse of a masonry building in the 2016 Amatrice, Italy EQ c) Exterior nonstructural wall damage in RC building in the 2011 Van, Turkey EQ d) Brick sandwich wall failure in the 2011 Van, Turkey EQ e) Out-of-plane failure of exterior walls in the 1999 Kocaeli, Turkey EQ f) RC building failure from soil liquefaction in the 1999 Kocaeli, Turkey EQ (no damage to nonstructural members) g) Exterior nonstructural wall damage in RC building in the 2011 Van, Turkey EQ.

- Torsional irregularity
- Pounding of buildings in series (the hammering effect)
- Inappropriate rebar arrangement in RC members
- Nonductile detailing (lack of confinement in RC members, problems in beam-to-column connection regions)
- Insufficient cross section dimensions
- Short (or captive) columns (high cyclic shear forces)
- Short beams (high cyclic shear forces)
- Insufficient lateral stiffness/rigidity (excessive P-Δ effects, a.k.a. second order effects)
- Soft/weak stories
- Brittle fracture of welds in steel connections
- Bolt failures in steel connections
- Low cycle fatigue failure of steel members (especially for slender cross-sectioned members vulnerable to local buckling and then fracture)
- Local soil conditions (e.g. liquefaction)
- Nonstructural damages (cladding, walls, facade, interior members), etc.

Building codes encourage the designer to design buildings with regular structural systems since both their seismic behavior is predictable and thus their seismic vulnerability is less, Figure 4. On the contrary, it should be noted that seismic behavior of irregular buildings is complex and therefore their behavior may not be well predicted by even using sophisticated computer software, Aka et al. (2001). In other words, architectural-based seismic damages can be avoided by using simple, regular systems. Some of the widely observed damages mainly related to facades in classical buildings are give in Figure 5.

Limiting Nonstructural Damage

Reducing the risk of nonstructural earthquake damage has always been a concern of engineers and architects. These issues are well discussed in FEMA publications, (e.g. FEMA 450-451). Nonstructural elements may be a risk to life. Damage from objects falling off ceilings even in modern offices during earthquakes poses a significant risk to health and safety.

The nonstructural portions of a building include every part of the building except the columns, beams, slabs, RC shear walls/cores, braces, seismic devices (if any), steel plate shear walls, etc. Common nonstructural components include building envelopes (including facades of any type), partitions, ceilings, all equipment (both mechanical and electrical such as heating-ventilating-air conditioning (HVAC)), furnishings, finishing members etc.

Usually three types of risk are considered for nonstructural members: life safety (LS), property loss (PL), interruption or loss of essential function (LF). LS is the first type of risk in which people could be injured and killed by damaged or falling nonstructural component.

For property loss, a damaged piece of ancient pottery in a museum may be irreplaceable, but for insurance purposes might have a value of several tens of thousands of dollars. Since most of a building is nonstructural, most of the value exposed to risk of damage is nonstructural. Considering the fact that the cost of an average building's foundation and superstructure is about 25% of the whole construction cost, potential seismic damage to the nonstructural elements can be quite costly. Property losses are often estimated to be one third of the total earthquake losses. Such losses can be mitigated by using seismic devices (seismic isolators of any kind to detach the building superstructure from its foundation and supporting it by a set of bearings, seismic dampers (viscous, visco-elastic, metallic, buckling restrained braces (BRBs) etc). Using such seismic devices decreases seismic demands in other parts of the buildings (both in structural and nonstructural components), JSSI (2013). This is called as 'damage controlled design'. For example, when appropriately designed and constructed, seismic isolators would significantly reduce story accelerations in critical facilities such as hospitals that house sensitive/fragile medical equipment. Also, special emphasis should be paid on protecting data centers, rack storage, fire protection systems, gas lines, suspended ceilings and light fixtures. It is important to have a plan for a smooth and quick recovery after an earthquake.

Nonstructural damages in conventional buildings can also be limited by limiting interstory drift ratios (i.e. $(\Delta_{i+1} - \Delta_i)/h$) as given below:

- 0.5% for buildings with nonstructural elements of brittle materials attached to the structure (e.g. brick masonry infills)
- 0.75% for buildings with ductile nonstructural elements
- 1.00% for buildings with nonstructural elements that do not interfere with structural deformations such as facade systems having this special connection details.

Here, Δ_{i+1} is the lateral displacement of the i+1 th story, Δ_I is the lateral displacement of the i th story. h is the story height. In brief, interstory drift ratios shown above should be tolerated by the interior or exterior partition elements. There are special details for this purpose.

In recent years, earthquake insurance is gaining a lot of positive attention. For example, in New Zealand, building owners may submit an earthquake damage declaration form to selected insurance companies. Information submitted in this form should be correct and complete and sets for the basis for their insurance contract. Two basic damage levels are mentioned: 'Superficial Damage' means minor damage to the secondary structure such as window frames, partitions, and nonstructural cracking to internal walls. 'Structural Damage' means damage to the primary structure that supports the floors and roofs which cause the structural integrity of the building to be compromised.

Serious causalities in building facades from past earthquakes have been few so far. For example, falling concrete panels from a store during the 1964 Alaska earthquake killed two people. In the 1987 Whittier, CA earthquake, a student was killed by a concrete panel that fell from a parking structure at California State University, LA. Other lightweight facade systems composed of metal and glass curtain walls usually performed well because of inherent strength of glass, framing elements, and small glass panel dimensions. In the 1985 Mexico city earthquake, a number of glass facade damage incidents was observed. However, it has been understood that the glass has considerable in-plane strength and out-of-plane flexibility.

Seismic Testing Procedure Of Facade Members

This testing procedure simulates in-plane earthquake effect for defining horizontal displacement of the specimen considering AAMA 501.4 (2009) test standard. A 0.01h lateral displacement is applied on the specimen under consideration. At the end of the test, specimen is visually observed whether it has experienced any failure or not. This test is usually applied in combination with air filtration, water tightness, wind resistance, dynamic water test and thermal cycling or aging (if applicable). An example of full-scale test for this type of test sequence including seismic effects is given in Yalaz et al. (2017) and Ilter et al. (2017). For the seismic performance tests as per Japan standard JASS 14 (2012) is given below.

Three different and increasing levels of performance are considered:

- Grade 1 = h/300: no component of the facade, neither internal or external, must be damaged by the seismic action. To this performance level is associated a high probability seismic event in the Japan territory.
- Grade 2 = h/200: external components must not exceed the admissible tension. In addition, the structural sealing must be fixed to rehabilitate the service conditions of the facade. To this performance level is associated the verification of the greatest earthquake ever happened in the past.
- Grade 3 = h/100: no damages to the glass plates or fall of components are admissible. To this performance level is associated with the verification of the greatest earthquake expected for the next 100 years.

  where h is the interstory height. The aim of the Japanese standard is clearly to verify that the facade is able to follow and resist, without any serious damage, the interstory drift. On the contrary, it does not require any force-based verification, that for such an element, already designed for wind pressure, would be less significant.

Conclusions

For earthquake proof design of buildings, a holistic approach combining the structural and nonstructural elements (building envelopes (including facades), partitions, ceilings, both mechanical and electrical equipment such as HVAC systems, furnishings, finishing members etc.) is required for overall safety and a smooth recovery after the earthquake. Fortunately, most building modern seismic codes propose design principles for both elements. Since past and recent earthquakes revealed that nonstructural damage may be significant and costly after a devastating earthquake, minimizing such damages is attracting more attention. In this respect, insurance companies prefer to insure seismically designed buildings having seismic proof structural and nonstructural elements. Story drifts and accelerations have a pronounced impact on seismic safety of building facade systems. Therefore, buildings having higher importance factors and incorporating special seismic devices can be preferred in seismically vulnerable zones where large amounts of ground accelerations are anticipated since next generation structures need to be low damage and resilient.

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Figure 1c	Adapted and re-drawn from ASCE 7-16 and
Table 1	Adapted and re-drawn from SEAOC (Structural Engineering Association of California)
Figure 3a	Adapted from JSSI
Figure 3b	Adapted and re-drawn from Renschler et al. (2010)
Figures 3cde	Adapted and re-drawn from Cimellaro et al. (2009)
Figure 4	Prof.Akira Wada

Notes

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Mikkel K. Kragh is Professor and Head of SDU Civil & Architectural Engineering at the University of Southern Denmark, where he is currently strengthening the research group and broadening the scope with a strong focus on resilience and digitalization. Before joining the SDU, he worked internationally as a specialist, running a number of projects in the field between architectural design and product development. Mikkel is a frequent speaker at international workshops and conferences, where he discusses aspects of high performance and the value of design.

Mikkel has worked internationally as a façade specialist on numerous prestigious construction projects with Dow Corning, Arup consulting engineers, and the Permasteelisa Group. In parallel with design work, he has led a number of collaborative R&D projects, consistently pushing the boundaries in the field of high performance facades. Having held various positions spanning research, specialist contracting, specialist consulting, supplier, and having chaired the Society of Façade Engineering, he has unique insight into high performance building solutions as well as the role of specialist design input in the Construction Industry.

In 2014, Mikkel was awarded the CIBSE Silver Medal for outstanding service to the Chartered Institution of Building Services Engineers. In 2017, Mikkel became a member of the ATV – the Danish Academy of the Technical Sciences - an independent, member-driven think tank. ATV's vision is that Denmark shall be one of five leading Science and Engineering regions in the world – to the benefit of future generations.

Notes

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Sanjay Seth is Senior Director & Senior Fellow of the Sustainable Habitat Division with The Energy and Resources Institute (TERI). He is also the Chief Executive Officer of GRIHA Council which administers the Green Rating for Integrated Habitat Assessment. Prior to joining TERI, he worked with the Bureau of Energy Efficiency, Ministry of Power, Government of India and headed the vertical on Building Energy Efficiency.

He was also the interim Secretary of the Bureau of Energy Efficiency and responsible for the administration and financial management of the organization. In this capacity, he provided oversight to the implementation of policies and programmes of BEE as well as the National Mission on Enhanced Energy Efficiency (NMEEE), and all international bilateral/multilateral cooperation programmes. He also represented BEE on the Board of Energy Efficiency Services Limited (EESL) as Director. He joined BEE in 2007, with the introduction of the "Energy Conservation Building Code (ECBC)", and was given the responsibility of developing an enabling framework for facilitating its implementation in a consistent manner throughout the country. By training he is a Civil Engineer and has more than twenty nine years of experience in the power sector of which the last nine years have been on the Demand Side. Prior to joining the Bureau, he has worked in various capacities in a Central Public Sector Generating company, under the Ministry of Power and was associated with planning, monitoring, co-ordination and construction management of Hydro and Thermal power projects.

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B. Arch., Masters (Environment & Energy Studies, AA, School of Architecture, London), Fellow & Associate Director for Centre for Research on Sustainable Building Science at TERI, architect with specialisation in development of passive and low energy design strategies to obtain sustainable habitats. She has been working with TERI for 12 years. She has been leading and coordinating Building Science Research and Policy Activities for TERI in South India. Some of her key projects as team leader include: High Performance Commercial Buildings in India project to implement ECBC, which was carried out under Asia Pacific Partnership funded by US DoS from 2007-2010, "Development of Environmental Building Regulations and Guidelines for Bangalore city" which was supported by REEEP (Renewable Energy Efficiency Partnership). She has provided green building consultancy and certification for both buildings in private sectors and Government. Some of them include: ITC Chennai Factory, ITC Pune Factory, Fortis Hospitals, Head Quarters of Power Grid Corporation of India Limited. Etc. She has developed Design as well as Financial Model for Low Cost Climate Resilient Housing in Nepal and Bangladesh under the funding from IFC. She has also worked with HUDCO for establishing Affordable and Replicable Green Features in Residential Sectors. She has worked under the funding from UNEP for establishing Sustainability Index for materials to be used in Affordable Housing. She has worked with State Governments like Tamil Nadu to develop Financial Incentive for Green Building. She also coordinates GRIHA activities in South India.

Climate Responsive Facades and Sustainable Building Materials

Abstract

The subcontinent of India experiences diverse climate zones, namely- hot &dry, composite, warm &humid, moderate and cold. Building designs need to respond to the outdoor climates while providing indoor occupant comfort.

One of the most critical parameter to which the facades need to respond in India is high intensity of solar radiation received. The paper shows various strategies and external shading devices designed for commercial and residential buildings to achieve indoor occupant comfort. The paper also provides case studies to show an integrated and holistic approach of responsive facades built in dense urban areas to achieve both visual and thermal comfort inside buildings, while maintaining comfortable outdoor neighborhood.

In India there are four key parameters which have to be considered while integrating sustainability, these are- Economics, Environment benefits, social acceptance and climate resilience. There are several new building materials in the market, which need to be assessed for their sustainability based upon the above parameters. The paper discusses research being carried out at TERI to create a tool to calculate Sustainability Index of building materials.

Climate responsive facades // visual and thermal comfort // external shading devices // Sustainability Index

Introduction

Indian traditional architecture was always climate responsive with integration of solar passive design elements to maintain comfort indoors, without depending upon artificial methods of cooling and lighting. (Fig 1)

In solar passive architectural design, the focus is on utilization of sun, wind, water and earth, the natural resources to achieve thermal and visual comfort in the built environment. Modern buildings in India are however, missing the cultural & climate context in order to provide global appearance. India receives abundance of solar radiation and hence it becomes critical to design buildings in order to minimize the external heat gains while allowing adequate daylight. (Fig 2)

Fenestration design hence becomes a very critical façade element in Indian climate to optimize the energy consumption of building while providing occupant comfort.

The paper thus showcases methodology adopted in a few buildings in India in order to optimize the fenestration design of facades to conserve energy and achieve occupant comfort. The second part of the paper showcases Sustainability Index framework developed in order to quantify the sustainability Index of materials used in the facades of a building.

Fig. 2: Clockwise from top; Bengal Intelligent Park Phase IV; DLF IT; Globsyn Crystals; Infinity Waterside

Site Planning

Buildings are usually designed in a neighborhood, and hence it is critical to see the impact of the new construction on existing buildings as well as it is important to design the outer envelope of the new building, keeping in mind the existing buildings and site features. In sustainable buildings, in order to integrate daylight and natural ventilation, it is important to carry out a solar analysis and a CFD analysis in order to influence the design elements of the façade. Below figures are from a project carried out by TERI for ITC, Guntur. (Fig. 3, 4, 5, 6)

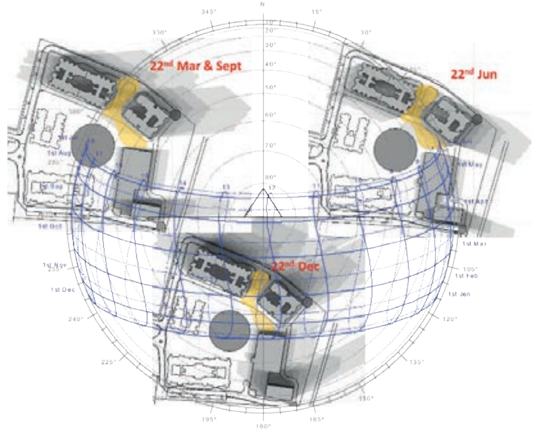


Fig. 3: shows space required between two blocks to integrate daylight at the lowest floor levels

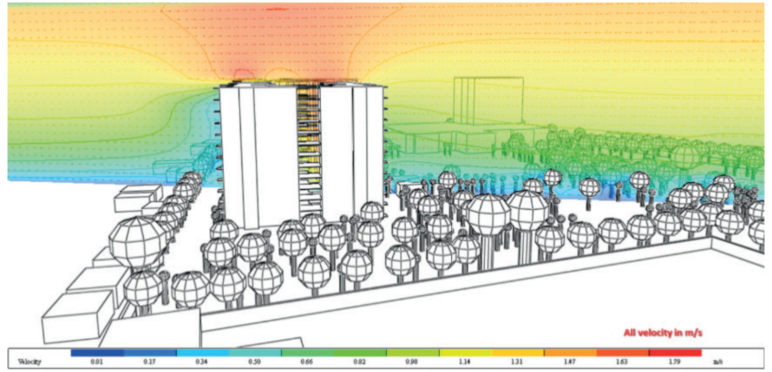


Fig. 4: shows CFD analysis at neighbourhood level to break the façade into bridges, to enhance cross ventilations inside the buildings

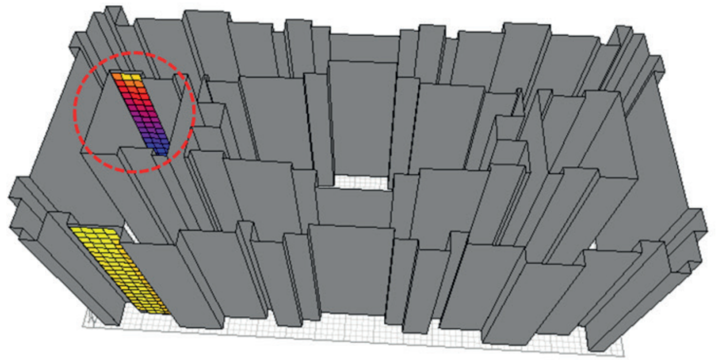


Fig. 5: showing solar irradiation analysis carried out to identify critical facades and provide external shading accordingly.

Fig 7

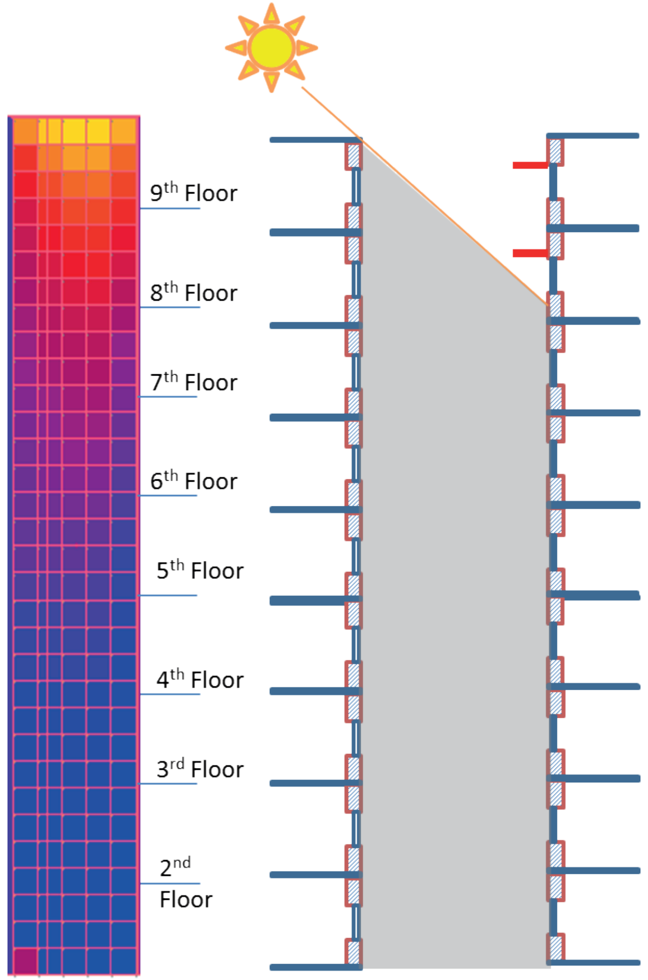


Fig 6: shows solar exposure of the façade of an internal courtyard and responsive fenestration and shading designed.

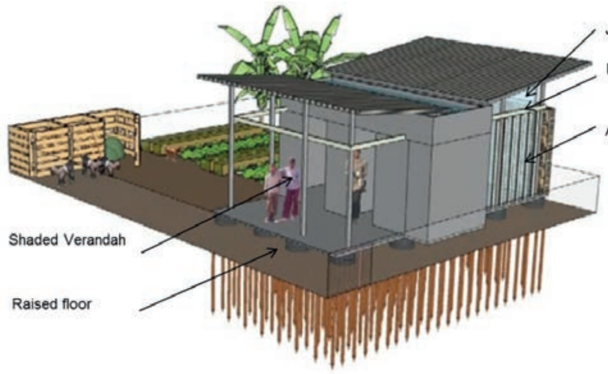


Fig. 8: Climate resilient affordable housing unit proposed for Chennai city (Courtesy: Biome Environmental Solutions

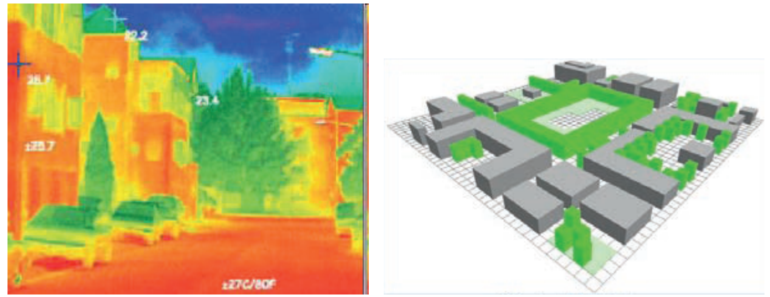


Fig. 9: Climate resilient affordable housing unit proposed for Chennai city (Courtesy: Biome Environmental Solutions

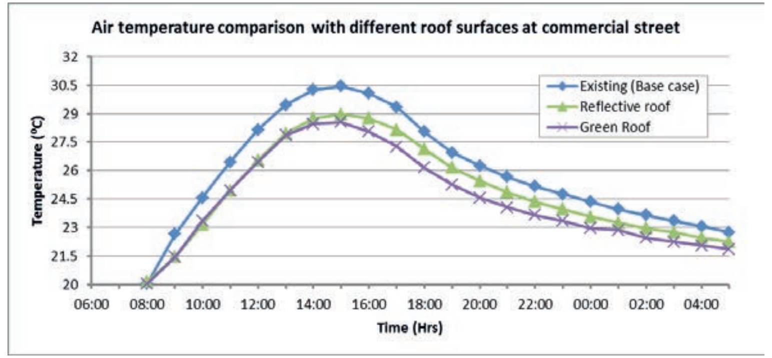
Façade designs to respond to the climate vulnerabilities

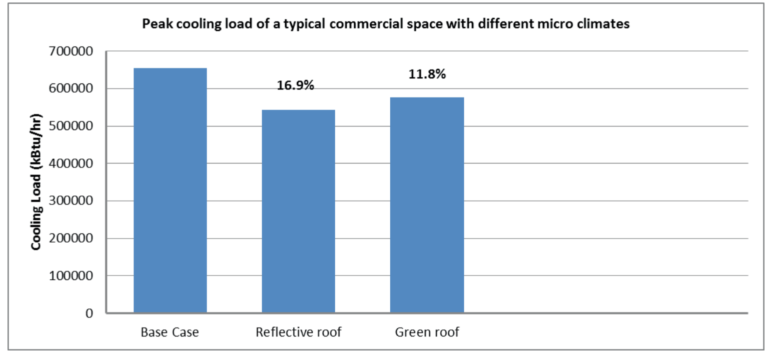
South Asia is highly prone to disasters due to geological reasons as well as due to the stress posed by growing population and urbanization. Rapid construction activities without respecting the environment and geographical constrains is adversely affecting the fragile regions. Climate resilience is an important aspect which thus needs to be addressed in all future construction. (Fig. 7)

In India the poor and economically weaker section are affected the most during climate vulnerabilities also it is the economically weaker section followed by the low income group that together make up 96% of urban housing shortage (IFMR). Thus it is critical to design affordable buildings which are also climate responsive. One such effort was carried out together with Biome Environmental Solutions to design a climate responsive affordable housing unit. The house had a raised floor to respond to the flooding issue in low lying areas of coastal Chennai, as well as to respond to the warm-humid climate, the house comprised of operable screens/ jail to allow air movement and ventilation inside the house. (Fig. 8)

Cities in India are observing very high temperatures in comparison to the last decade, and hence material selection and surface finish of facades play a vital role in order to maintain comfortable microclimate and combat urban heat island effects of built environment. (Fig. 9)

TERI carried out a study to quantify the impact of light coloured external surface finishes on the energy consumption of air conditioned buildings as well as to see the impact on the environmental conditions of the microclimate of a commercial street. Figures below show the results depicted using softwares.





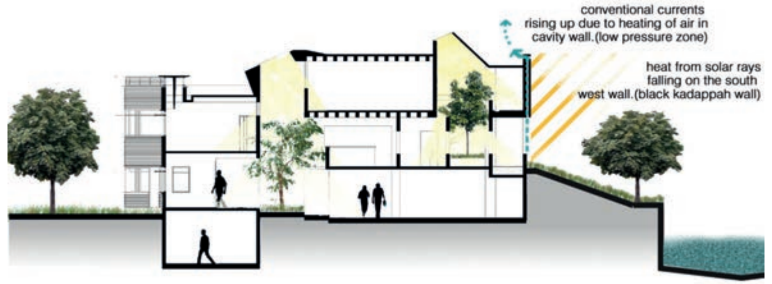
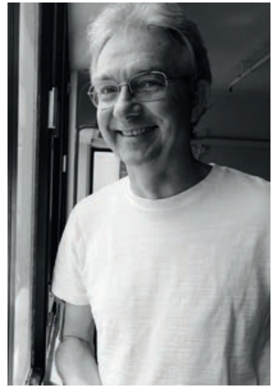


Fig. 10: Some projects of TERI

Notes

Robert-Jan van Santen

Co Director of VS-A Group; Lille, France



Graduated in architecture in 1985 in Versailles (FR), worked for 4 years with Renzo PIANO in Paris and set up his consulting office in 1989, specialized in building envelopes. Today, VS-A has companies based in Lille (France), Hong Kong (CN) and Seoul (KR).

Robert-Jan van Santen is a Dutch Architect that has created façade consulting offices in Lille, France, and in Hong-Kong, totalizing 35 employees. He got the silver medal of the French Académie d'Architecture for his research and technique activities.
He has been working on light-weight envelopes for 25 years, in collaboration with prestigious international architects like OMA, Zaha HADID, Christian de PORTZAMPARC, Steven HOLL, mainly in Europe, but also in Asia and Africa.

He works on Indian projects in collaboration with Binoy KUMAR DAS of FCD (Mumbai).

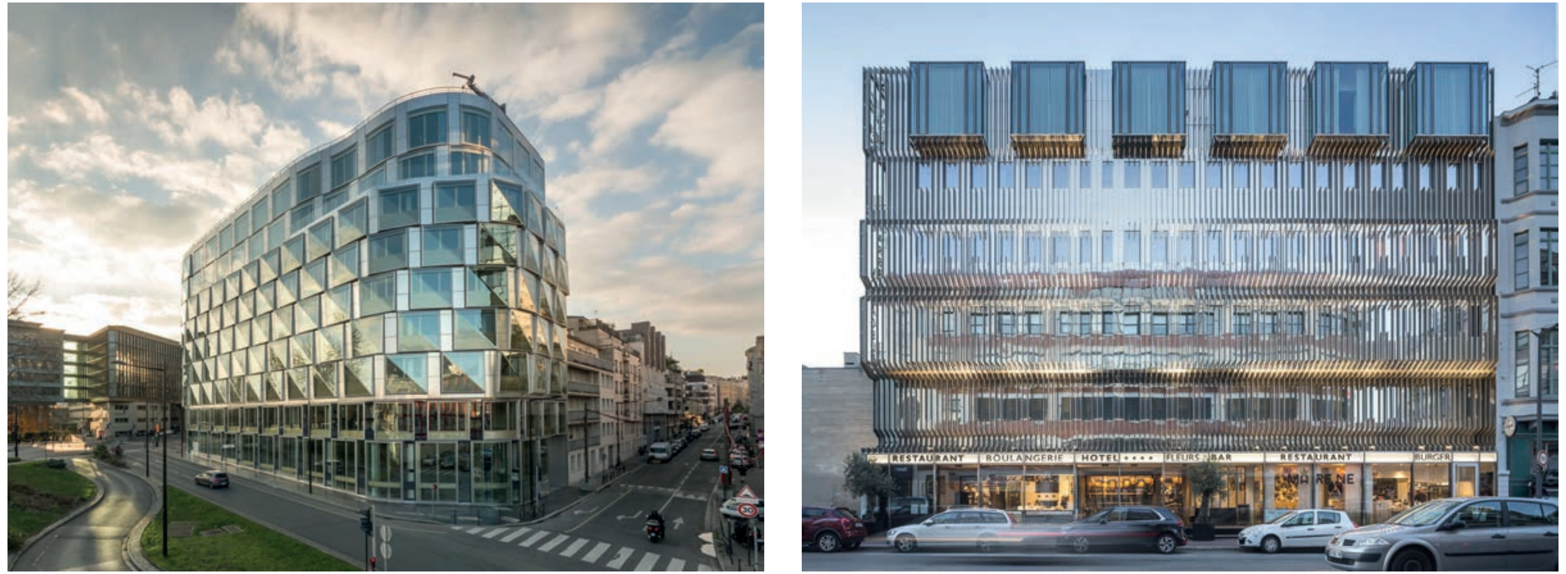


Fig.: Quai Ouest (left); Arbre Voyageur (right) ; photos: http://www.vs-a.eu/en/project/

Abstract

With 30 years of experience in the field of building envelopes, Robert-Jan van Santen was involved in multiple refurnishing projects and mostly, the façade needed to be replaced in totality, even if the client explicitly wanted the new façade to look exactly like the old one. Upgrading some performances while reusing some of the existing components seemed unrealistic. Robert-Jan van Santen will investigate in his lecture if a façade can be designed by predicting it's future upgrading and what potential chances might arise in 30 or 50 years. He presents the strategic attitude of VS-A towards this challenge.

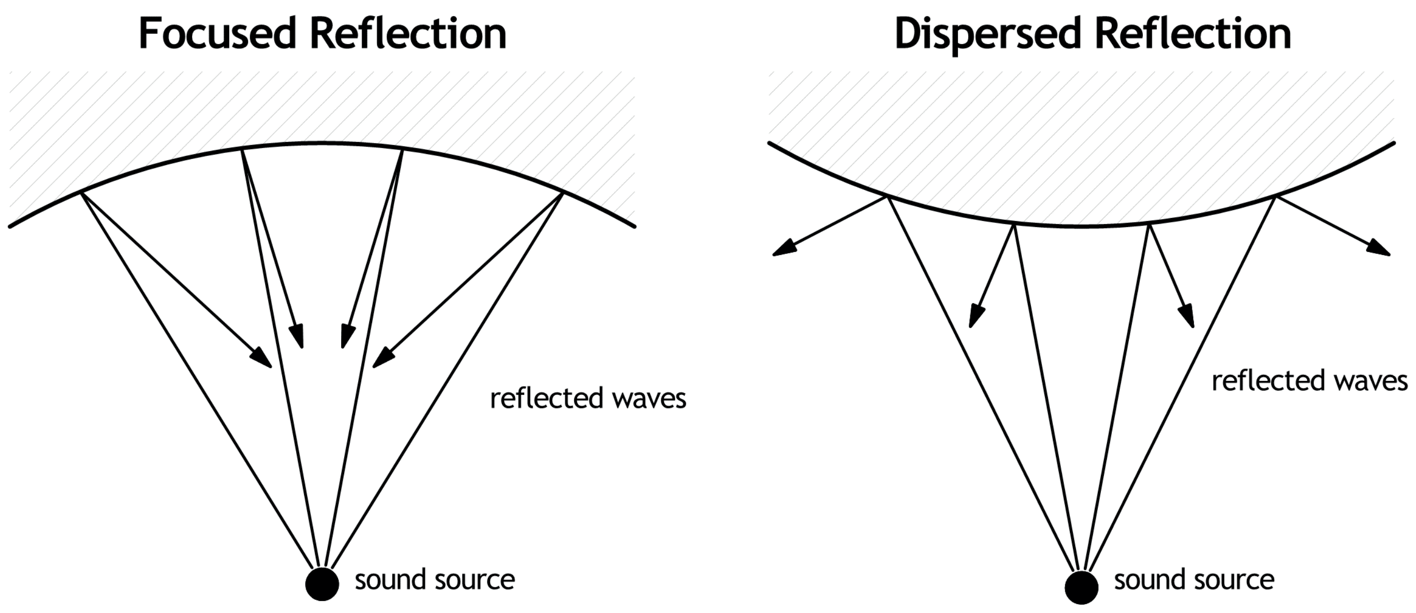
refurnishing // upgrading // curtain-wall design performance // façade-consultant architect // VS-A

Notes

Spencer Culhane

Architectural Advisor, Schüco USA; New York

Spencer Culhane currently works as an Architectural Advisor for Schüco USA in New York City where he helps architects, consultants and developers plan their building envelopes. He has been in the facade industry since 2011. He holds a Bachelors degree from the Massachusetts College of Art and Design and is a Solar Decathlon Alumni. He is currently pursuing a Master of Engineering degree at the Hochschule Ostwestfalen-Lippe with a specialization in Facades.



Diagrams comparing focused and dispersed reflection of sound waves from convex and concave surfaces (Barron, 2010)

Transparent Facades for Music Performance Spaces

Abstract
Incorporating transparency into music performance spaces creates acoustic and architectural challenges. The focus of this paper investigates the use of architectural glass facades as an acoustic insulator from exterior noise and controlled reflector of interior sound. A collection of completed case study projects with vision glazing in performance spaces is analyzed for their acoustic qualities. The results of the analysis are distilled into a set of design criteria for the use of acoustic glazing in future applications.

Transparency // music performance spaces // façades // glazing // acoustics // attenuation //specular reflections

Introduction
Incorporating transparency into music performance spaces creates acoustic and architectural challenges. Protection from ambient noise pollution is typically addressed through a combination of vibration isolation, structural de-coupling, and multi-layered absorptive enclosure. The use of vision glazing requires the glazing frame and glass unit to attenuate unwanted noise. Additionally, glass has a low material absorption coefficient and induces specular reflection when used on the interior of a performance space. The focus of this paper investigates the use of architectural glass facades as an acoustic insulator from exterior noise and controlled reflector of interior sound. A collection of completed case study projects with vision glazing in performance spaces is analyzed for their architectural and acoustic qualities. The results of the analysis are distilled into a set of design criteria for the use of acoustic glazing in future applications. Lastly, opportunities for additional research into the use of vision glass within performance spaces are presented.

Sound is the result of positive and negative pressure fluctuations in the atmosphere. These pressure variations are comprised of longitudinal waves which have an amplitude, frequency and direction. The amplitude is determined by the magnitude of pressure fluctuation. Atmospheric pressure variation can be expressed in Pascals (Pa). However, this unit is inconvenient for describing sound pressure levels due to the human range of audibility exceeding a nonlinear ratio from 20 Pa (threshold of hearing) to 1000000000 Pa (threshold of pain) (Brüel & Kjær, 2001). Therefore, sound is typically described in decibels (dB), a logarithmic ratio between measured sound intensity and a reference value. Sound at the lower threshold of hearing is described as 0 dB and threshold of pain at 140 dB. Increasing the sound level of 10 dB results in a perceptible doubling of sound pressure (Barron, 2010). (Fig. 1, 2)

All sounds exist with a specific frequency, depending on their source, which is described in hertz (Hz). The range of human hearing is limited to sound waves with a frequency between 20

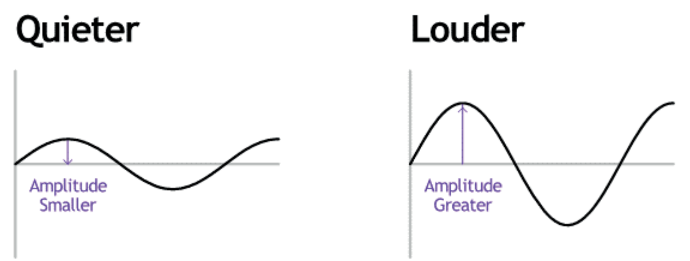


Fig. 1: Relationship between Amplitude and Loudness (Solla, 2012)

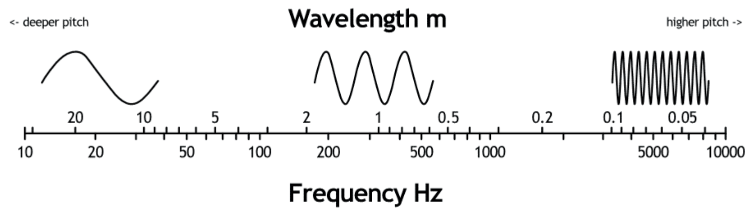


Fig. 3: Linear Graph of Sound Wavelength and Frequency (K.B.Ginn, 1978)

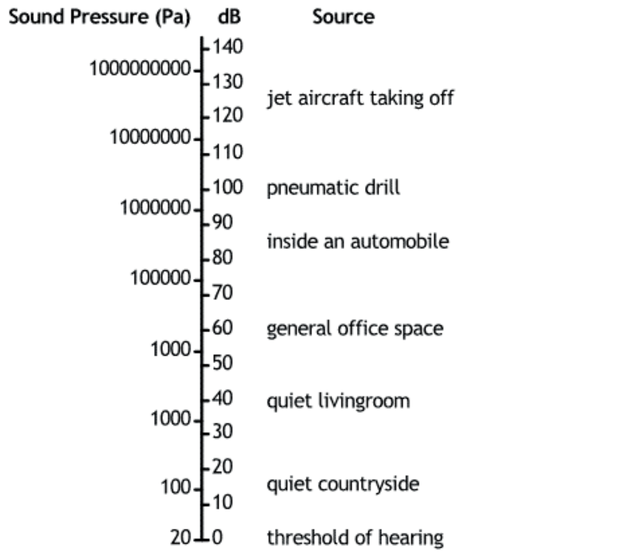


Fig.2: Comparison of Pascals to dB (K.B.Ginn, 1978)

Hz and 20,000 Hz. Interrelated to frequency is wavelength, the distance between maxima in a plane wave. (Fig. 3)

At lower frequencies, wave lengths are longer, producing sounds with a deeper pitch. At higher frequencies, wavelengths are shorter resulting in a higher pitch. As the amplitude of a sound wave increases, the perceived loudness also increases. The human sensitivity and perception are greatest for sounds within 1 kHz to 4 kHz. As such, methods of measuring sound are typically adjusted to that range using a dB (A) filter (Solla, 2012). While pressure levels and frequencies are quantifiable, the definition of loudness is subjective. From the results of multiple subjective tests, the loudness of sounds within a specific range of decibel level and frequency range has been organized using the designation of phons according to ISO 226:2003. The results describe how sounds at various pressure levels and frequencies are perceived for loudness with a higher phon value indicating a louder sound.

The pressure level and loudness of a sound wave is not constant and changes as the wave propagates away from the source. For every doubling of distance from the source there is a 6dB decrease in the pressure level. This is due to the spherical spreading of sound waves once they leave a source (Barron, 2010). (Fig. 4)

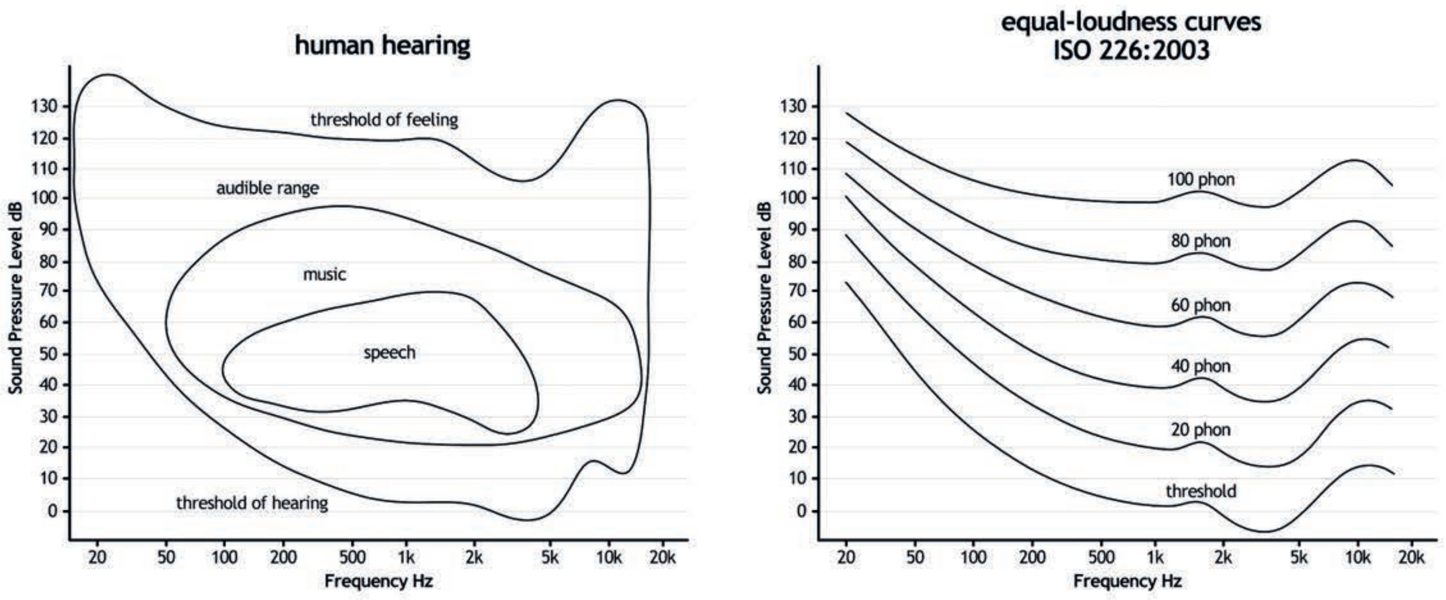


Fig. 4: Human hearing and perception of loudness (K.B.Ginn, 1978)

With respect to facades, acoustics is primarily considered for the reduction of noise transmission from exterior to interior. The acoustic attenuation properties for building materials and enclosure systems are determined through testing according to ISO 717 (AGGA, 2013). A material's mass, stiffness and damping effect the transmission of sound. For a unified comparison of dissimilar materials, a weighted sound reduction index in decibels (Rw) is used to classify attenuation. Similar the dB scale, this value includes a frequency correction factor for the sensitivity of human hearing. Rw covers the frequencies of 500 Hz to 3150 Hz. For lower frequency sounds such as music, loud conversations or aircraft noise a short distance away, the spectrum adaptation term C is used. For higher frequency sounds, the term C_{tr} is used, examples include urban traffic or aircraft a long distance away. (Solla, 2012).

Glass panels have unique properties in façade sound attenuation. The Rw of a given glass unit depends on the lite thickness (mass), lamination interlayer (damping), and insulating cavity thickness. (Quirt, 1988). For monolithic glass, the thickness of the pane has a natural frequency at which it achieves coincidence resonance and reduced attenuation. This effect can influence the sound reduction performance of a given glass thickness as much as 10 to 15 dB (Saint-Gobain, 2017). The coincident frequency for a single monolithic glass (*f_g in Hz*) can be estimated using the formula below where *d = lite thickness* in mm:

$$f_g = \frac{12000\,Hz}{d}$$

Fig. 5: Formula for coincident frequency of monolithic glass lites (Templeton, 1986)

Glass Thickness *d* (mm)	Coincident Frequency *f_s* (Hz)
4	3000
6	2000
8	1500
10	1200

Fig. 6: typical glass thicknesses and coincident frequency (Templeton, 1986)

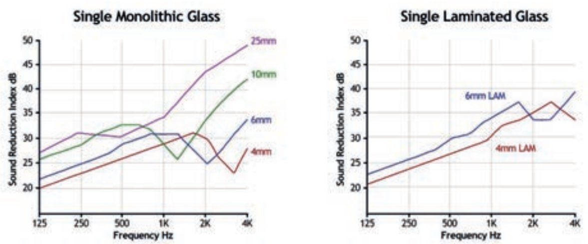


Fig. 7: Single glass lite sound reduction values, Monolithic and Laminated (Templeton, 1986)

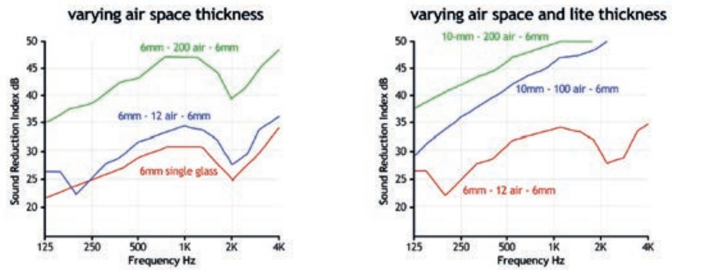


Fig. 8: Sound reduction values for multiple glass lites with fixed and varying air spaces (Templeton, 1986)

For insulated glass units, the cavity operates as spring, transferring the vibration from one pane to another. The greatest sound reduction benefits of an IGU or DGU come from the flexibility to combine multiple glass thicknesses, each with a separate coincidence frequency (Templeton, 1986). The addition of PVB interlayers in laminated glass has a damping effect and shifts the coincident frequency of the lite by reducing its mass. Variations in interlayer density and thickness effect the resulting attenuation performance.

When using asymmetrical glasses, a 30% difference in thickness in optimal for increasing attenuation (Pilkington, 2008). Air spaces greater than 60 mm between glass lites offer additional benefits for sound reduction.

The above figures show reference assemblies with, 12mm, 100mm, and 200mm air spaces between lites. While the multi-glass assemblies are typically IGUs or DGUs, acoustic glazing can also be configured via multi-layered framing systems where glass lites are dry sealed with gaskets, so long as the assembly maintains a continuous air seal. (Fig. 8)

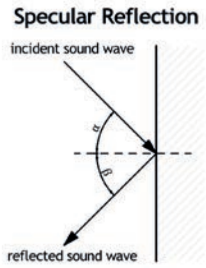


Fig. 9: Diagram of specular reflection of sound waves (K.B.Ginn, 1978)

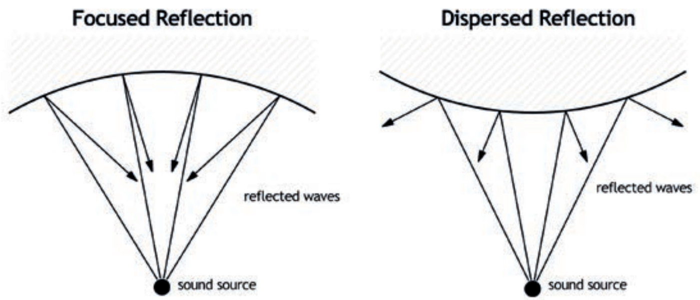


Fig. 10: Diagrams comparing focused and dispersed reflection of sound waves from convex and concave surfaces (Barron, 2010)

Sound waves interact with surfaces in four principle ways: diffraction, scattering, absorption, and reflection. The mode of interaction depends on the incident wave pressure level, frequency and direction, in addition to the obstruction's surface absorption coefficient, geometry and dimensions.

If the wavelength is disproportionately large compared with an obstacle, diffraction will occur, and the wave fronts recombine after passing by the obstacle. (Barron, 2010) This normally occurs for sound at low-frequency intersecting with small objects.

Acoustically scattering surfaces are comprised of irregular protrusions with a depth of 0.3m to 0.6m, corresponding to a specific sound wavelength. Smaller projects correlate with scattering of higher frequency waves.

Absorption occurs when sound waves are dissipated in a porous material through friction from the movement of air particles in the pores. Within performance spaces, the largest absorber is typically the audience, absorbing nearly 90% of the incident sound (Barron, 2010) The classification of an absorptive material is based its absorption coefficient, a value of 0.0 to 1.0 delineating the amount of incident energy the material can absorb.

When a sound wave collides with an object of a dimension greater than its wave length, it is reflected. A single sound wave can reflect multiple time until its energy is absorbed (Barron, 2010). Specular reflection occurs when a sound wave hits a planar surface. If the surface is concave or convex, the reflected wave is focused or dispersed, respectively. (Fig. 9)

The design and control of reflected sound is integral to the acoustic design of performance spaces. The directionality of reflected sound is determined by the angle of incidence between the source wave and the surface of the obstacle. Concave surfaces produce focused reflections which can be detrimental if the source and receiver are within the extended circle of the surface radius. (Fig. 10)

Fig. 11: Photograph of Isabella Stewart Gardner Museum with New Wing in background. Image from Jesse Costa/WBUR

Fig.12: Calderwood Hall building section. Drawing from Renzo Piano Building Workshop

Content

The case studies for this paper were selected based on the utilization of vision glazing in an acoustically engineered performance space. The three spaces evaluated: the Isabella Stewart Gardner Museum's Calderwood Hall in Boston, the Appel Room at Columbus Circle in New York, and the Casa da Musica in Porto, each includes a unique use of glazing in the auditoria envelope. Each project is designed for a specific type of music and performance, further distinguishing their individual designs.

Calderwood Hall

The Isabella Stewart Gardner Museum in Boston Massachusetts opened its expansion in 2012 with a new wing designed by Renzo Piano Building Workshop. The new addition consists of 70,000 sqft (6500 sqm) of new program including a 6,000 sqft (557 sqm) chamber music performance space, Calderwood Hall.

The new wing sits adjacent to the existing museum separated by a landscaped courtyard. The new structure is defined by two rectangular volumes, one housing a mixed-use large format gallery and the other, Calderwood Hall. (Fig. 12, 13, 14)

The Calderwood Hall volume is a vertically oriented chamber music hall with a floor level stage and three levels of single row balcony

Fig.13: Photography of Calderwood Hall interior view. Image from The Boston Musical Intelligencer

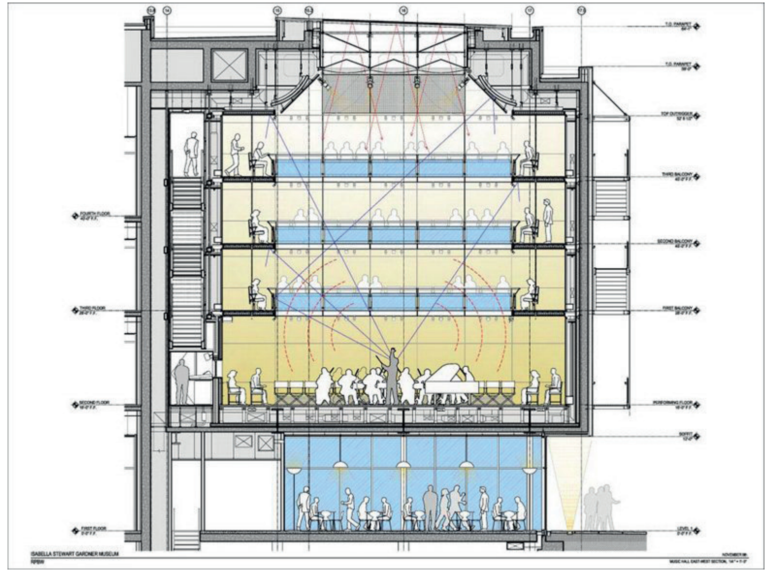


Fig. 14: Calderwood Hall building section. Drawing from Renzo Piano Building Workshop

seating. The cube like volume is an uncommon typology for a performance space due the potential for flutter echoes from multiple reflections between the parallel wall surfaces. To address this, acoustic consultant Nagata Acoustics Inc., modified the reflection angle of the extensive roof skylight. The complete skylight assembly consists of two glazing layers enclosing a ventilated cavity. The air space contributes significantly to the outdoor – indoor noise transmission reduction. The interior layer was configured as a series of nine pyramid shaped sections dimensioned to reflect the sound from the performers into convex absorption and dispersion reflecting panels suspended from the ceiling. The assembly successfully mitigates the unwanted reflections between the skylight and the Alaskan yellow cedar stage floor below (Nagata, 2012). After commissioning, the hall achieved a mid-frequency reverberation time of 1.0 sec, unoccupied and 0.9 sec occupied. (Fig. 15, 16, 17)

Casa da Musica

Designed by OMA and completed in 2005, the Casa da Musica in Porto Portugal is a concert hall home to the National Orchestra of Porto. The building sits in the center of a public square on the Rotunda da Boavista. To allow greater engagement with the public, two faces of the angular building are full height glazing looking directly into the main orchestra auditorium. (Fig. 18, 19)
To control the acoustic isolation from the bustling traffic circle

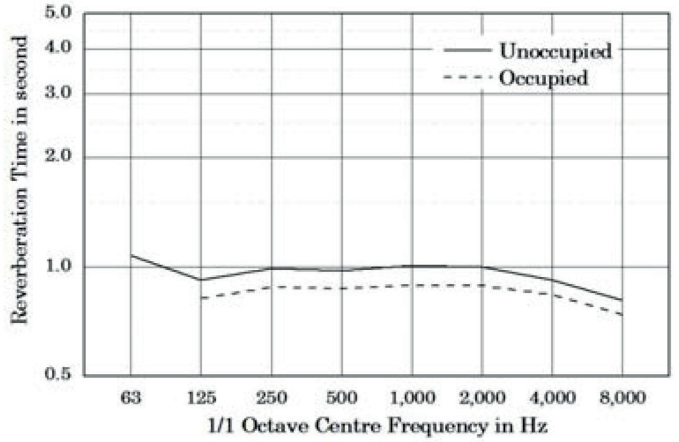


Fig. 15: Graph of Calderwood hall reverberation times (Nagata, 2012)

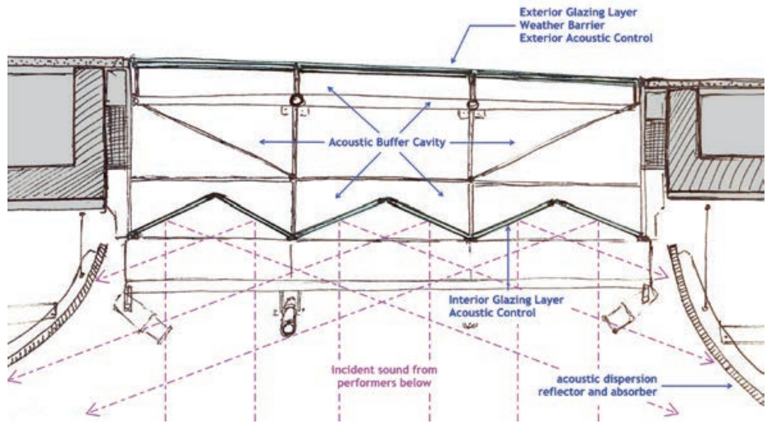


Fig. 17: Calderwood hall skylight and roof section drawing with incident sound wave interactions. Drawing by the author.

Fig. 16: Photograph of Calderwood Hall skylight interior view image from DAVID L. RYAN Boston Globe

Fig. 18: Photograph of Casa da Musica exterior view from street. Image by Philippe Ruault

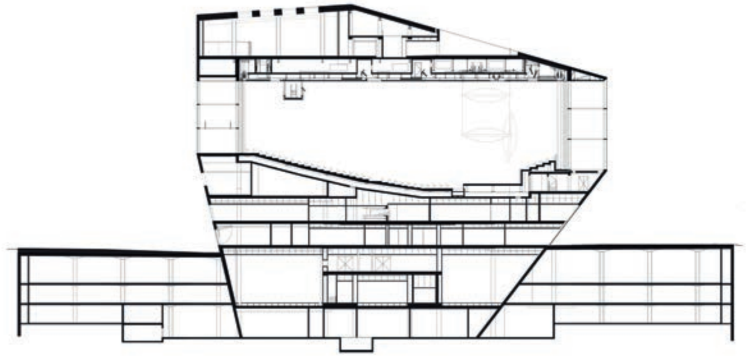


Fig. 19: Casa da Musica longitudinal building section. Drawing from OMA

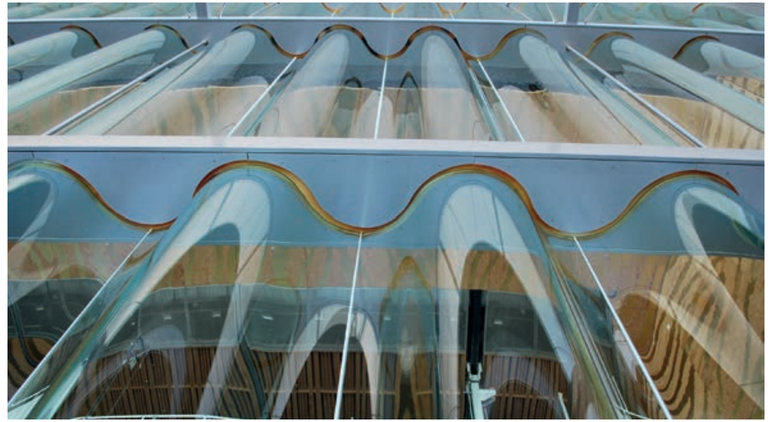


Fig. 21: Photograph of Casa da Musica curved glass facade detail. Image by Philippe Ruault

Fig. 20: Photograph of Casa da Musica interior auditorium stage view. Image by Philippe Ruault

Fig. 22: Photograph of Casa da Musica twin facade access hall. Image by Philippe Ruault

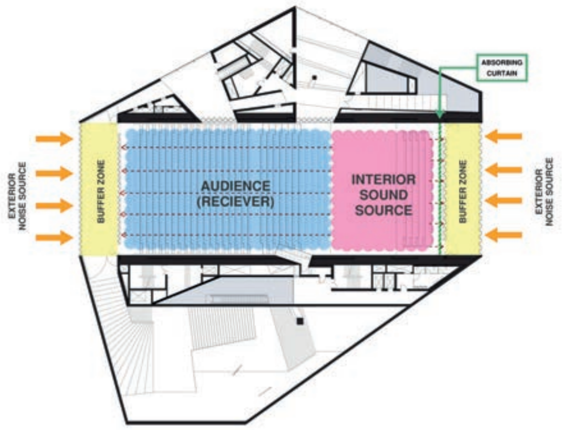


Fig. 23: Plan drawing diagram of audience receiver, interior sound source, exterior noise source, and facade control layers. Drawing by OMA

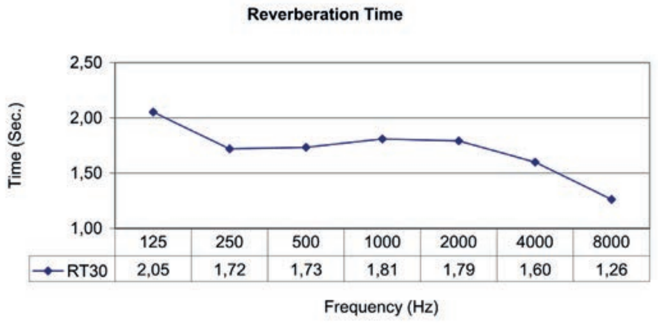


Fig. 24: Graph of Casa da Musica reverberation time (Santiago, 2007)

outside adjacent to the site, a twin wall system was implemented using two layers of hot bent laminated sinusoidal glass with a corridor between. (Fig. 20)

The full height glass walls sit directly behind the performers and opposite them directly behind the audience. Though the glass geometry was designed to effectively disperse direct reflection sound without flutter echoes or distortion of the sound coloration, full height acoustically absorbent curtains were included in the design (Nijse, 2014). During the on-site testing and commissioning, the effect of using the curtain directly behind the performers and not on the audience side of the auditorium created a much better acoustic result. The performers and hall manager agreed unanimously that the curtain improved the balance, feedback, and room response (Kahle, 2013). (Fig. 21, 22, 23, 24)

Appel Room (formerly Allen Room)

The Appel Room is a focal point of the Skidmore, Owings and Merrill designed Time Warner Center in New York City. Completed in 2003, the 2.8 million sqft (260k sqm) development houses the Lincoln Jazz center and the Appel room, its smaller venue. The vision glass in the performance space consists of a dramatic double cable net wall façade with views directly out to Central Park and the New York skyline. (Fig. 25, 26)

Due to the wide range of adjacent noise sources, a completely separated two-layer façade solution was developed using single laminated glass in cable net configurations. The exterior façade extends from the main entry of the building 150 ft (46 m) vertically to the top of the Appel Room supported by a 82 ft (25 m) long truss. Immediately behind the outer layer, an additional inclined cable net wall encloses the Appel room (Knaack, 2008). (Fig. 27, 28)
The direct specular reflections from the cable net wall behind the

Fig. 25: Diagram of Columbus Circle commercial segment building section. Image by Neoscape 2009

Fig. 26: Photograph of Columbus Circle. Image by RFC Graphics 2009

Fig. 27: Columbus Circle night view of Appel room from exterior

stage is accommodated by its subtle angle toward the ceiling. Suspended above the audience are a network of black polystyrene diffusers designed to scatter the sound waves at predictable angles. This method allows the entire rear surface of the performance space to be a non-absorbing material without compromising the acoustic quality.

Conclusion

The three-case study projects show a clear response to the core challenges of integrating vision glazing into performance spaces. The Isabella Stewart Calderwood Hall used controlled specular reflection to avoid parallel reflections. The Casa da Musica implements scattering sinusoidal glass and dynamic curtains for additional variation in acoustic performance. The Appel Room in Columbus Center re-directs specular reflections into an extensive array of ceiling mounted diffusers. (Fig. 29, 30)

A set of design principles for the use of vision glazing within performance spaces can be extrapolated from the analysis of the case study. Firstly, due to the demanding acoustic insulation required between indoor and outdoor environments, the use of a double skin façade or twin wall is highly effective over a single frame system. Secondly, the geometry of the interior glass planes function as reflectors. The size, shape and geometry of the panels effects the propagation and amplification of the incident sound. These attributes can be utilized to control the resulting reflections to meet project specific acoustic requirements. Thirdly, the variations in performance type and space function necessitate adaptability to various types sound and source types. The reflectivity and absorption coefficient of the glass wall can be controlled with dynamic shielding. The simplest form of this is in the use of an absorptive retractable curtain. These three principles are critical

Fig. 28: Photograph view from the audience onto the Appel Room stage. Image by Alamy Stock Photo

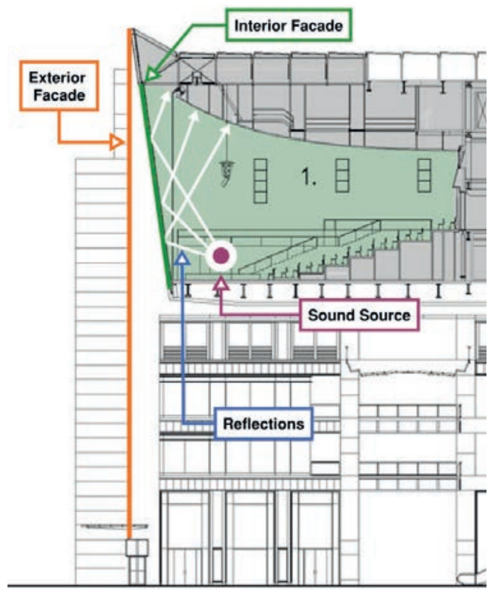


Fig. 29: Diagram of Appel Room stage and facade sound reflections by Author.

for successful implementation of transparent glass facades in performance spaces.

The implementation of vision glazing into performance spaces is feasible but requires careful acoustic engineering and planning. The use of architectural glass facades as acoustic insulation and reflector of interior sound has been successful in the case study project referenced. As a result, a set of design principles is extrapolated from the analysis of the case studies. Despite each project serving a unique function and existing in a separate context, they each share a set of core design principles that have enable their successful function.

Expanded research into these findings is necessary to validate the analyzed results. Due to the lack of existing buildings matching the profile of the case study projects, further analysis can be conducted through simulation and physical mock up testing. An investigation into the relationship between performance space dimensions and the area of a beneficial planar specular reflector could address the successful implementation of simple glass facades in small performance spaces.

Project	Capacity (persons)	Area (m^2)	Reverberation Time - Unoccupied (sec.)	Performance Type	Interior Glazing System	Interior Glass Type	Glazing Orientation	Complete Façade System
Casa da Musica	1238	1100	1.77	Orchestra Hall	Sinusoidal Laminated Glass	Corrugated Laminated	Vertical	Twin Wall - separated with corridor
The Appel Room	550	500	1.8	Jazz Club	Point Supported Cable Net	Insulated Laminated	Vertical Sloped	Twin Wall - cable new
Calderwood Hall	296	557	1	Chamber Music Hall	Stick Façade Skylight Pyramid Shaped Glass	Insulated Laminated	Horizontal	Double Roof Glazing Stick Curtain Wall

Fig. 30: Table of Case study project data by Author

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ConstructionLab

Annual Report 2015-17

Fig. 1: ConstructionLab-Team

Research - ConstructionLab

The ConstructionLab has been established in 2008 and since then focused the research on aspects of the building envelope, computational tools and material development. Next to technological improvements and innovation the research is aiming to improve the quality of life and the user comfort in the interior and and urban environment.

To do so, methodologies to evaluate spatial experience, acceptance and usability, authenticity and identification of the user with ist environment have been applied and further developed. They will be optimised to become part of the design process and of education in the design and planning disciplines. The challenge in most projects is the process management taking into consideration different stakeholders, disciplines and expectations in times of „open innovation“ to further develop it towards an „open source architecture“.

Central questions to be considered and further investigated are:

▪ What are creative and targeted methods of communication and collaboration?

▪ How are innovations triggered by different factors, technologies, and market needs?

▪ How can innovation in the built environment be fostered and increased?

Fig. 1: Photo of the room-in-room system used for indicative assessment, but with a different spatial configuration.

Eco Silence - Development of an ecologically optimised Room-in-Room System for Office Areas

Dipl.-Ing. Christoph Kirch, M.A. Sabrina Mix, Prof. Dipl.-Ing. Jens-Uwe Schulz, Prof. Dr.-Ing. Uta Pottgiesser

ZIM
Zentrales Innovationsprogramm Mittelstand

Room-in-room systems in office areas

A recent survey shows that most people (about 70%) work in open office structures, namely in open space or group offices (Steelcase, 2015), despite controversial discussions on acoustic and visual disturbances of these space solutions. However, they often show improved space efficiency, as opposed to traditional cell offices, and allow for more direct communication between individual employees and for working in a team.

To improve the undisturbed co-operation of different activities in such open office structures, room-in-room systems are sometimes used today; these can also be placed into larger spatial contexts later. They can subdivide the entire area, regardless of building grid and connections, thereby creating profound acoustic barriers as well as visual separation. In this way, activities with a high level of communicative exchange, such as meetings, conferences or telephone calls, can be screened off from other work areas, and, on the other hand, particularly quiet area can be created, as a so-called "thinktanks".

Sustainability in construction

Over the past few decades, "sustainability" has taken on increased social significance. The construction industry is responsible for about 50% of generated waste in Germany (Federal Statistical Office, 2017) and for approx. 40% of resource deployment worldwide. Against this background and given further population and urban growth, the need for resource-conserving and low-pollutant construction is clearly evident. The requirements for interior space have also risen and extended to include the areas of sustainability assessment and life cycle assessment (LCA).

Today, there is a consensus that sustainability consists of the four dimensions "ecology", "economy", "social awareness" and "cultural awareness" (SRU, 2008) and can only be implemented if all dimensions are taken into account. Based on this basic model, extensive standards and certification systems have been developed over the past few years that can be applied to buildings, construction systems and building products.

On 2 January 2017, the DGNB (German Society for Sustainable Building) issued a certificate for interior spaces that was in the initial application phase until 31st July 2017. This certificate is suitable for the certification of offices (10 years) and trade (5 years). The weighting of the main criterion groups is distributed differently from building certifications, so that furnishing and interior construction are assessed separately from the surrounding building. This allows for individual certification of the entire interior. "Issues that do not play a role in the actual project or which cannot be influenced" can be "turned off" by flexibly applying the criteria (DGNB 2017). Since room-in-room systems represent only part of the entire interior, their certification alone is not possible. However, relevant criteria such as "environmental impacts during the life cycle", "costs during the life cycle" and "indoor ventilation" (within the room-in-room system) are considered during development. The criteria "flexibility and usability", "acoustic comfort" and "visual comfort" were also considered and integrated into the room-in-room system. At present, sustainability assessment covers the entire life cycle of the interior: from manufacturing, assembly, maintenance and demolition to disposal (from the cradle to the grave).

As buildings are made up of building products and construction systems, their fulfilment of sustainability criteria determines proportionately the sustainability of the entire building, even if certain products are not relevant for all sustainability criteria.

Sustainability of common room-in-room systems

Room-in-room systems for office areas are offered by some manufacturers of partitions. Here two functions concerning

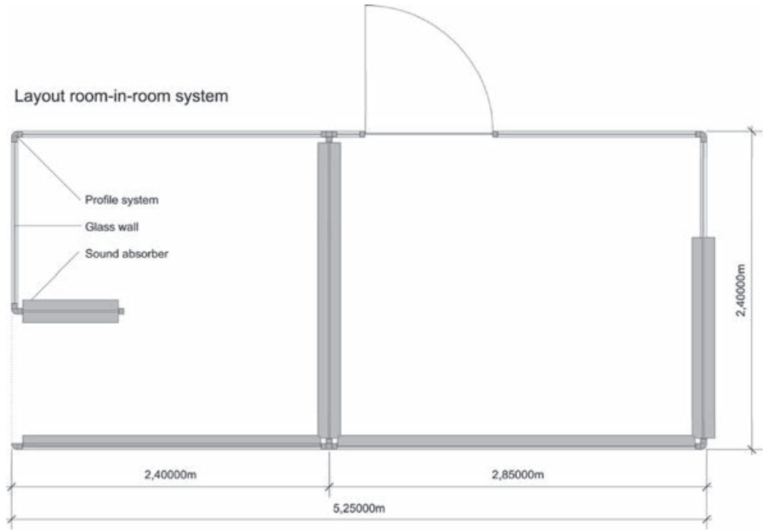


Fig. 2: Layout of the room-in-room system used for an indicative evaluation

acoustics are required: sound insulation, which manages a reduction in noise level through walls and sound absorption in the room, which, in combination with the use of sound-proof, sound-reflecting materials (glass) ensures quiet acoustics in the interior of the room by reducing the reverberation.

Therefore, a room-in-room system is basically suitable for making a positive contribution with the economic and sociocultural-functional sustainability criteria "acoustical comfort", "visual comfort" (daylight) and "surface efficiency".
Until now, such room-in-room systems have only been developed according to constructive, acoustic, economic and building engineering requirements, and ecological aspects have only been

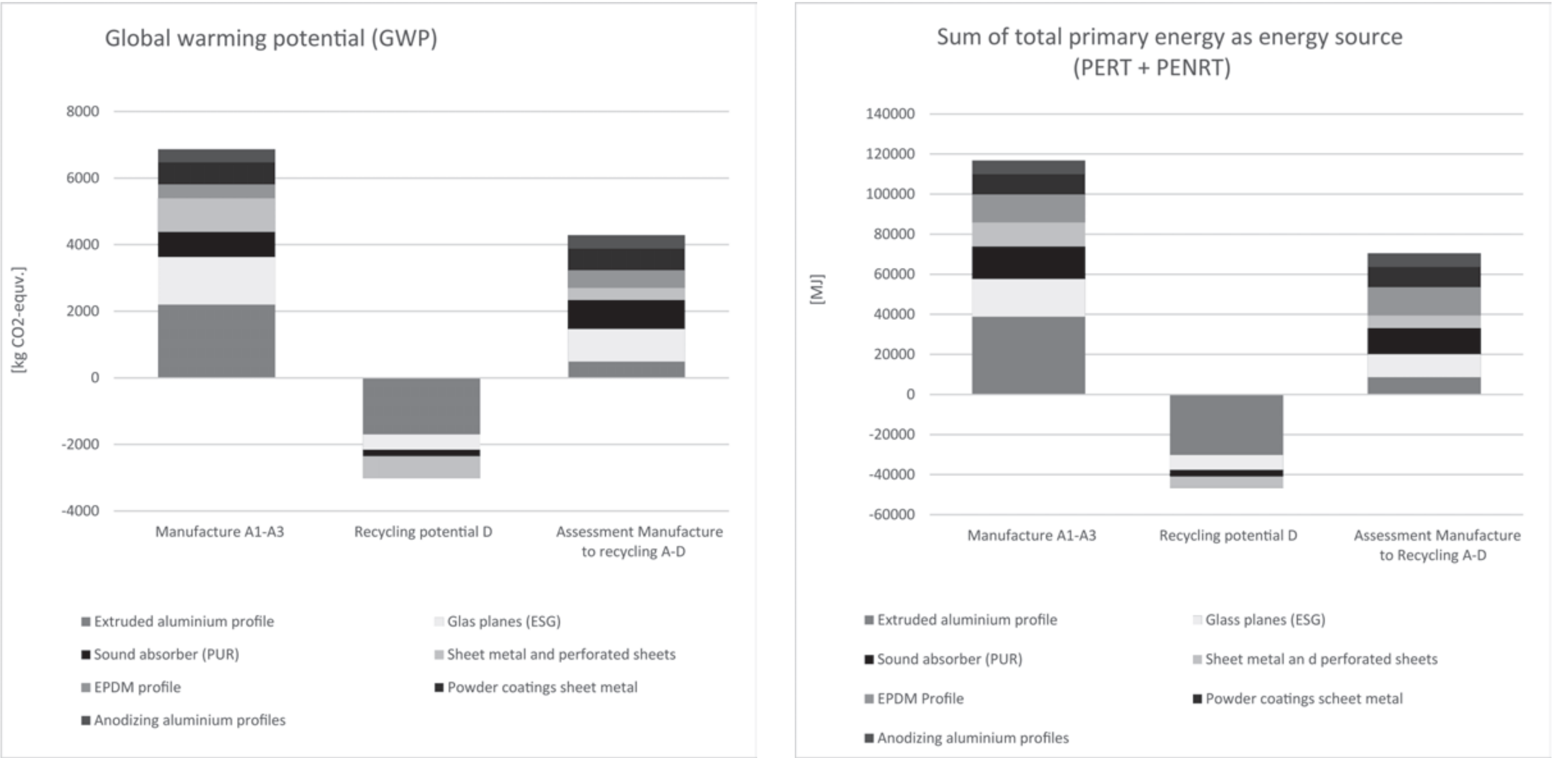
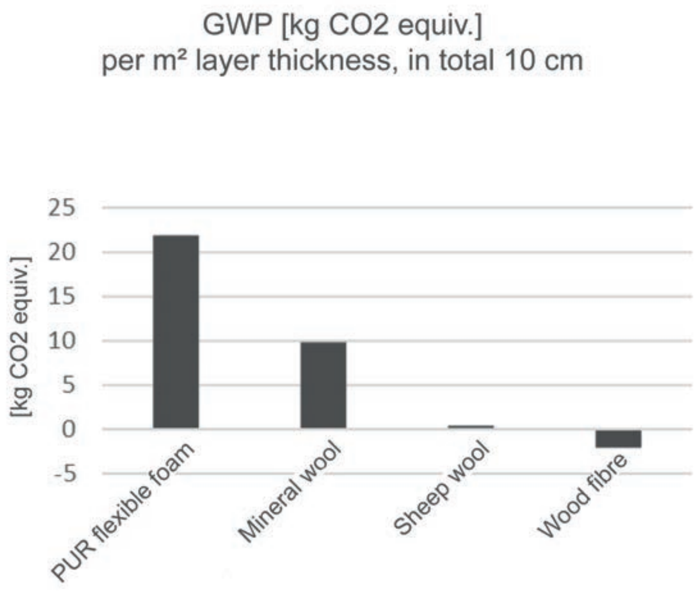


Fig. 3: LCA of a room-in-room system with conventional construction

taken into consideration marginally. In order to harness the benefits of a room-in-room system optimally for sustainable construction, ecological sustainability criteria, such as energy efficiency, the reduction of global warming potential potential, and also the reduction of pollutants must be implemented accordingly.

Figures 1 and 2 show a room-in-room system that is available on the market with aluminium profiles and glass surfaces in combination with a sound absorber made of PUR flexible foam in a steel sheet cassette. For this overall design, an estimated LCA was drawn up to show the influence of individual components on the overall system.

Figure 3 shows the ecological data estimated for the system for primary energy requirement (PERT+PERNT) and global warming



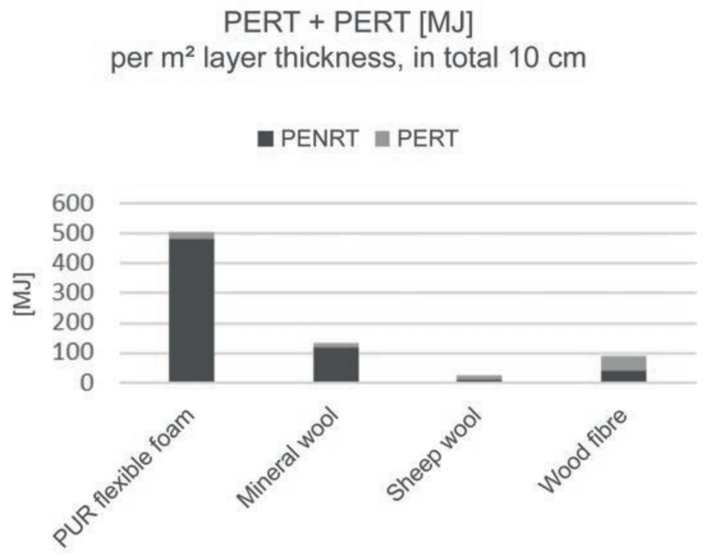


Fig. 4: Total energy requirement from non-renewable primary energy (PENRT) + total renewable primary energy (PERT) as well asglobal warming potential (GWP) per m² layer build-up, at 10 cm total layer thickness - observation time frame of 25 years

Material	PUR flexible foam	Mineral wool	Sheep wool	Wood fibre
Description	Standard SilenceSolutions	SilenceSolutions from SilenceProtect	Variant 1 from EcoSilence	Variant 2 aus EcoSilence
Number of layers	5	2	9	2
Total thickness [cm]	10	10	10	10
Surface weight [kg/m²]	4.36	7	6.3	7.4

Fig. 5: Overview of different absorbers for a comparative LCA

potential (GWP). The calculations were done with average data provided by the Federal Ministry of Environment, Nature Conservation, Construction and Reactor Safety (BMUB) via the ÖKOBAUDAT. The modularised processes according to DIN EN 15804 for production (Module A), disposal (Module C) and recycling potential (module D) are shown. For this purpose, the sum was shown via the manufacturing, disposal and end-of-life processes (Modules A, B and D). Since there are credits in part due to recycling, such as the use of the calorific value during the burning of plastics, the total energy expenditure is reduced, and the actual relevant size is shown. In doing so, simplifications were made (no lighting and ventilation) and partly comparable replacement materials (PUR flexible foam not available as a data set for mats) had to be used.

The approximate assessment of the LCA shows the relatively similar proportion of each individual component to the overall balance sheet, which is mainly due to the respective credits through the creditable recycling potential. This suggests that changes must be made in all components to achieve the goal. These changes should, of course, be achieved with consistent performance of physical and static constructional properties and are possible in three directions:

- Replacement by more ecological (substitutions) or
- less material quantities (efficiency increase) or
- the complete omission of components.

The main focus was initially on substitution with more ecological materials and thus alternative sound-absorbing materials and materials for construction.

Determination of acoustically effective absorption materials under ecological and economic aspects

Porous or fibrous materials are generally suitable for sound absorption. The research focus was placed on organic materials from renewable raw materials, because savings on energy and, above all, reduction of greenhouse gases are more likely.

The exact sound-absorbing effect of the materials must be determined empirically by measurements, as comparable data are only available to a limited extent. Therefore, research for potentially suitable, sound-absorbing materials was carried out. After literature reviews of sound absorption data for renewable raw materials for the first classification as to potential suitability, products available on the market and products with building control certification were sought. Building materials which have been approved by the building authorities simplify the administrative procedure for later approval, as otherwise an "approval in individual cases" must be obtained each time. For easy handling and reproducibility of acoustic properties, mat or plate shapes were favoured. The data of the 66 investigated materials were compared in a table. In addition to bulk density and flow resistance, information on pricing was also compiled, wherever possible, to be able to evaluate the material economically already during the first phase.

After compilation of the data, a comparative evaluation of each material was carried out according to positive and negative characteristics, and a selection was made for the acoustic measurements. Combinations of sheep wool or wood fibre mats of different bulk densities were used to avoid a mixture of materials.

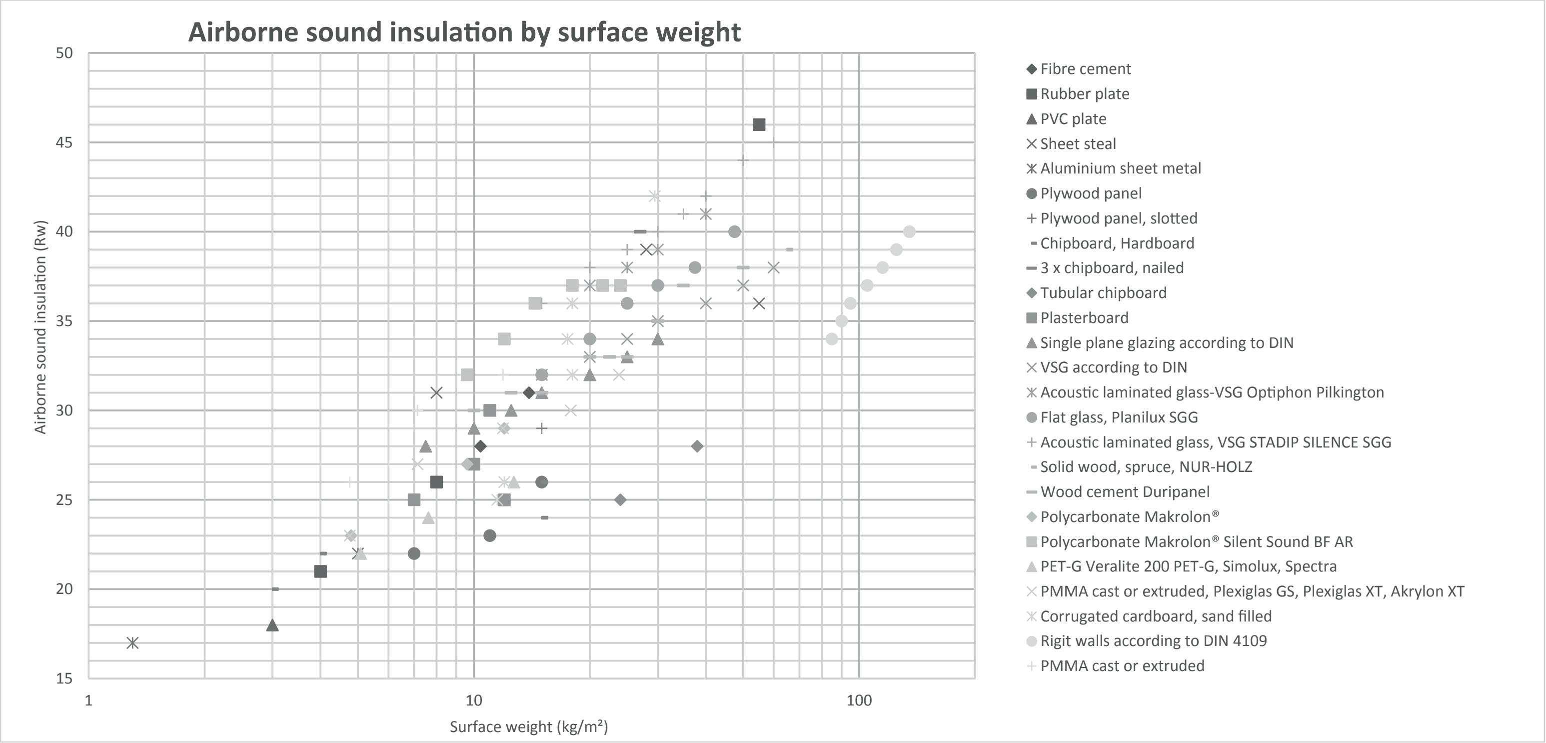


Fig. 6: Compilation of the sound reduction index of single-layer plates in relation to the weight of the surface according to the manufacturer and literature (Fasold and Sonntag, 1978; Larm et al., 2005)

After the empirical development of the sound absorber in this way, a detailed comparison of the environmental effects with the exact bulk and materials used was carried out. The combination of mineral wool of different densities from the ZIM project "SilenceProtect" (Kirch and Böhm, 2013), as well as the standard sound absorber of the SilenceSolutions made of PUR foam, were used to pin down the improvement of environmental effects (see Fig. 4 and 5).

Since evaluation systems like BNB, and DGNB, use the ÖKOBAUDAT as a data basis, this was used to evaluate the environmental effects of the materials.

Determination of construction materials under ecological and economic aspects

The room-in-room system primarily has the task of reducing the sound level between interior and exterior areas within a defined range. The partition has to primarily fulfil this task. Usually, comparative life cycle assessments of materials are based on a weight unit, area or volume. However, it had to be determined first of all which materials have an ecological advantage in terms of a comparable sound insulation (as a functional unit).

The sound-absorbing dimension of flat materials depends, on the one hand, on their surface weight, but also on their bending stiffness, which also depends on the respective layer thickness. The difficulty is that the airborne sound insulation range of 30 to 40 dB required for the room-in-room system, the coincidence limit (the track-adaptation limit frequency at which the wavelength of the track of the airborne sound is the same as the length of the bending wave of the component) has a decisive influence. While the sound insulation value increases analogously for softened components (e.g. steel sheet), there is a plateau for other materials (e.g. glass, gypsum, concrete), in which the sound insulation value hardly increases, despite increasing surface weight. From a certain level, the component is once again flex-resistant enough to allow the sound insulation value to increase as the mass continues to increase (Fasold and Sonntag, 1978). However, between this sufficiently stiff and flexible area, the basis weight factor partially lies at 2-4. Naturally, this phenomenon had to be taken into account during the comparative assessment of surface materials and their environmental impact as well, and a comparison in terms of a weight unit alone would not have been enough. The material-dependent surface weight for achieving a certain sound reduction index must be compared during the life cycle assessment. For example, 8 kg/m² of steel sheet with approx. 25 kg/m² flat glass, since both achieve a sound insulation value of 32 dB.

Since the sound insulation range, 30 - 40 dB is rather low for components in the construction area, there is relatively little empirical data for one-layer, flat materials. With light, flexible materials, two-shell components with a relatively large, damped gap are created in the construction area. However, this should be avoided for the room-in-room system, because, in addition to the larger building volume, the constructional effort also increases disproportionately.

With the compilation of the empirically determined sound reduction index of ultimately 146 materials and the selection of some single-layered materials with sound insulation indices of 30 dB, 35 dB and 40 dB ± 2 dB (most deviations are however lower), a comparison of environmental effects with generalised data from the ÖKOBAUDAT could be made. With these results, a selection of wall surface materials for construction work can be made, which have better insulating properties with the same sound insulation effect - for example a woodchip board instead of glass.

Since transparent surfaces have to be used for lighting and visual connection of spatial areas, alternative materials with a better LCA can be used for areas on the ceiling and for sound-absorbing surfaces (see Fig. 7, 8 and 9)

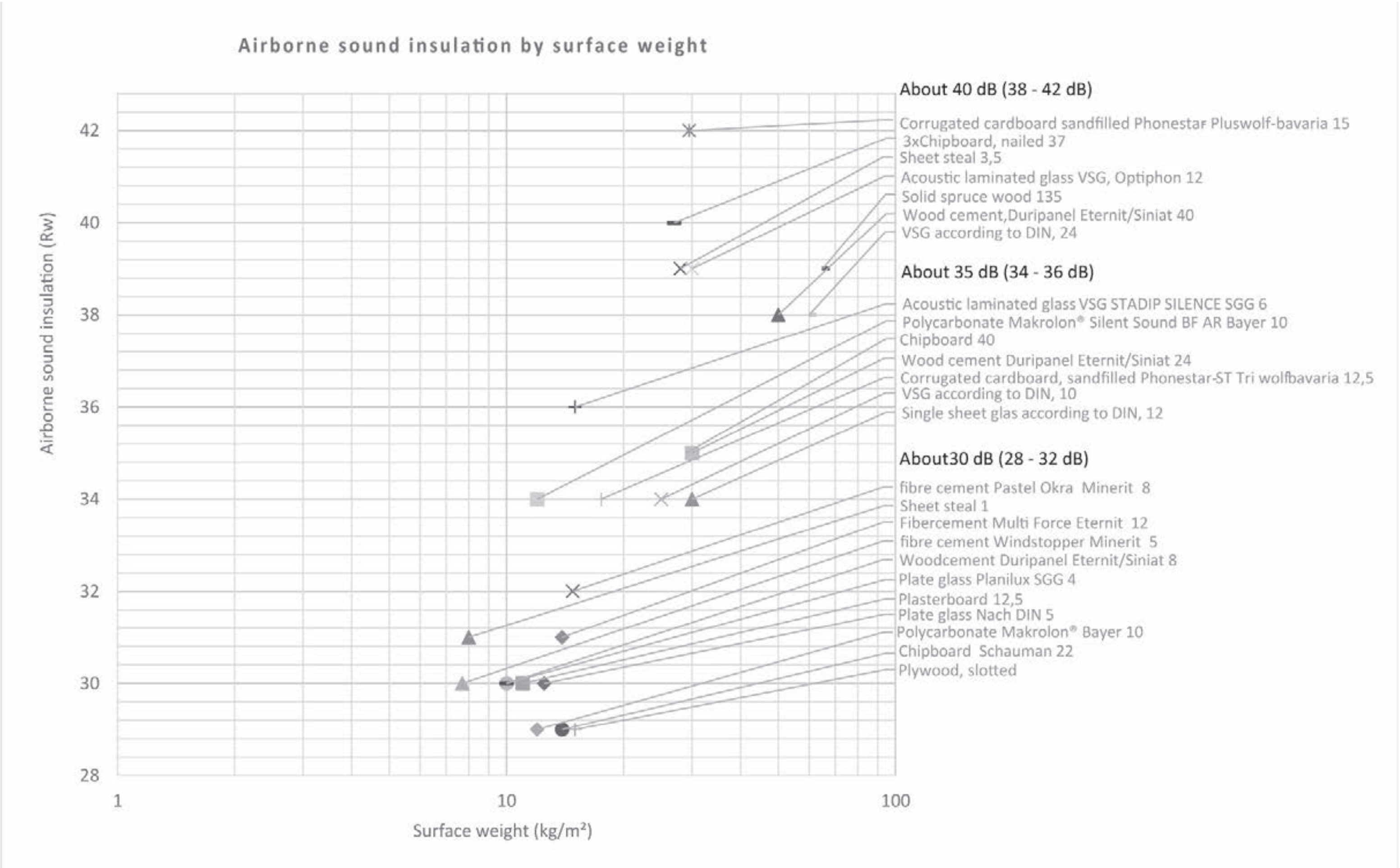


Fig. 7: Sound reduction index of the selected one-layer materials in relation to the surface weight or layer thickness

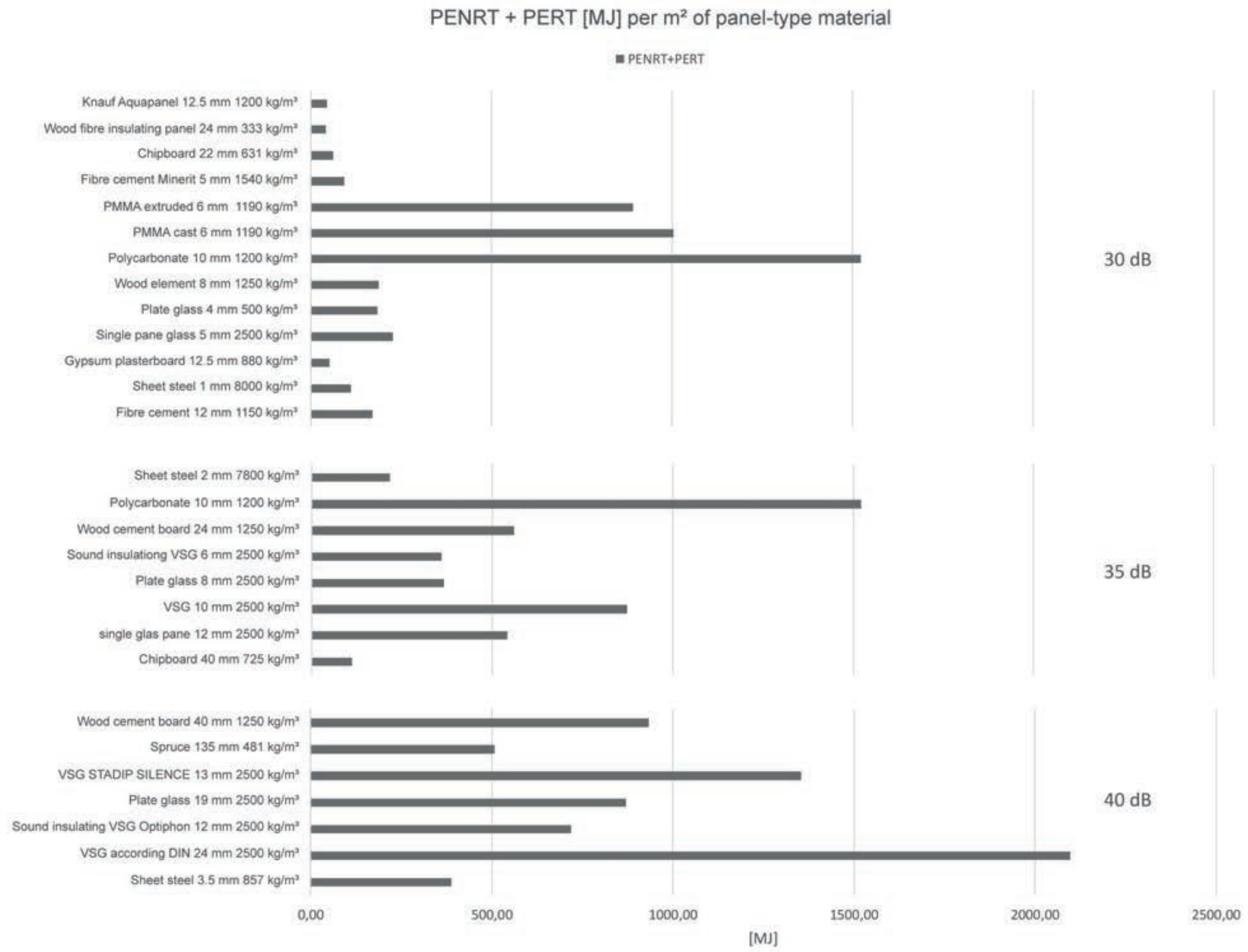


Fig. 8.: Total energy consumption from total non-renewable primary energy (PENRT) + total renewable primary energy (PERT) per m² of panel-type material for 30, 35 and 40 dB - observation time frame of 25 years

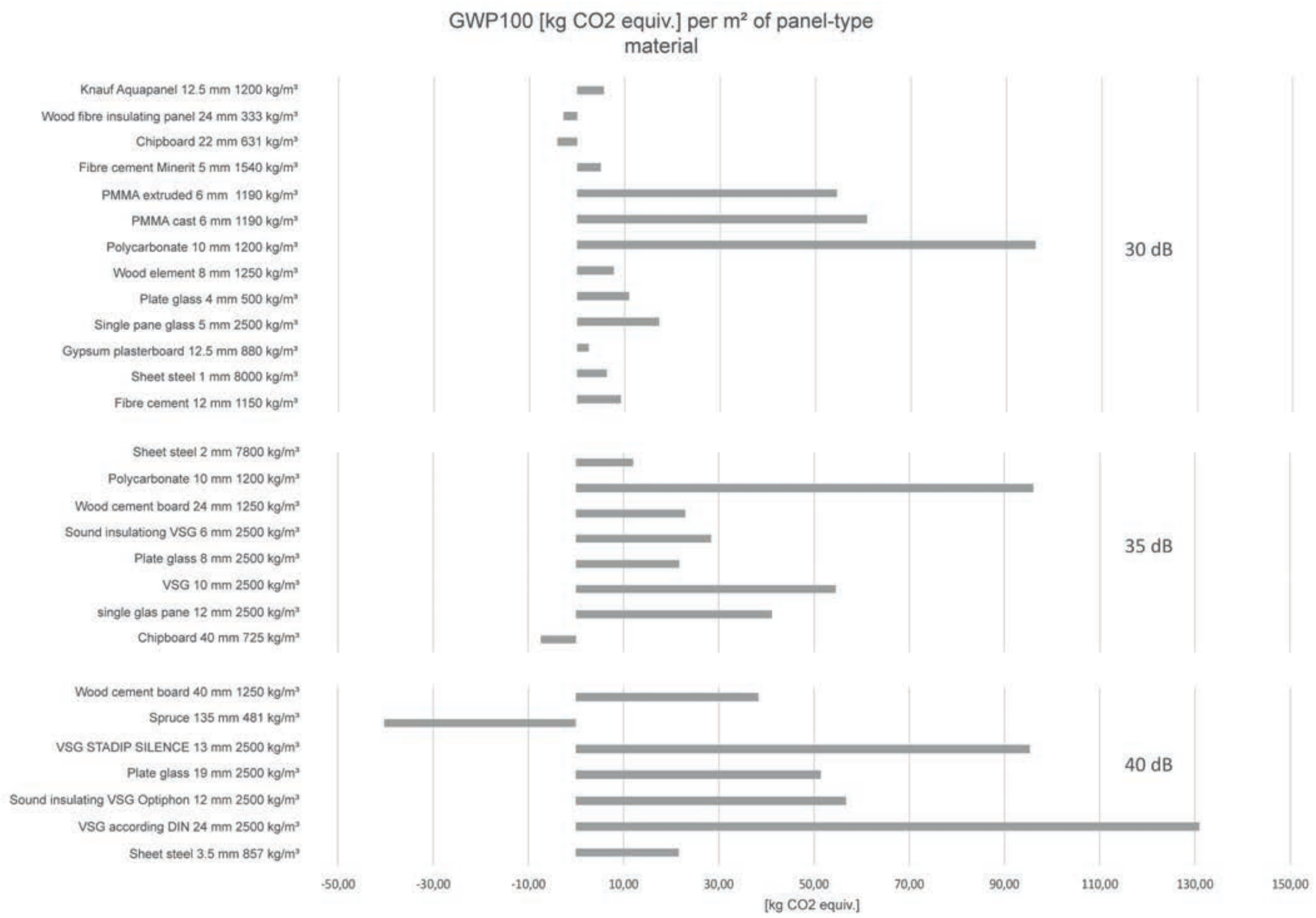


Fig. 9: Global warming potential (GWP100) per m² of panel-type material for 30, 35 and 40 dB

Further steps with the EcoSilence project

During the further development of the project, the room-in-room system will be designed and constructed in detail, whereby solutions will also be used to ensure optimum dismantling. Reversible joining techniques of the various building materials enable a system-independent separation of the material in end-of-life scenarios and improve recyclability. Bonded connections are unfavourable here since the materials cannot be fed into the respective cycle of materials optimally.

In addition to improved materiality, there is further potential for optimisation into a strong modularisation of the elements. This facilitates a re-use during renovation or after removal and reduces the amount of waste.

Market relevance as to sustainability, user comfort and health

As to interior design, the trend has been moving towards natural materials, renewable raw materials and homelike and healthy living environments for some time now. Places of work are no longer viewed as strictly functional, but also as to their impact on their quality of stay, and the well-being and health of their users. With increasing density of the building envelope for energetic reasons, the certification of emission-free materials goes hand in hand with interior designing to achieve acceptable room air quality (cf. "Evaluation System for Sustainable Building", BNB 3.1.3, BMUB 2015). This leads to an overall increase in market potential for sustainable products, beyond pure environmental data, as well as the necessity of new, sustainable design methods, particularly for interior elements and thus also for room-in-room systems.

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Thematische Schwerpunkte der Modellvorhaben Variowohnungen

Stand: November 2017

				Gebäudekennwerte												Bauweise / Baukonstruktion								
				Art der Baumaßnahme				Anzahl Wohneinheiten				Gebäudetyp				Bauweise				Besondere (städtebauliche) Anforderungen				
Ort	Wohnungsbaugesellschaft	Studierendenwerk	privat (GmbH)	Neubau	Umnutzung	Lückenschluß	Aufstockung	bis 50	50 - 100	100 - 200	über 200	Block / Gebäude im Block	Zeile	Punkthaus / Solitär	Cluster	Massivbau (Beton, Mauerwerk)	Leichtbau (Holz, Stahl)	Modulare Bauweise	hybride Bauweise	Schallschutz	aufwendige Gründung	Kontamination	Schadstoffe im Gebäude	Denkmalschutz
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Projekt 2		•		•						•		•				•				•	•	•		
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	Ökonomie									Ökologie						
	Bauzeitverkürzung					Betriebskostenminimierung / Nutzersensibilisierung				Energetischer Standard			Zertifizierung		Mobilität	
Ort	vorgefertigte Nasszellen	vorgefertigte Bauteile, serielles Bauen	vorgefertigte Raumzellen / Module	konfektionierte Bauweise	BIM / digitale Fertigung	Verbrauchs-Monitore	individualisierte Verbrauchsanzeigen	Wettbewerbe	Sparsame Geräte / Installationen / robuste Materialien	KFW 55-Haus	KFW 40-Haus	Passivhausstandard	NaWoh	DGNB	E-bike-Ladestationen	Car-Sharing
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Projekt 24		•								•			•			
Projekt 25	•	•					•						•			
Projekt 26			•										•			

	Nutzung & Nachnutzung									Räumliche und gestalterische Qualitäten									
	weitere Nutzung	Umbaubarkeit					vorbereitet für altersgerechtes Wohnen			besondere gemeinschaftsfördernde Angebote						Lage / Kontext			
Ort	(außer Student / Azubi Wohnen)	flexible Grundrisse (Skelettbau)	Aussparung in Wandschotten	Umbaubarkeit zwischen Wandschotten	Gebäudetechnik umprogrammierbar	zusätzliche Reserven für Leitungen	ready	ready plus	all ready	Café	Werkstatt	Gärten / Dachgärten / urban gardening	Arbeits- / Lernräume	Kunst / Kultur / Veranstaltungen	Sporteinrichtungen	Zentrum	Wohngebiet	Mischgebiet	Universität
Projekt 1		•										•							•
Projekt 2				•			(•)									•			
Projekt 3	•	•			•		•	(•)		•	•	•		•			•		
Projekt 4		•				•		•				•			•		•		
Projekt 5			•		•			•				•					•		
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Projekt 7				•				•				•			•			•	
Projekt 8		•	•				•			•		•			•	•			•
Projekt 9		•					•									•			•
Projekt 10			•				•	(•)					•						•
Projekt 11				•			•					•						•	
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Projekt 17			•				•					•			•			•	
Projekt 18	•	•					•	(•)				•				•			•
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Projekt 20	•	•			•					•	•	•						•	
Projekt 21	•		•		•		•	(•)		•		•						•	
Projekt 22			•				(•)					•	•				•		
Projekt 23	•	•			•		•	(•)		•		•						•	
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Projekt 26		•						•									•		

Fig. 1: Matrix of focal points: Thematic focuses of the model projects 'Variowohnungen'.

Research Project „Variowohnungen“

Scientific accompanying Research for the Demonstration Projects for the sustainable and affordable Construction of variable Housing.

Prof. Carsten Wiewiorra, Dipl.-Ing. / M.A. Christine Naumann, Christina Hagenhoff B.A., Prof. Hans Sachs, Prof. Dr.-Ing. Uta Pottgiesser

Background

The number of students in Germany rises. Because of that, especially in conurbations, the demand for living space is very high. At the same time, the demand for housing also rises among apprentices, pensioners and recognized refugees. For this reason, sustainable and housing is needed, which is affordable for people with low income but is nevertheless of high architectural quality. The architectural, structural and technical innovations developed in the demonstration projects will be accompanied and evaluated to contribute to the development of guidelines and policies for sustainable use of variable housing.

Support Program

The research project “Variowohnen” is a part of the Future Investment Program of the GermanFederal Government and is run within the framework of the Research Initiative “Zukunft Bau” by the Federal Ministry for the Environment, Nature Conservation, Construction and Reactor Safety (BMUB). The Federal Institute for Building, Urban and Spatial Research (BBSR) is responsible for the technical and scientific support, as well as for the administrative implementation.

“Variowohnungen” - Variable Housing

“Variowohnungen” are small modular apartments of at least 20 square meters. They have an individual room, a cooking space and a bathroom. At f irst, they are to be used by students and trainees, but optionally it should also be possible to convert them for use by pensioners or recognized refugees.

“Variowohnungen” are sustainable and respond to demographic change. Moreover, they should also be low cost and quick and easy to build. They must be ready for occupancy, and can be offered furnished or unfurnished.

Fig. 2: Prof. Carsten Wiewiorra at the first network-meeting in Berlin.

Research

Each project has a research component that is to provide the basis for the further development and the sustainable use of variable housing. The research takes place in four main areas (the investigation of the building construction with the aim of building acceleration and cost minimization; the investigation of mixed and flexible reuse as well as the spatial and design quality; the scientific evaluation of the building costs and the efficiency of the structural and technical concept; the proof of sustainability).

In cooperation with the planning agency so•li•dar from Berlin and the htw Berlin, the HS-OWL will conduct the scientific research. The aim is to work out the qualities of the individual projects, and to make a comparison of them, to examine obstacles in the planning and construction process and to evaluate solutions. Network meetings are intended to support the exchange of information between the projects, an d symposia will be held for the interested professional public.

Focus of work of HS OWL

The focus of work of HS OWL will be on the content. This includes, for example, the collection, processing and evaluation of project data. Online data queries will be developed which, according to the project process, record the so-called “hard data” of the project. In addition, with the progressive development of the projects, interviews and project visits will take place to gather the so-called “soft data”. Individual evaluations, contradictions and cross-comparisons will be part of the analysis.

To build up a network between all participating projects, the thematic and research foci of the individual projects will be compiled in a focal matrix and will be presented on a communication platform and published in further publications.

Fig. 1: Flood in the village of Brockwitz. Photo: SV Coswig/Normann.

HUeBro: Building Elevation in Flood Areas

Prof. Dr. Axel Häusler, Prof. ir. Michel Melenhorst, Prof. Dr.-Ing. Uta Pottgiesser, Prof. Kathrin Volk,
Dipl. - Ing. Benjamin Dally, B.A. Jens Renneke, Dipl. - Ing. Carsten Schade

Due to the anthropogenic climate change, the number of extreme weather events will rise. Settlements alongside rivers are increasingly endangered by flooding. Protecting them by conventional measures of flood protection such as dikes will not always be possible. Reasons of economic efficiency, technology, urban design or open space planning can lead to other solutions. On the example of Brockwitz, a village in Saxony, Germany, a new research project will investigate how house elevation can be used as a measure of flood protection. As of April 2017, ConstructionLab is engaged in the research project "Haushebung in Ueberschwemmungsgebieten am Beispiel des Elbe-Dorfes Brockwitz" (short: HUeBro) ("House Elevation in Flood Areas, on the Example of the Village of Brockwitz/ Elbe"). Together with its research partners, ConstructionLab will investigate house elevation as a measure of flood protection. Up till now, house elevation has only been used in the mining industry.

HUeBro is funded by the German Ministry of Environmental Protection as a flagship project to assess the impacts of climate change. It takes as an example the village of Brockwitz, on the banks of the river Elbe in the municipality of Coswig close to Dresden in the German state of Saxony, where after several serious flooding events since 2013 different measures of flood protection were tried out. Building a dike in the foreland of theriver Elbe was discarded due to the technical infrastructure and reasons of hydro-engineering and urban/open space planning. Elevating houses on the lower side of Brockwitz is perhaps a more economic form of flood protection, which will also take into account the interests of the inhabitants and urban/ open space planning. Using the example of Brockwitz, guidelines for future house elevation projects in flood areas will be developed. ConstructionLab will undertake the project with its research partner and will be responsible for "Building typology and lifting techniques" and "Building construction design and building service engineering". nextPlace (GIS/visualization) and urbanLab (urban/open space planning), both research groups at the University of Applied Sciences OWL, will also be engaged in HUeBro. At the University of Applied Sciences OWL, the project will be supervised by Dr. Axel Häusler, Michel Melenhorst, Dr. Uta Pottgiesser and Kathrin Volk.

House elevation // house lifting techniques // building construction design; // building service engineering // innovative flood protection // climate change // village development // open space planning // participation procedures

Local planning

In the case of a partial elevation of a location, the usual components of a built-up town centre are partly taken apart and combined in a new constellation. Even if the original state is mimicked as congruently as possible, there is a need for change and optimisation potential resulting from the elevation. In order to increase the acceptance of the measures, they should be implemented respecting the identification of the inhabitants with their town. (Fig. 2)

Within this work package the approach will therefore be to involve citizens as far as possible in the development of solutions. Brockwitz, for example, develops transferable urban development solutions and tests appropriate participation procedures. This is based on experiences from projects and lessons learned in similar contexts; the urgent requirement is to make the local people understand the three-dimensional spatial changes. At the same time, things can be learned from the change processes at another location, whether this involves hydraulic engineering or not. An inspirational book will collect exemplary and inspiring projects and solutions that can be transferred to house elevation, and will be presented in Brockwitz.

This will be followed by a multi-day excursion with scientists involved in the project and affected residents to exemplary projects (Germany, Netherlands, Belgium). The ensuing working processes will be further analysed through conversations with more local parties involved (other inhabitants, authorities, entrepreneurs etc.), by preparing pictures, as well as audio, text and video documentations, and by constructing a participation model (1:400, size - about 4x4 meters)

Fig. 2: Participation models will be used to involve the citizens in the development of solutions. Photo: Michel Melenhorst.

which has proved successful in previous processes and whose transferability to the method described here is to be tested. The preparatory phase will lead to the workshop phase. Participation of residents, local managers and project participants will be used to develop variants for the urban development processes. Advanced architecture and urban planning students from the University of Applied Sciences OWL will take part, who will contribute their diverse experiences in designing variants to the workshop groups. The project leaders will repeatedly place at the centre of the draft design the topics of morphology, historic monument preservation, material/immaterial value, visibility, time, material, colour, business, hydrology and natural values. An initial assessment of the feasibility and innovation of the ideas will be made using the "How? Now! Wow! " method.

The results of the work package will be further elaborated with the aid of visualisations, models, brochures and further developed in an additional feedback loop with local stakeholders. Based on the multitude of previously developed variants additional abstracted solutions and strategies for other local situations will be developed and the method of participation used is to be evaluated for its applicability and will then be fully documented. All results will be incorporated in the final report.

Open space planning

The project will open up a chance to consider afresh the complex themes of landscapes and settlements affected by floods and flooding from various perspectives. Flood protection is linked to high technical effort and landscape consumption.

As mono-functional structures, dikes or retention areas add little to the experience of landscape or the design of open spaces. Within the present project, solutions for floodwater protection can be developed and conceived not only from the aspects of functional safety and floodwater management, but also as a design potential for the landscape and open spaces in the town. Brockwitz and the surrounding landscape will be a test case for innovative flood protection measures which, as a green infrastructure, also make a contribution to the development of resilient landscape and settlement areas. Thereby, different levels of consideration will be involved: River landscapes as large-scale landscape systems cannot be considered solely in relationship to one place. The river system and its large-scale interrelations must be understood and developed in order to develop further considerations, approaches and measures concerning the settlement area or individual building projects.

In the preparatory phase, various open-space planning questions will be examined: how the raising of parts of a village can be integrated into rural settlement structures and how flood protection measures can be integrated as a new creative space element into a village housing area with no developed open space system; these issues will be of central importance. On the macro level, measures are to be developed and presented which will deal with the development of the open space of individual raised buildings. The special approach of "house elevation" changes the access and connection of a building to the outside area. On the object level will be investigated how the open space needs to be adapted in order to be able to continue to make use of the structure house - garden - landscape area of Elbe/Lockwitzbach Valley as an experienceable residential and living space. For example, the elevation of houses (often including the garden / open space) leads to the question of how the access to the river floodplain is to be designed in the future or how the volume under the elevated house/open space may not only be filled but also be made available for other uses.

The results of the workshop phase will be further developed (visualisations, models, brochures) within the framework of the work package and finally elaborated in another feedback loop with local stakeholders (based on the variety of previously developed variants, also derived will be solutions and strategies developed for different local situations, and participation methods will be evaluated for their applicability. The aim is to develop new solutions from the above-mentioned questions, which can also be applied to other river landscape areas. The results lead to the final report

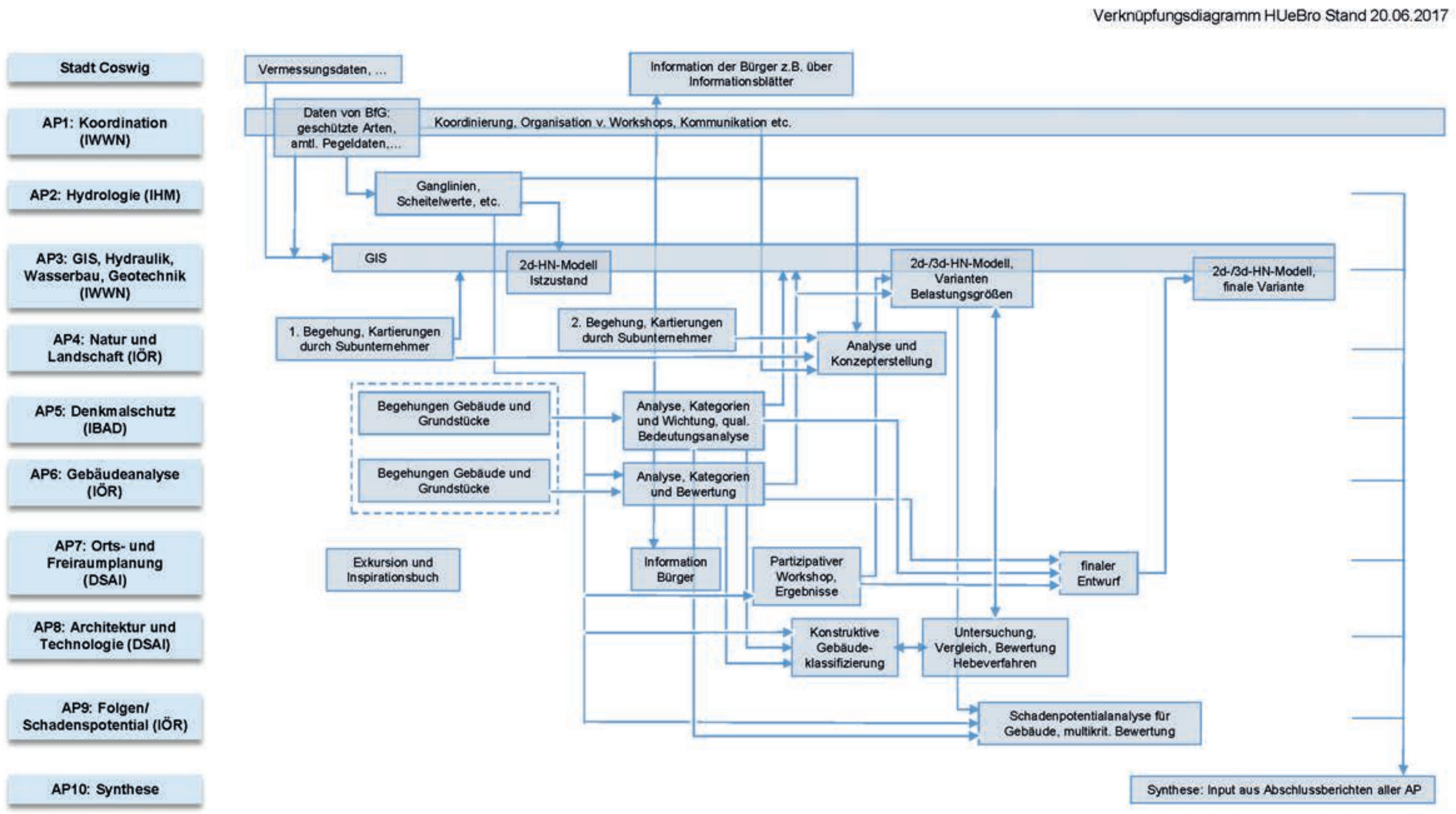


Fig. 3: Diagram of the link-up between the different work packages within the project.

Data-based townscape analysis

The hydraulic elevating of a single building presents a challenge above all to static and technical engineering design. On the other hand, the elevation of an entire district raises questions about the functioning of the development, the flowing and dormant transport, the everyday road networks and urban appearance. This leads to the following aspects of examination and work packages: Complementing and adapting the building and area catalogue, including a linked database for assigning the buildings to building construction types and monument protection classes. Before setting up a work package, a basic data structure is necessary. Here, GIS data from hydrology and hydraulics are gathered as well as from the monument-preserving building-typological evaluations. (Fig. 3)

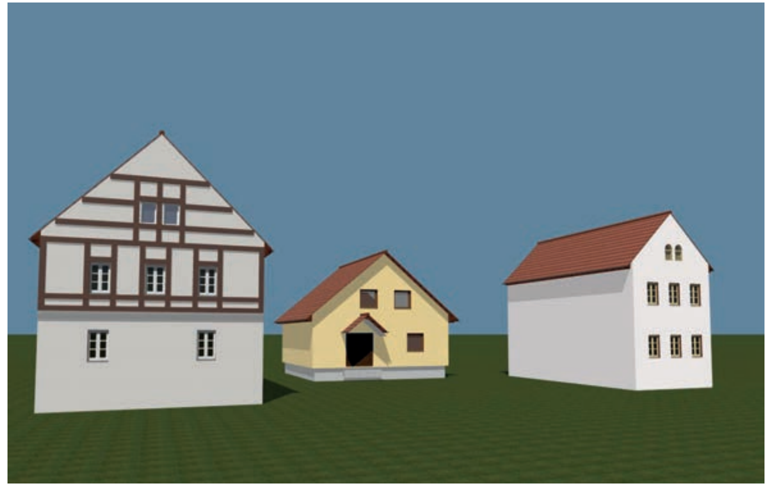
Analysis of the road network structure of the site for the functional assessment of the road sections: The road network is basically the oldest structural element of each location. The analysis of the links between existing source and destination points provides important insights into the internal movement processes within a locality and community structure. For example, everyday frequencies and usage habits of individual route sections can be estimated as well as their importance in the entire road network. The district to be lifted is largely characterised by a longitudinal connection and the access roads leading from it. In order to classify road sections with regard to constructional realisation, however, their significance is to be classified with reference to the overall network.

The aim of the analysis will thus be to formulate a decision-making aid which should give special priority to road sections in the planning and implementation phases. For this purpose, GIS-based methods of network analysis and different accessibility studies will be used in the investigation. The analysis will be based on the available georeferenced ALKIS database of the municipal or county administration. Analysis of the visual relations for the identification of the locality-typical spatial typologies: The cognitive image of a community structure consists of several, spatially concise individual perceptions. Each sequence is formed by the individual position of the observer, prominent structures, the spatial ensemble, and the visual relations associated therewith. This complex perception network is responsible for the recognition of space, the emotional attachment to the locality, and the orientation within the spatial structure. Some of the dominant perceptual sequences can be examined in more detail with so-called 'line-of-sight' analyses.

Consequently, relevant road sections will be analysed with regard to their spatial composition and the structure-forming spatial edges, based on the previous work steps and with the aid of a computer-generated 3D model. The results are to be included in the planning decisions with the results from locality planning/open space planning. The line of sight analysis thus enables the best possible inclusion and maintenance of one's own locality and orientation for the occupants and users within the elevation process. (Fig. 4, 5)

Building typologies and elevation procedures

The hydraulic elevation of a single building body represents a static and technical strain on constructions. Depending on the building method, construction and material, structural and technical features and stresses of the structures during the process as well



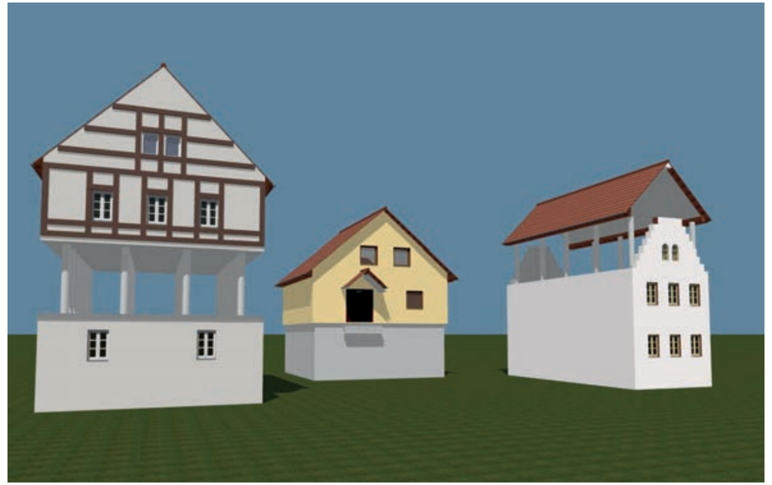


Fig. 4, 5: Diagrams of different building typologies and elevation procedures. Pictures: SV Coswig/Lier.

as the necessity of functional, design and technical-constructive adaptations after the elevation will provide essential data for the elevation of the individual building bodies. Against this backdrop, investigations will be carried out of the structural, technological and user-specific aspects in the context of the elevation of the house.

The aim of this work package is the development of a matrix for the typology of all affected buildings in order to carry out house elevations as well as the comparative assessment of different hydraulic lifting methods offered on the market. After a fire in 1571, the present-day townscape of Brockwitz is marked by various building types and construction ages. Many buildings are important architectural witnesses to the village's development at specific times and, hence, of special relevance in view of the local construction history. Data on the construction stages is available at the town of Coswig, the monument preservation assessment of the building fabric will be carried out in the work package by the TU Dresden.

This preparatory work will be the basis for the detailed building-type study on the further building-constructional and material-specific assessment of the existing building substance in this work package. All buildings that are potentially affected by the elevation will thus be assessed with regard to structural, static, spatial and material-related risks during and after the elevation. On the basis of criteria to be defined and a checklist that builds on them, the buildings will be compiled into a matrix. Due to the specific character of the buildings as well as the necessary degree of detail in the observation, additional on-site inspections will be required as well as a test of a practical system for the detection of possible damages which already existed before the elevation. The comparative assessment of different hydraulic elevation processes on the market is necessary from the perspective of the applicants in order to be able to estimate the costs, potentials and risks for different building types and sizes. Only in this way can decisions for the affected buildings be weighted meaningfully and evaluated with regard to the temporal, constructive and financial overall risk. (Fig. 6)

Fig. 6: The aim is to formulate a decision-making aid: The Federal Minister of the Interior visited Brockwitz in 2017 at the beginning of the project. Photo: SV Coswig/Lindackers.

The aim is to formulate a decision-making aid for the citizens, but also for other municipalities affected by floods, regarding the preparation, monitoring and follow-up of the entire procedure, in order to also increase the acceptance among owners and users concerned. The model for the typology and the checklists will be tried and tested to offer a guide for the energetic modernisation of the building stock. The results of the work package and the monument preservation survey are to be used in a data-based townscape analysis and can be transferred to other flood-affected areas.

Name: HUeBro - Haushebung in Ueberschwemmungsgebieten am Beispiel des Elbe-Dorfes Brockwitz

Funding by: Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (Funding line: Measures of Adapting to Climate Change)

Partners:
- Technische Universität Dresden, Institut für Hydrologie und Meterorologie (IHM),
- Technische Hochschule Nürnberg GSO, Labor für Wasserbau (LWN) (lead)
- Leibniz-Institut für ökologische Raumentwicklung (IÖR),
- Technische Universität Dresden, Insitut für Baugeschichte, Architekturtheorie und Denkmalpflege (IBAD)
- University of Applied Sciences Ostwestfalen-Lippe (Research groups ConstructionLab, nextPlace, urbanLab)
- Municipality of Coswig

Contact: Prof. Michel Melenhorst (http://www.hs-owl.de/fb1/forschung/urbanlab/u-team.html)

Duration: 04/2017 - 03/2019

EU-COST Action TUD1403 Adaptive Facade Network (AFN)

Prof. Dr.-Ing. Uta Pottgiesser

Multi-functional and adaptive building envelopes can provide step-change improvements in the energy efficiency and economic value of new and refurbished buildings, while improving the wellbeing of building occupants. They therefore represent a significant and viable contribution to meeting the EU 2020 targets. The COST Action 'Adaptive Façade Network' aims to harness this knowledge and will thereby generate new ideas and concepts at a fundamental and product/system development level. This will be achieved by creating a research network with a strong multidisciplinary approach, involving academics, industrial partners from the façade supply chain, and other stakeholders.

The COST Action has 170 participants from 27 EU-countries and is organised in four working groups. It will facilitate the sharing of experimental data, the development of modelling and simulation techniques, and the sharing of common evaluation methods. The work of this COST action is expected to be the basis for exploiting recent technological developments in adaptive façades and energy efficient buildings, and will help to train future generations of façade R&D professionals in Europe.

Main activities of the COST Action are:

- offer Training Schools with PhD- and Master Students
- foster Early Career Researcher (ECR)
- create Short Term Scientific Missions (STSM)
- contribute to knowledge through Educational Package (EduPack)
- enable joint scientific publications and research proposals
- increase networking through conferences and lectures

More information: http://tu1403.eu/

Fig. 1: efnMOBILE 2.0 - Workshop Antwerp 2017

efnMOBILE 2.0 Efficient Envelopes

Prof. Dr.-Ing. Uta Pottgiesser, Susann Kreplin, B.A.

efnMOBILE 2.0 is the second edition of a series of travelling student workshops to provide the European Facade Network (efn), its conferences and the connected industry, i.e. the architecture and engineering community, with a local platform for communication, exhibition, innovative development and interaction. efnMOBILE 2.0 has been travelling along with the annual conferences of the European Facade Network and to other related events within Europe and in exchange with the global facade community. It is striving to develop from a European communication and technology exchange instrument into an international tool and format.

All events of efnMOBILE 2.0 follow an overall theme: 'Efficient Envelopes'. They focus on adaptive and transdisciplinary approaches to improve the building envelope's, and thus the building's, performance through human-centered solutions in facade technology. The hope is to encourage the upcoming generation of architects, designers and engineers to allow themselves to follow uncharted paths of development, to think outside the box, to build showcase examples, and to come up with ground-breaking solutions – for better designs in terms of climate, health and an overall building design approach. The concept is meant to foster the dialogue about sustainable design and development and to increase awareness and actionable solutions for sustainable design.

In 2016 and 2017 efnMOBILE 2.0 workshops took place at three efn-conferences:

Lucerne 2016, Delft 2017 and Detmold 2017, additionally in Dusseldorf 2016 (glasstec fair), in Antwerp 2017 (University) and in Istanbul 2017 (ICBEST conference).

Fig. 1: Photo - Collage, efnMOBILE - Workshops and Student Project thedeserteyes

MID // MIAD

Prof. Dr.-Ing. Uta Pottgiesser

The Master of Integrated Design (MID) focuses on qualifying architects and engineers for interdisciplinary, international and to a growing extent digitally supported jobs. Special emphasis is laid on the cooperation between the university and external partners, linking to other universities, planning offices, the construction industry and software manufacturers. Globalisation in general and in the construction industry in particular has brought about new demands on buildings, building components and construction projects. Moreover, digital technology has effected lasting changes to the planning, production, construction and operating phase. Consequently, job profiles are getting more sophisticated. The MID-programme therefore teaches in particular theoretical and practice-oriented skills of digital analysis, design-, planning- and production methods and gives a detailed overview of the latest technological developments. It includes operative aspects of information technology, new developments in building materials and scientific work as part of the architectural education.

The MID programme is linked with the degree programme Master of Integrated Architectural Design (MIAD) and offers the two specialisations of Facade Design and Computational Design. Both specialisations have joint courses and collaborate in the project modules. The standard study period is four semesters as a 2-year full-time course and is divided into four module blocks: Core Modules are shared by both specialisations and teach theory and scientific methods, communication, construction and various tools. Project Modules are studio-based, with different foci within the specialisations. Through experimental design students gain practice-oriented skills. The Specialised Modules deepen students' knowledge in their chosen specialisation, such as climate, comfort, materials, safety, planning and production or digital fabrications, computational optimisation and simulations. Elective Modules can be chosen individually. The fourth semester is reserved for the Master thesis.

Coordinators / Team

Prof. Dr. Uta Pottgiesser
i. V. Prof. Daniel Arztmann
Prof. Hans Sachs
Prof. Jens-Uwe Schulz

Coordinators:
Facade Design: M. Arch. Anica Dragutinovic
Computational Design: M.IA. Jan Kahre - Heidemann

Fig. 1: Symposium "Digital Methods"

Master-Kick-Off-Workshop at glasstec 2016

Form Finding Fabrication‘ and Symposium ‚Digital Methods‘ at the glasstec 2016 in Düsseldorf

Prof. Hans Sachs, Prof. Dr.-Ing. Uta Pottgiesser, Susann Kreplin B.A.

From September 20th to 23rd, 2016 the European Facade Network (efn) in cooperation with the Detmold School of Architecture and Interior Architecture (HS OWL) and the TU Delft hosted the workshop ‘Form Finding Fabrication’ and the Symposium ‘Digital Methods’ at the glasstec 2016 trade fair in Düsseldorf.

Workshop and symposium constituted the semester kick-off for Detmold’s new master students and were led by Prof.i.V. Hans Sachs and Dipl.-Ing. David Lemberski.

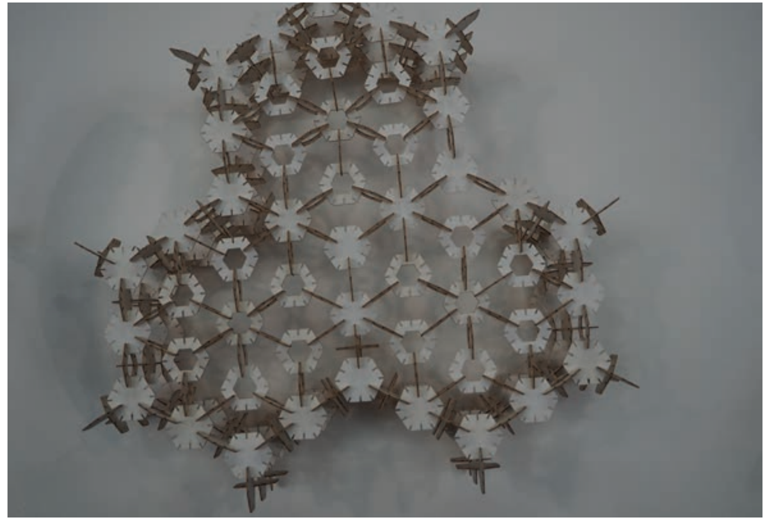
More than 80 students in the field of architecture (Master Of Integrated Design - MID) and interior architecture (Master Innenarchitektur-Raumkunst – MIAR) developed a huge variety of digital and physical prototype wall and roof structures in an interdisciplinary and interactive design and modeling process. The focus of this experimental workshop was on the interconnection of analogue and digital modelling and fabrication techniques by using 3D printers, two CNC laser cutters, a CNC wirebender and cutting plotters. Within this interdisciplinary setup our international and national ‘newcomer students’ interconnected greatly at an early stage of their studies and immediately learned how to use and integrate innovative modelling and prototyping techniques in the design development process.

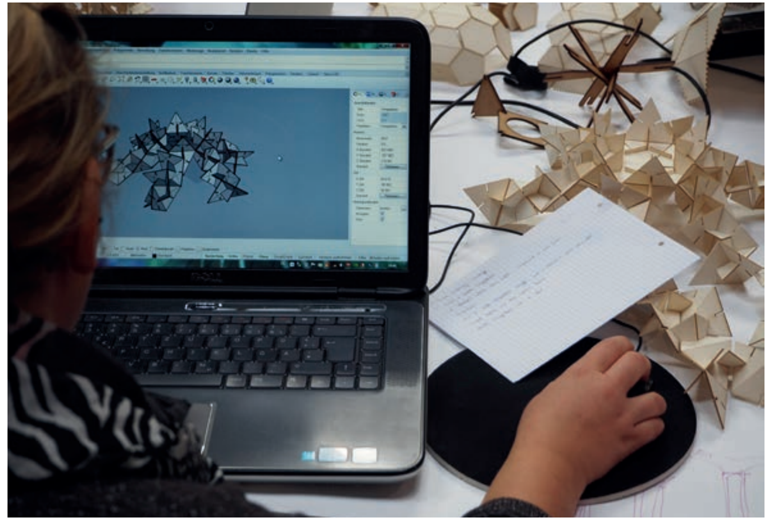
At the symposium ‘Digital Methods’ which took place on September 21st at the EFN trade booth eight expert speakers from several universities and companies presented their strategies, concepts and methods of design and development processes in a digital context.

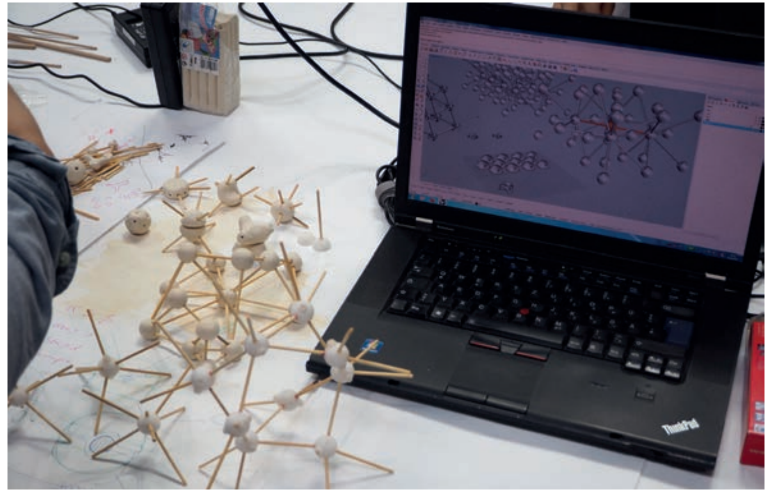
The symposium had a focus on future strategies, techniques and (working- and development-) methods that emerge from the application and interconnection of various kinds of arising digital tools. All speakers had a focus on digital techniques and working methods while coming from different disciplines such as architectural design, urban planning or from innovative digital (industrial) production processes (Industrie 4.0). In this way was presented a great variety of possible applications of digital tools and methods, not only in an architectural context but also at the intersection with other other product related disciplines.

Workshop and symposium were by the ALCOA Foundation through the project ‘efnMOBILE.Efficient Envelopes’, by the glasstec fair and by internal grants of HS OWL. Special thanks to Susann Kreplin and her team for design and organisation of the fair booth.

Fig. 2-6: Workshop "Form Finding Fabrication"







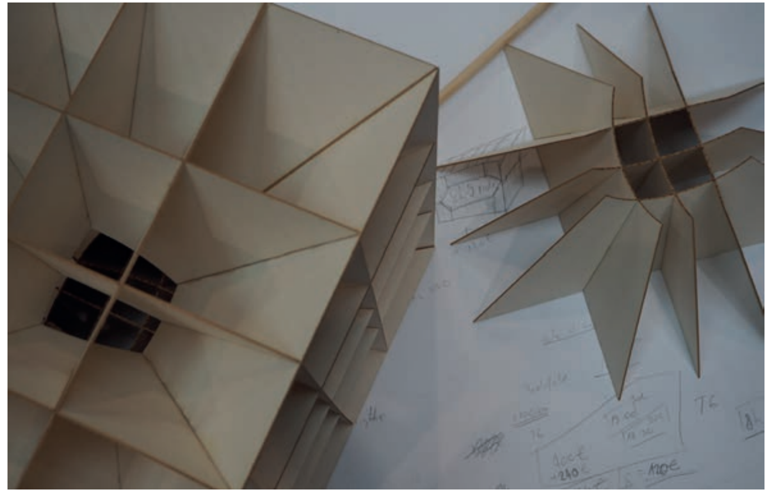


Fig. 1: ICBEST Istanbul; International Conference on Building Envelope Systems and Technologies

ICBEST Istanbul 2017 - Student Design Competition

10 Facades for the Future: Concretise your Utopia

Prof. Dr.-Ing. Uta Pottgiesser, Anica Dragutinovic (M.Arch.)

Introduction

ICBEST Istanbul is the premier conference for attendees to benefit from cutting edge information on building envelope systems and technologies. ICBEST is a worldwide forum for building envelope architecture and engineering. It provides information exchange, networking, and discussions of recent developments and their application, thus bridging the gap between architects, designers, engineers, manufacturers, and researchers. During the industry exhibition, top international companies will be showcasing products and technology solutions of interest to conference attendees.

The Students Competition

10 Facades for the Future: 'Concretise your Utopia' was a design competition for the facade system of the future in the pursuit of new and creative ideas. It was open worldwide to undergraduate and master students of all building-related fields. Interdisciplinary teams were encouraged to join, as well single-discipline teams or individual applicants. 10 Facades for the Future's challenge is to search for a new face for middle to high-rise office or apartment buildings as well as to search for an innovative facade system that will improve the performance of these buildings in terms of energy efficiency, environmental sustainability, adaptability, production efficiency, wind and seismic resistance. In this search for innovation, the adoption of widely known strategies such as prefabrication or more recent ones such as biomimicry will both be welcomed. Solutions that combine facade and roof as a single element can also be investigated.

1. The site and the climate

The location of the buildings in which the new facade system will be used can be anywhere in the world. However, entrants are expected to specify a climate type according to the Köppen-Geiger classification scheme, and to design the facade system according to the type selected. A specific city can be chosen instead of using a notional location with a specified climate. In that case, the long-term climatic conditions of that city should be considered during facade system design, and that data should be provided in the design report.

2. Performances to be fulfilled by the facade system

All performances listed below should be considered in the facade system proposal, at least at a minimum level. Entrants can either select a limited number of performances as the focus of significant improvement, or prefer to make general improvements in all of them. In either case, explanatory reviews of each performance should be provided in the design report together with the design scenario explaining assumptions on e.g. climate, wind pressure, earthquake zone, and exterior noise level. Performances that have to be considered in the future facade system proposal and their extent are as follows:

a) Structural safety – providing the desired level of structural performance when subjected to all possible load combinations that are expected during construction and throughout their intended life, such as impact, wind and earthquake loads depending on the design scenario;

Fig. 2: 10 Facades for the Future - Concretise your Utopia

b) Fire safety – providing safeguards against smoke generation and spread of fire to, including but not limited to, adjacent floors and/ or buildings;

c) Technical functionality and durability – ensuring that the facade system proposal together with its joints with other elements/ components (i) makes provisions and adequate controls against water and air leakage, differential movements and condensation, and (ii) continues to function properly during its intended service life needing only normal maintenance when subjected to expected degrading agents such as rainwater, solar radiation, frost, depending on the design scenario;

d) Indoor environment related performances –making provisions to help maintain adequate interior activity spaces in terms of air temperature, air quality, and lighting and sound levels;

Fig. 2: Master students from master program MIAD_Facade Design from Hochschule Ostwestfalen-Lippe and Prof. Dr.-Ing. Uta Pottgiesser

e) Environmental sustainability – making provisions to help reduce use phase space conditioning and lighting energy consumption, and lower its embodied energy, together with provisions to protect all natural resources;

f) Constructability/maintainability – making provisions for efficient and economical construction and maintenance of the system, and for efficient and economical manufacturing of its components as well;

g) Usability / User related functionality – making provisions for different user behaviors and expectations in the context of residential and office buildings.

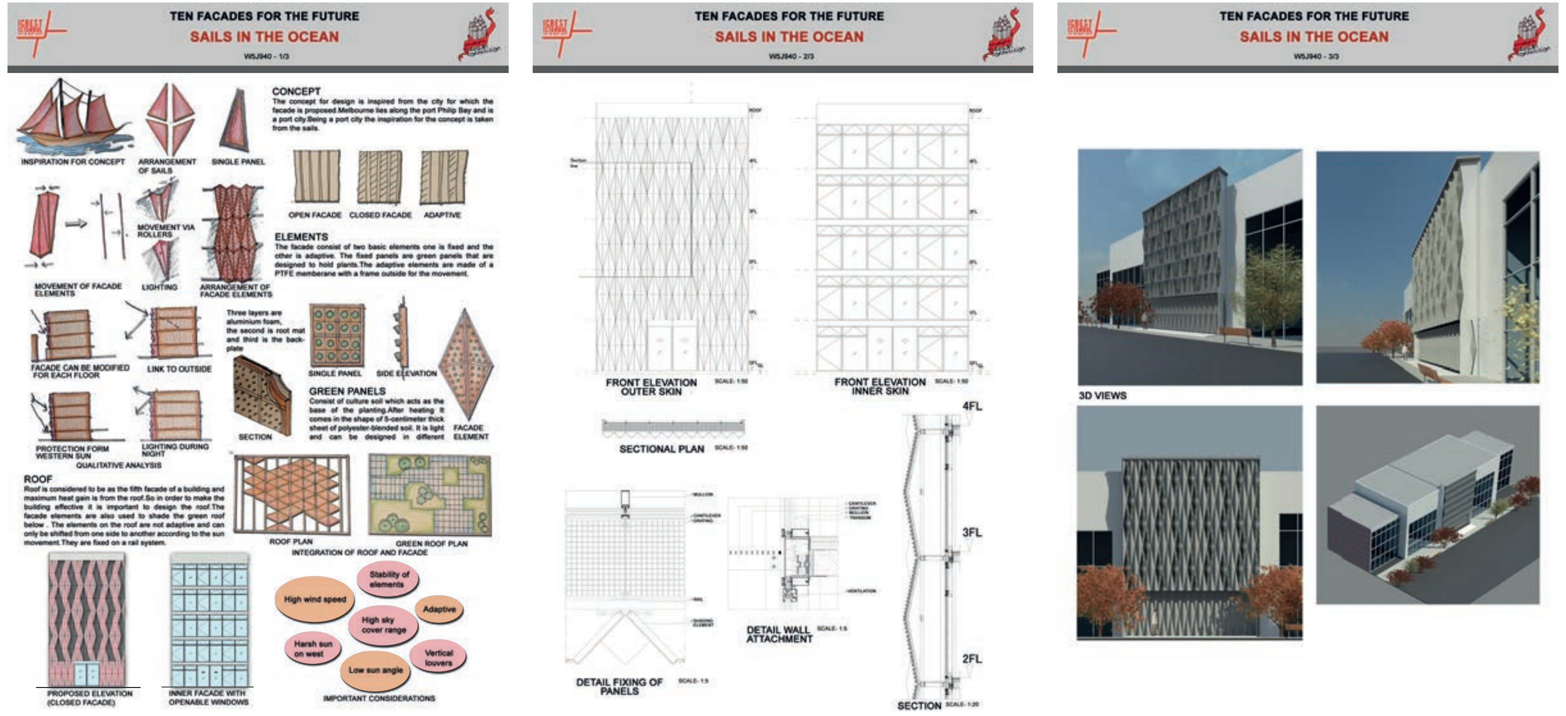
h) Assessment of and selection from the facade system proposals will be based on these listed performances. Materials that are potentially hazardous, e.g. due to gas or solid particles emitted, shall not be used in the proposal.

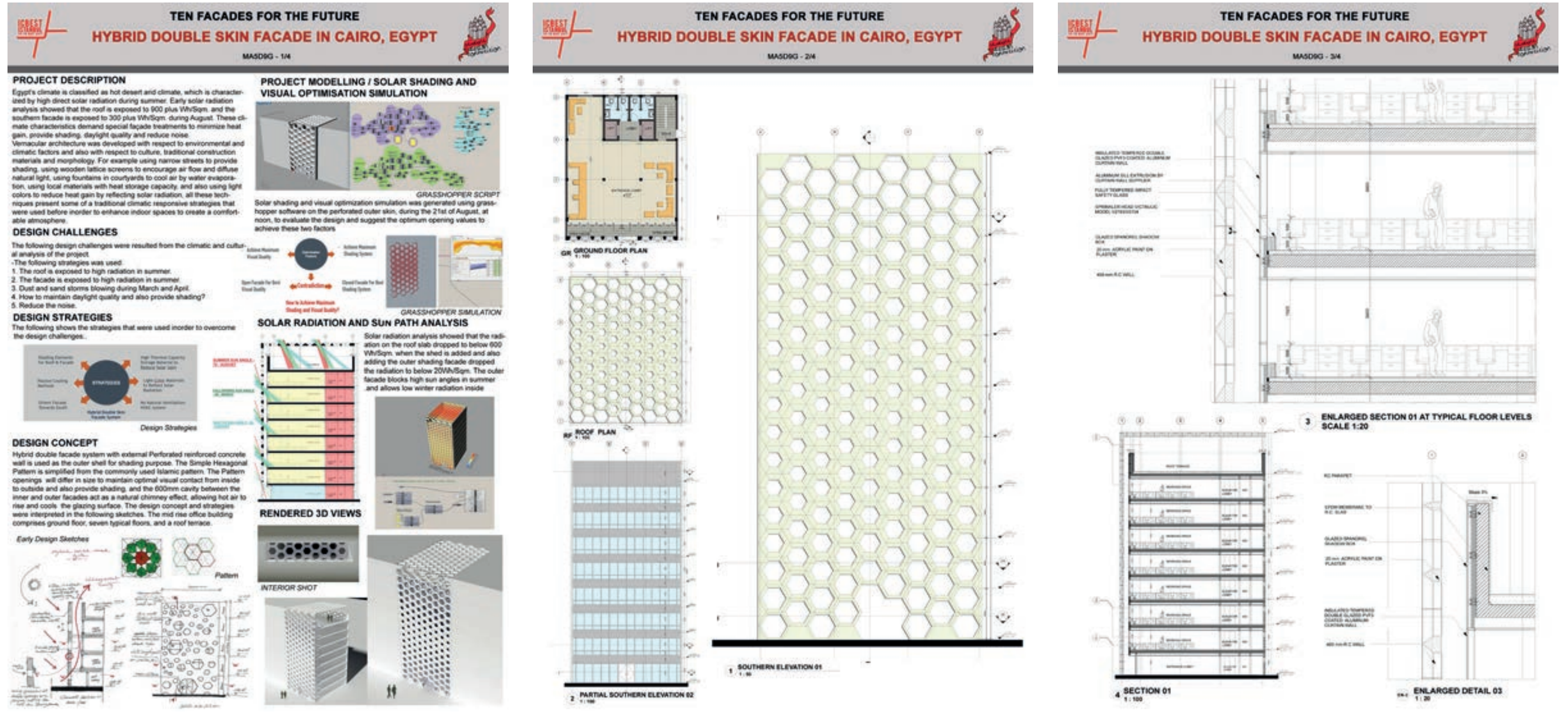
3. Structural system of the building

Structural system and structural material to be used in that system will be determined freely by the entrants, in relation to the design scenario defined. Entrants have to specify and explain the relation and integration of the facade system proposal and structural system, where they are free to determine the scale and detail of explanatory drawing(s).

Façade design proposals

According to the jury assessments based on the design criteria, five proposals were selected, and are shown below. Three of them are from the master programme MIAD_Facade Design from Hochschule Ostwestfalen-Lippe.





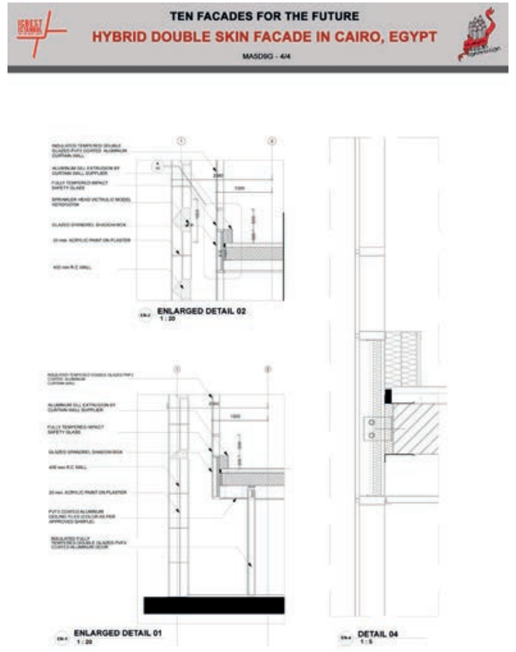
Qualified proposals:

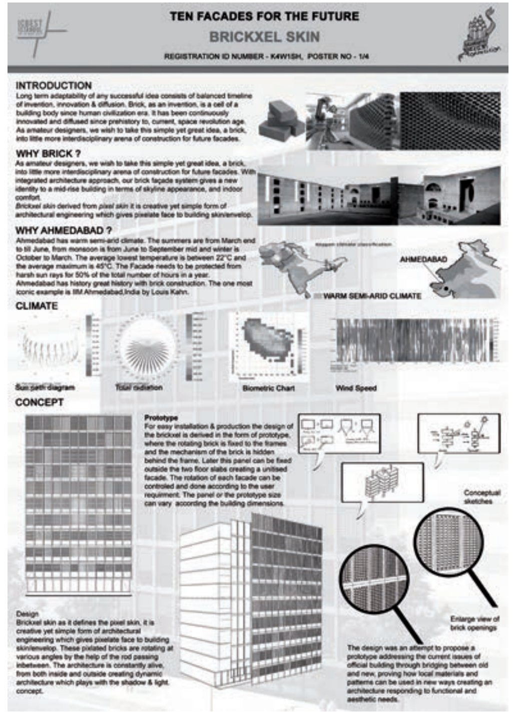
Sails in The Ocean

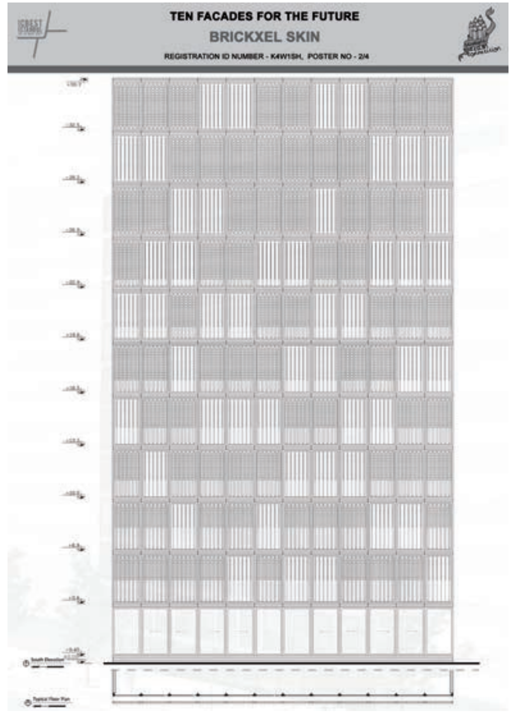
Tavishi Rana, TubaElaCinar
OWL University of Applied Sciences – MIAD (FD)

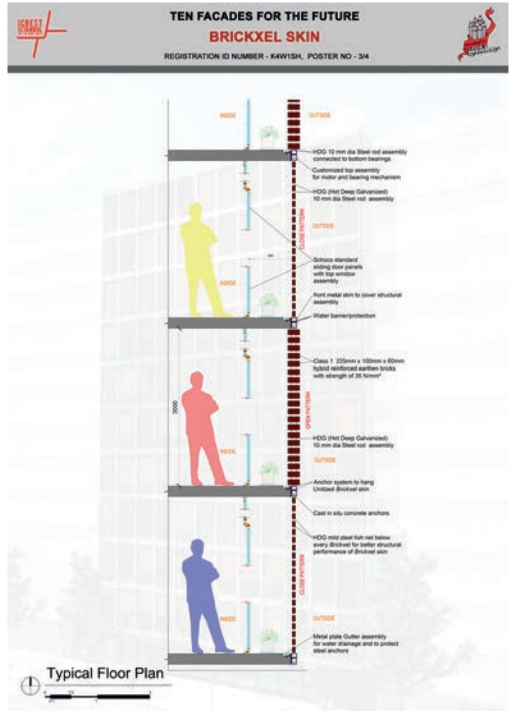
Hybrid Double Skin Façade in Cairo, Egypt

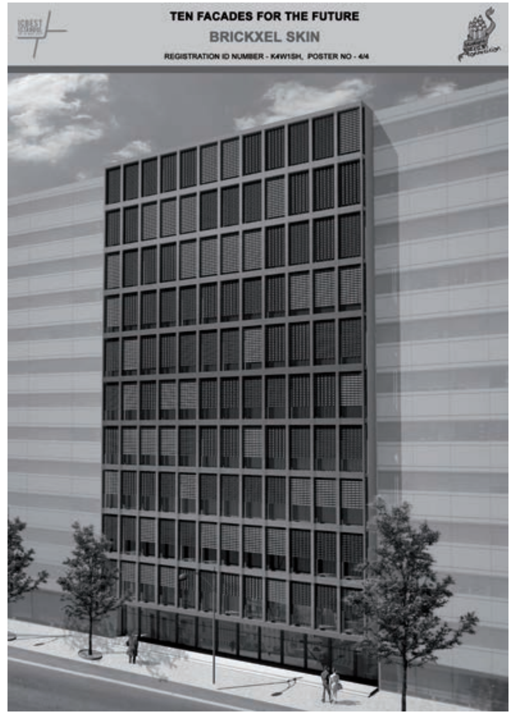
Radwa Abouelseoud, Jameela Eranpurwala
OWL University of Applied Sciences – MIAD (FD and CD)











Brickxel Skin

Urvashi Tuli, Mahsa Shafighnia, Ankit Patel
OWL Univeristy of Applied Sciences – MIAD (FD)

Digital Hut

Prof. Hans Sachs; Prof. Dipl.-Ing. MArch. Julian Krüger; Hochschule Wismar

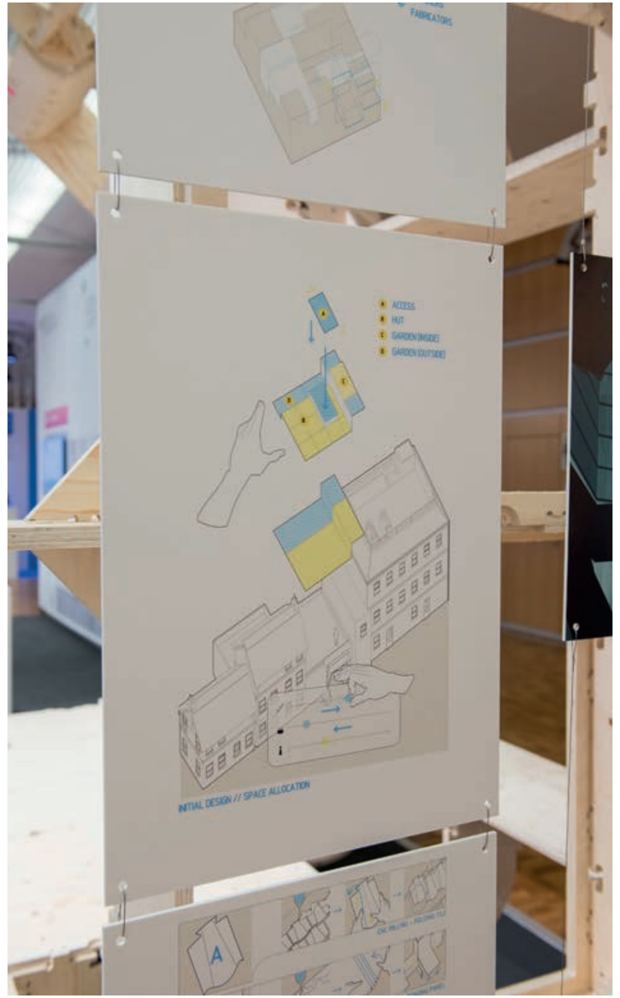


Fig. 1/2: Digital hut prototype at international trade show “BAU”, Munich 2017

Abstract

The "Digital Hut" is the prototype for an experimental building system implementing digital building design, planning and fabrication processes on an abstract level. The project followed in part the model of the "Wikihouse" concept - a constructive open source modular system for digitally fabricated buildings - in order to deepen aspects of architectural design, construction and social participation. The developed system remains in a permanent process of transformation, since the users are an important part of the design and development process according to the collaborative development and the principles of "Open Innovation".

" Everybody has a creative potential and from the moment you can express this creative potential, you can start changing the world. "
Paulo Coelho

Open Architecture // Adaptive Architecture // Participation // Digital Fabrication // Generative Modeling // Project Sharing // Collaborative Design // Urban Densification // CNC Fabrication // Network Modelling // BIM – Building Information Modeling // Digital Crafting

Context and Goals

The research project “Digital Hut” was initiated in December 2015 by the Chair for Experimental Design at the Hochschule Wismar under the direction of architect Prof. Dipl.-Ing. Julian Krüger in collaboration with the design office "responsive design studio" and the department of CAAD at the “University of Applied Sciences Ostwestfalen Lippe” under the direction of Prof. Dipl.-Ing. Hans Sachs. In addition to the funding provided by the "Initiative Zukunft Bau" of the “Federal Institute for Research on Building, Urban Affairs and Spatial Development” (BBSR), further project partners supported the project through material donations, services and know-how.

Against the background of the rapid development and spread of digital and the so-called "exponential technologies", we are increasingly challenged to rethink social, economic and political structures and to formulate new strategies. The interlinking between the interaction of man and object, and the automated control of processes offers a great array of opportunities.

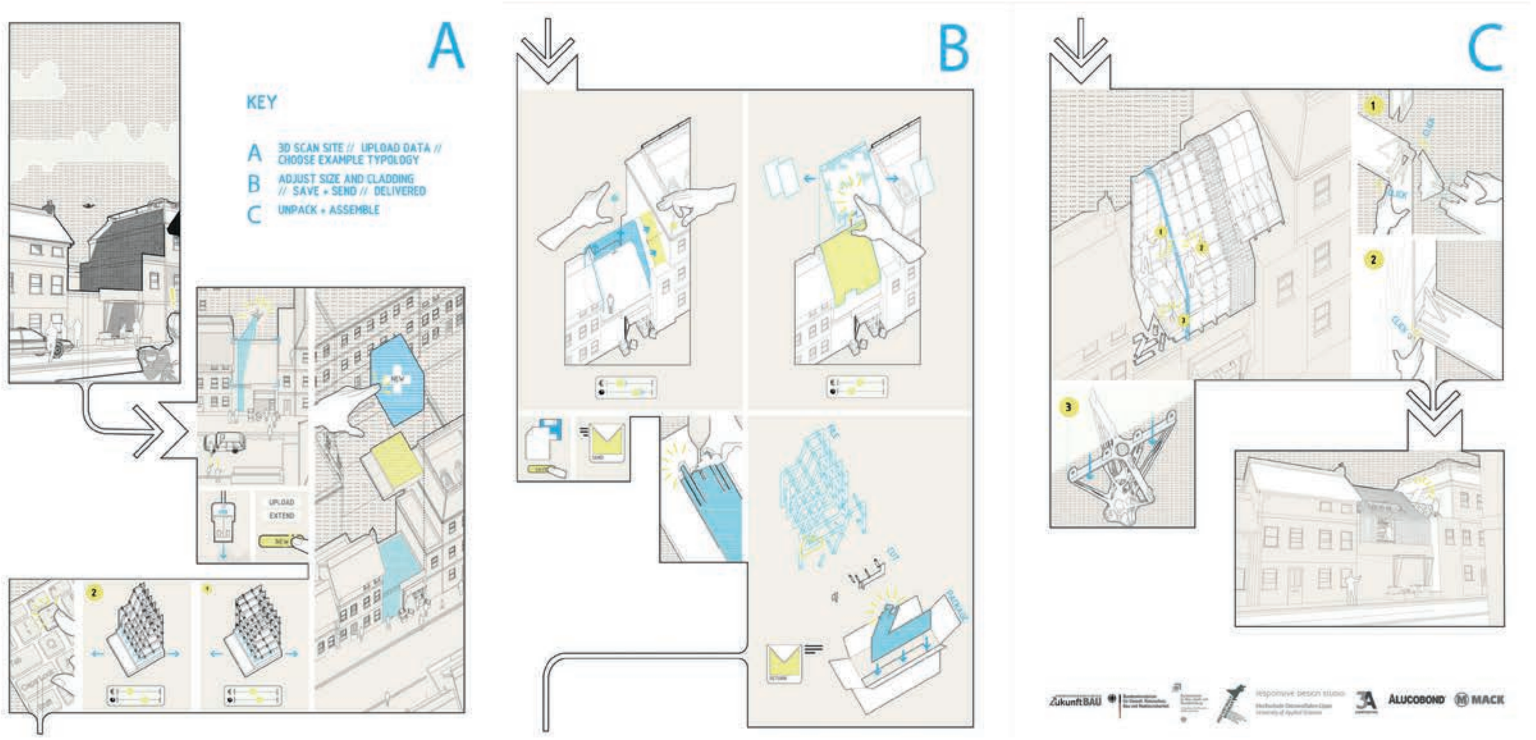


Fig. 3: Conceptual storyboard for a possible "digitalized" process chain for a customized minimal housing unit - 2nd "Digital Hut" Workshop, in cooperation with Ben Sykes Thompson (arch. cand., UCL)

In this context there is an ever greater scope for innovative techniques and concepts. This raises a number of relevant questions: How will the way we invent, plan and build space change? Will architecture itself and the process of creating architecture become much more flexible? Is it possible to customize and fabricate buildings locally and assemble them even without tools? How will the digital revolution (in planning and fabrication) change the built environment of our cities and how we live in them? Can we use new technologies to modify and extend buildings on demand to create spaces which can easily adapt to change?

Can architecture be completely customized and fully sustainable? Will digital communication and social aspects of "participation" and "sharing" make architecture more creative and inventive?

These developments and ideas confront not just our society but also our industry with immense challenges. The main goal of the research project "Digital Hut" was the design and the prototypical production of a true "minimal house" using digital technologies, both as development and production and also later as actual architecture. The first concepts of the "Digital Hut" were inspired by the myth of the "Primitive Hut" with the goal to develop and realise a "minimal dwelling of the 21st century" on the basis of the integrated and comprehensive use of various digital technologies. The focus lay on the co-creation by the users themselves of affordable, minimum but high quality living space in various urban environments, a comprehensive digital construction system and consultant designers and planners.

In the first part of this multi-phase project, digital production methods were used to develop a variable and reduced light-weight building system that can be configured and assembled by the users themselves - without the use of complex or heavy tools. Through the use of digital processing techniques and sustainable building materials in combination with a truly adaptive space and design concept, a special attempt was made to meet the requirements of a mobile and networked society.

At this stage the research centred on the interconnection of different interfaces, and the collaboration of the users. This was achieved through the exchange of production files and the local or decentralised digital prefabrication of the building. The design process was highly individual in order to create and realize high-quality, adaptable and atmospheric living and work spaces.

"It is easier to ship recipes than cakes and biscuits"
John Maynard Keynes

The high adaptability of the building system resulted in a large number of possible applications, such as the densification of urban areas or the creation of visionary temporary buildings as an impulse for sustainable, well-designed, innovative and creative architecture. The "Digital Hut" project opened up a multitude of possibilities for the integration of participatory, socially inclusive and also transparent project development through the virtual networking of its players. Changing demands on life in cities can be met flexibly with a participatory approach.

New chances for coexistence in our cities
- the combination of living spaces and nature or workrooms - can thus be created in an innovative way and in a particular context.

Technology

The latest developments in generative modelling (e.g. visual programming – Dynamo for Revit, Grashopper for Rhinoceros, etc.) and digital manufacturing provide architects and designers with broad access to various digital technologies. A large number of extensive "digital tools" offer new ways to integrate complex material, processing and user related information directly into the development and design processes, sometimes even in "real-time". This has led to a paradigm shift in the development and implementation of projects: The design and manufacturing methodology shifts from "standard" to "non-standard" (Bernard Cache, 2003) processes. This reverses basic hierarchical design principles such as "form first, material later" (Neri Oxman, 2012) and "top down" to "bottom up" strategies and a material- and process oriented design development. The basic goal is to create a more flexible production and design development process in various branches of industry through intelligent networking and automation.

*" You're either the one that creates the automation
or you're getting automated. "
Tom Preston-Werner*

With the integrated use of computer-based and computer-supported tools in industrial development and manufacturing, the boundaries between the areas of design and development as well as fabrication become increasingly blurred, and a closer linking of the two processes occurs. In particular, the methodology in design and development processes is decisively influenced by more flexible, digital production methods such as generative production (e.g. 3D printing).

The development phase of a so called generatively modelled and manufactured product extends to the last produced object in a (model) series. At the same time, the series production cycle begins with the first prototype. Production development cycles become more flexible and thus industrially manufactured objects reach a much higher degree of individuality. In terms of customizability, digital development and digital production methods can rather be compared to the principles of manual, hand-craft based, pre-industrial manufacturing than to the mass production of the 20th century.

The integrative approach of intelligently linking various disciplines and processes, as well as promoting the consistent, direct exchange of all project participants in the early stages of the design process in architecture took place within the framework of the "BIM - Building Information Modeling" method. A comprehensive application of this method has mostly been implemented in particularly large architectural and planning offices with strongly structured, sometimes static development and fabrication processes.

Simultaneously, the use of certain digital tools in prominent architectural projects is often reduced to an unconsidered realization of formal or rather technically optimized design concepts. Moreover, the general, social focus in architecture is -even today- still rather on

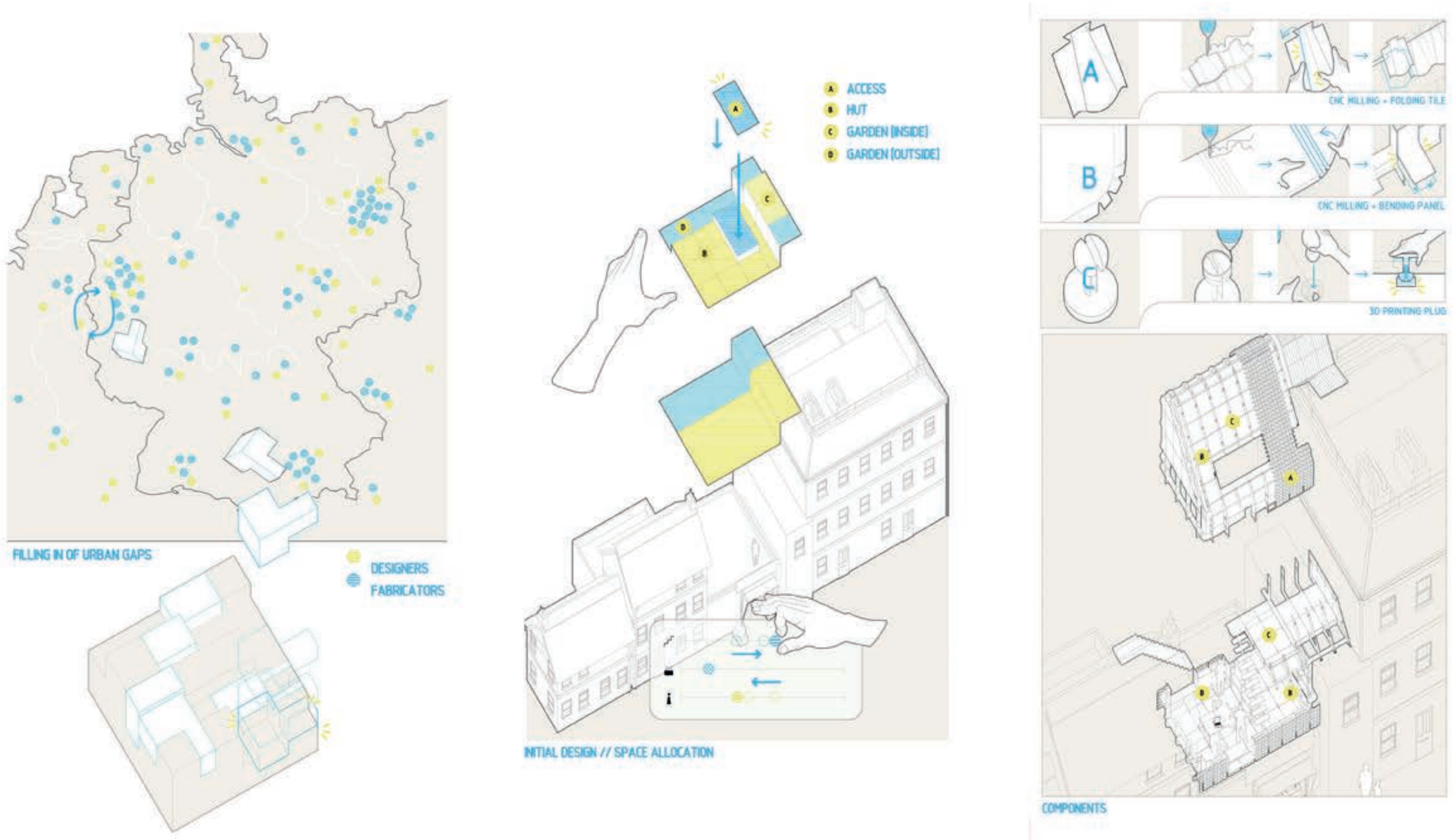
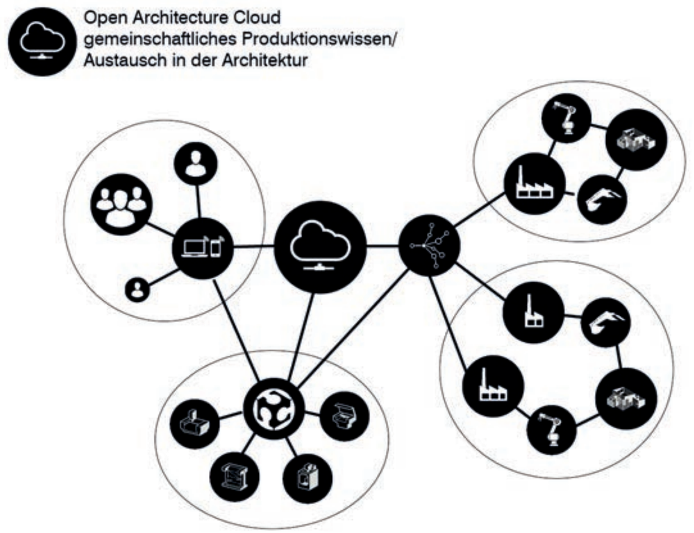


Fig. 4: Concept Drawings Fabrication Network / Parametric Building Design / Material-based digital fabrication techniques "Programming Material"



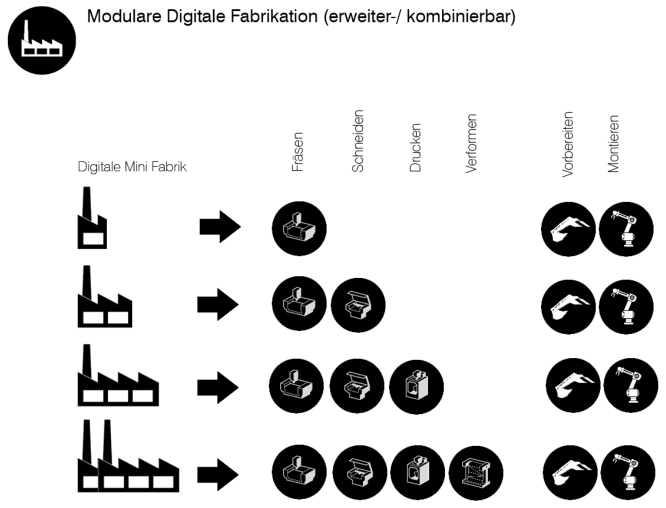


Fig. 5/6: Mind-map of a 'Digital Hut Cloud' for the interconnection of collaborative planning and fabrication

the finished building than on the complex planning and development process or the changing demands and the use of a building.

„ It almost seems as if the fence in the history of architecture still exists today: its main interest is still directed to the finished building, but hardly on the process of construction “
Chup Friemerts, on the Crystal Palace

Methodology
The individual workshops were held in cooperation with various partners and experts from the fields of architecture, design and digital production. A special emphasis was placed on user-generated, interactive design and production processes in order to develop a configurable, easy-to-build and adaptive residential unit and to realize it prototypically. At the centre of all workshops was the development of the digital process chain for a minimal housing scheme, which was to be adaptive and customizable. In the implementation phase, digital and decentralized production techniques, automation and networks increasingly replaced conventional industrial production processes.

A main goal of the construction system was its nearly tool-free assembly.

The “Digital Hut” can be assembled even by laymen in an easy and intuitive manner.

The following sections on the workshops describe the chronology of the research process, starting from the first conceptual sketches of the "Digital Hut" through various prototypical design details up to the 1:1 prototype for the stand of the "Initiative Zukunft Bau" for the trade fair BAU 2017 in Munich (see images above).

During the research phase the focus was on an experimental approach. Traditional woodwork was used in combination with the principles of connector systems. These were developed with conventional construction materials as well as composite materials in combination with highly precise, digital production techniques (CNC milling technology). The sustainable use of generative production processes, such as 3D printing was another important part of the research. Also the question of how to actively integrate the subsequent user of the building into the design and production process represented a focal point of the project.

The project was divided into 5 project phases/ workshops. The result of workshop 4 was the first 1:1 prototype of a "Digital Hut" which was presented on the trade fair stand "Initiative Zukunft Bau" of the BBSR in Munich in 2017 (Fig.1 und Fig.2).

Workshop 5 was initiated as an integrated student project called “Clip Hut”, where students of the “MID Master of Integrated Design” -programme at the Detmold School of Architecture and Interior Architecture developed and realised a 1:1 prototype of a generative building system based on the principles and research results of the previous workshops.

“Digital Hut” research and prototyping workshops (Feb 2015-Dec 2016)
In the first workshop, which was held in cooperation with architect Dipl.-Ing. Kolja Janiszewski (caramel architects, Vienna), a catalogue of reference projects was put together and initial conceptual ideas were formulated. The documentation served as an important basis for the first project sketches for a digital construction system, which can be individually configured by subsequent users and exchanged between participating users, planners and builders in a cloud.

The “Digital Hut” - as a single dwelling or conglomerate of building units - fits perfectly into urban niches. Building gaps or leftover spaces in the city offer a wide range of possible solutions for an individual housing generation.

The first conceptual design provided a parametric building design and construction system with various "architectural KITs" such as the "Building KIT", "Access KIT" and "Garden KIT" which can be individually adapted to different urban or rural environments. Each KIT refers to the principals of "Mass Customization", a - mostly digitalized - customer-specific or individualized mass production.

Any (user-) configuration refers to a "digital DNA", which is the basic structural system described as “generative 3D model”. The user finally configures his/her own ‘Digital Hut’ building system with a related software-application. This APP directly generates digital fabrication data (i.e. G-Code) for referenced CNC machines.

In the second workshop a first concept model of an adaptive construction system was developed. Then various material and finishing tests (CNC machines) were carried out with the aim of developing a comprehensive digital-based design system. On the basis of various test series in the field of the ‘form programming’ of certain semi-finished materials such as wooden boards and composite boards, individualized, easily pluggable design systems were tested and developed.

These adaptive design systems form the core of the “Digital Hut” construction system and should be integrated into the process chain of their development. They form the basis for the parametric architectural design. During the course of the workshop, a storyboard was developed in cooperation with architect BA. Ben Sykes Thompson describing and documenting the digital process chain from the customer to the finished building.

In workshop three and four the 1:1 prototype was designed and a first mock-up of the "Digital Hut" was realized in cooperation with the company Bächer & Bergmann GmbH in Cologne to test the design for its functionality and practicality.

In the two final workshops, a prototype of the "Digital Hut" was developed and implemented on the basis of the previously developed concepts and the material experiments. The basis for the design were further material experiments and tests for digital fabrication on the model scale and subsequently on the scale of 1:1.

The primary support system of the "Digital Hut" was a construction

Fig. 7: Interior Rendering of the Digital Hut (BAU, Munich, 2017)

made of 24mm wood sheets that could be CNC milled or cut. The joints were part of an extensive plug-in system which met the requirements for an adaptive and easy-to-install building structure with a high load carrying capacity and stiffness. The wooden structure sat on metal supports of which two possible solutions were developed. One, a footer system that consisted of two adaptable laser-cut 4mm steel plates, and two, a customizable 3D printed (Selective Laser Melting) metal foot that was optimized in form and material aspects in order to take on particular loads.

The wall and floor termination of the rib structure of the “Digital Hut” was formed by sheet elements that were fastened to the primary construction held in position by a simple pin connection and fixed to

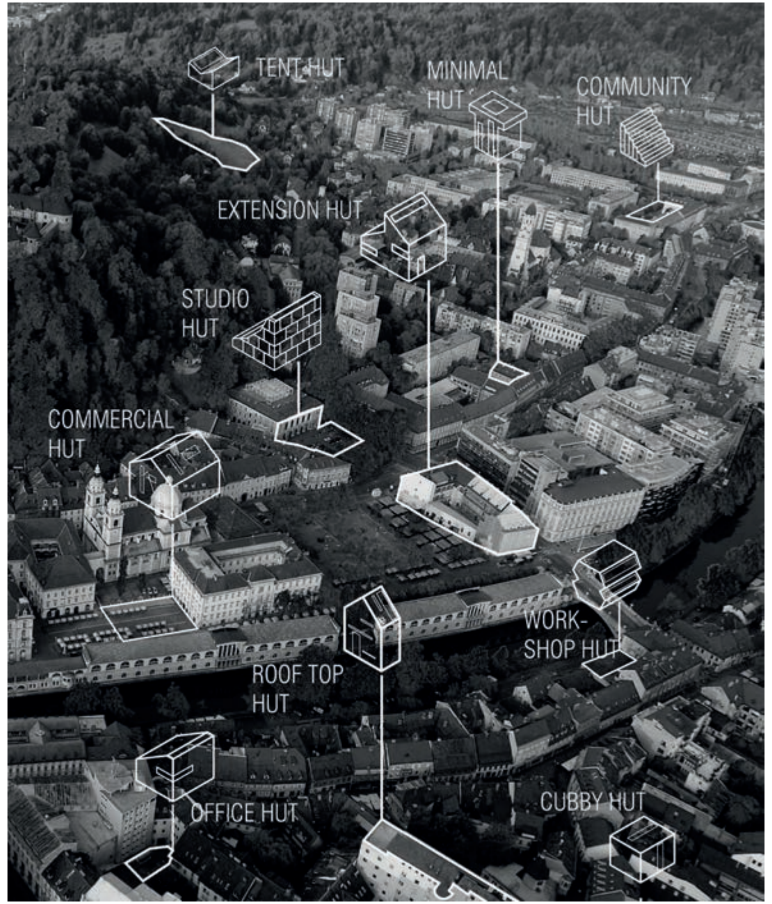


Fig. 8: Generating choice and adaptivity to urban context (ClipHut project)

the framework by a specially developed and 3D-printed expansion plug. The panels provided additional lateral enforcement to the system.

The “Digital Hut” can be cladded with different outer skins. For the prototype 1.0 a facade made from folded composite material from the company 3A Composites from Alucobond® was used. The aluminium-plastic compact plates can be cut by water-jet or CNC milled. Several test and development series resulted in a folding system consisting of longer strips of material, which were superimposed like traditional shingles and could withstand external weathering.

“Clip Hut” student project (Oct 2016 - Oct 2017)

Workshop five was an integrative student project, closely related to the research questions and goals of the “Digital Hut” but developing further those ideas. A team of 10 international students of the consecutive master study programme “MID Master of integrated Design” with the specialization “Computational Design” developed a prototype of an individualized housing unit based on generative, cross-linked modelling and fabrication methods and techniques. The project started with workshops within the project module P5 in the winter term of 2016/17 and fabrication was rolled out in the summer term 2017 within the module “digital fabrication”. The modules and project phases were organised and supervised by Jan Kahre-Heidemann (MA) in coordination with the “Digital Hut” team.

The 6m x 4m x 4,5m construction prototype was assembled (clipped together) in only 6 hours on the campus in Detmold. A special focus of the “Clip Hut” was to interconnect architectural key aspects with an automation network. This meant that the final configuration of an individualised “Hut” can be generated by a prototypical software-tool in “live” connection with existing architectural modelling and planning software.

Like the “Digital Hut” project, the “Clip Hut” is a generative building system based on various aspects at the intersection of the fields of architectural design, industrial IT and automation. The project is about generating choices and chances for its users, who are finally – at least partly – its designer, planner and builder.

The structure of the “Clip Hut” prototype is planned to be exhibited at the “Heimatwerker” project (refugee project, supported by Stadtbaukultur NRW) in Nieheim from September 2017 to facilitate the integration of refugees into the local community by offering a “Common Hut” to the people of Nieheim. The hut will provide space for communication, activities, events and services.

The construction system is made of high precision OSB panels which have been donated by “Egger Holzwerkstoffe GmbH”. The facade of “Clip Hut” is made of polycarbonate panels which were donated by the “Covestro AG”. The advantage of these facade elements is low weight and shape stability at high temperatures.

Fig. 9: Visualization of the first ClipHut prototype (planned construction in Nieheim: Oct. 2017)

Summary & Outlook

The dissolution of the boundaries between the disciplines of architecture, design, information technology, management, product development and materials science played a key role in the development of the research project "Digital Hut". These technological developments provided new opportunities for linking people, processes and products.

Today computation in architecture stands for high precision and flexibility of development and production processes. Considering existing, either craft based or highly industrialised structures in the building industry, this leads to a paradigm shift in the construction industry due to automation and networking. Within this context the project “Digital Hut” was less about the digitalization of existing processes in the development and construction of a building, but rather the disruptive application of different digital tools, methods and processes in the development, use, modification and dismantling, the so-called life cycle management of a building.

" It's the little things that make all the progress "
Ralf Reichwald and Frank Piller, Interaktive Wertschöpfung

The focus of the development of the “Digital Hut” was also on an open development and fabrication network of users, designers and builders. This bottom up architectural planning and development approach led to new ways of sharing and living in urban areas.

“Today, 54 per cent of the world´s population lives in urban areas, a proportion that is expected to increase by 66 per cent by 2050, also mega-cities with more than 10 million people are increasing in number” (United Nations, 2014). Therefore, we need strongly people-related, identifiable and adaptive building solutions for living and work spaces in urban areas. This approach - in the context of the movement “towards a non-standard mode of production” (Patrick Beaucé, Bernard Cache, 2003) - especially in architecture represents a first seed for a countermovement to the increasingly evolving "top down" development processes of large investors.

With this concept of networked processes we seek to establish a tight relationship between architecture and its users in order to place emphasis on a greater and more creative variety within the built environment and on our responsibility to take care of it.

Credits:
Digital Hut research team: Dipl.-Ing. Kolja Janiszewski, BA. Ben Sykes Thompson, BA. Mathias Karuzys,
ClipHut team: supervisor: Jan Kahre-Heidemann (M.A.)
Student team: Tomas Mena, Tomasz Vieira, Maria Wilkens
(please see further team members and supporters on the webpage cliphut.org)

Fig. 1

ClipHut

From digital design towards a digital fabricated prototype

Prof. Dipl Ing. Hans Sachs / Jan Christoph Kahre-Heidemann M.IA.

The development process of the ‘ClipHut’ was based on a circular metamorphosis of digital design and fabrication techniques according to Bob Sheil‘s principle – “design through making“. The design development was basically driven by constructive principles including material properties, their behaviour but also by an optimized interchange between digital and analogue – i.e.crafting inspired- fabrication techniques.The ‘Common Hut‘ was developed as a generative Housing unit based on a parametric design and construction system, which allowed a high level of adaptivity in the final compositional design steps.

The project was divided into the following stages: Exploration of a Cardboard-/ Wood-based (3D) main connector system; ‘Parametric Design and Construction Tool‘ for an adaptive wood-framework working with the connector system of stage 1; automized generation of fabrication and assembly data and the realization.

The project goal was to develop a minimal, generative housing unit, by integrating crafting inspired wood connections with computational modelling processes.

The structure was realized on the campus of the ‘Detmolder Schule für Architektur und Innenarchitektur’. The system will be licensed as a ‘creative commons license’ and represents a basic system for social housing and/or refugee housing.

Team of Students:
Tomas Mena, Thomaz Vieria, Helena Wilkens,
Onurcan Kurt, Alvaro Balderrama, Gesana Biti,
Supak Kosolsirisukkul, Angelina Aziz, Yi Ju, Spencer Pulham

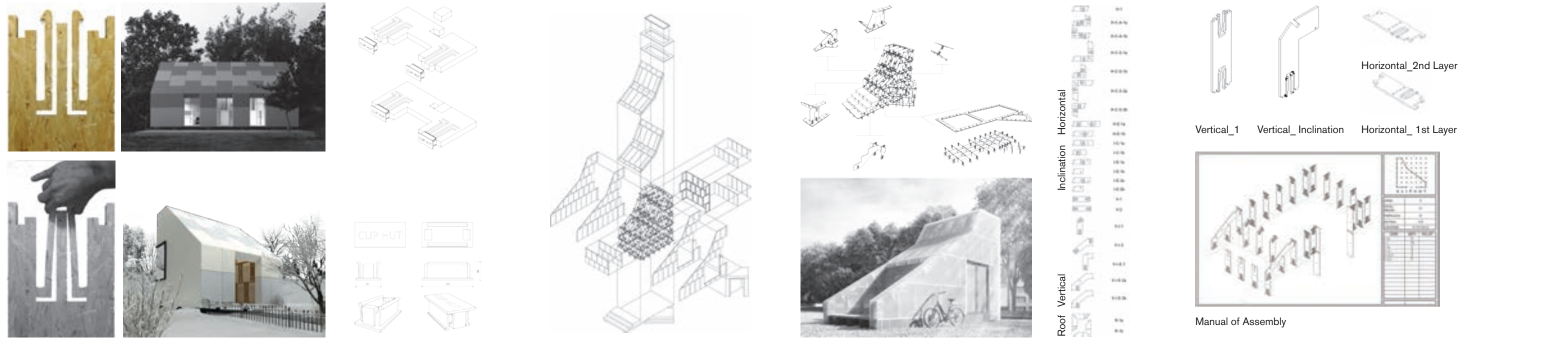
“Think globally and act locally. Create, manage and share a large amount of complex data through a friendly interface.”

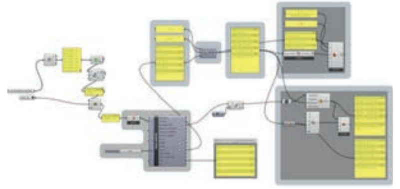
— Cliphut Team

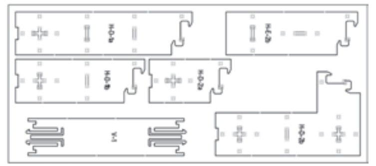
Digital Fabrication
Our main interest was to explore digital fabrication and parametric design in an architectural and social environment. Having a consciencious and sensitive approach to current and future issues in our fast growing society can bring together architecture and the new technologies.

Anyone / Anywhere
The adaptability of the ClipHut turns it into a device that has the potential to redefine public spaces and city programs. User customization means that the ClipHut can exist in practically any location, from parks to the roofs of buildings, and allow it to spread throughout communities.

Parametric System
In true computational design fashion, the ClipHut project focused on creating a parametric framework to simplify the design process thus enabling end users to participate in the design and function of their own shelter. The idea was to have an app that allows users to design their own ClipHut and generate all the necessary information so it can be digitally fabricated in the nearest factory.



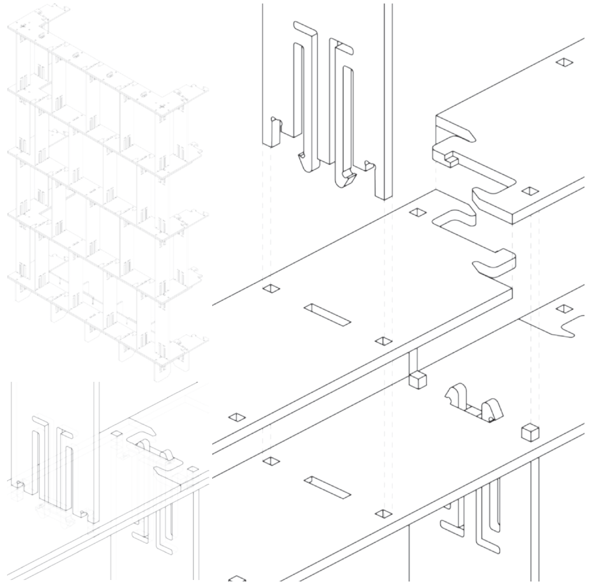




1	Contours	Milling contour 19mm depth, tool 110.
2	Holes	Pocket 19mm depth, tool 110
3	Text	Text milling 2 mm depth, tool 103
4	Pocket 1	Drill 19mm depth (circle d=10 > 10mm drill)
5	Pocket 2	Pocket 9mm depth, tool 110
6	Pocket 3	Pocket 19mm depth, tool 110
7	Sheet	Thickness of material/sheets

Material-Based Opimization
Based on such material features as flexibility and stability, we started researching into wood joints, which became a building system. The whole design was generated by the replication of its minimum modules (detail), in awareness of the material properties and the optimization of its performance.

Fabrication Process
After finishing the 3D model, we programmed an automated process to:
1- Sort the pieces by name.
2- Prepare the drawings to be cut in a CNC machine.
3- Plan all pieces and organize them by panels
This preparatory work ensured the best use of the material and reduced costs.



Assembling Process
It is important to say that our main interest was to explore the potential of technology to create new solutions in the field of architecture and construction and increase the quality and access to houses around the world. To accomplish this goal we believe that the only way is to empower people by giving them the tools they need so they can build their own houses cheaply and quickly. With this in mind, we defined some important concepts.

MIAD / MID Façade Consultancy

Prof. Dr.-Ing. Uta Pottgiesser, Prof. iV M. Eng. Daniel Arztmann

Fig.: Student Designs from MIAD students for the extension of Kunsthalle Bielefeld in the summer term 2017.

Project Integrated Building and Design: BIE ART EXT. Student Facade Consultancy of MID Students

In the second semester MIAD and MID students work on the same project topic but on different tasks. While MIAD students develop an architectural design, MID students focus on specific topics: analysis of existing old and new museum concepts, structure, and building envelope. The findings of this work are presented in a research paper on specific museum aspects. In the final part of the design process MID students apply the results of their research in a facade consultancy for the MIAD-projects. Here they are asked to do specific research depending on the design requirements and questions raised by the MIAD-students. The consultancy is supposed to support the development of alternative construction concepts and details for the facade. Concepts and process have to be documented in sketches, drawings, material or technology research together with the final facade design of the MiAD students as technical drawings.

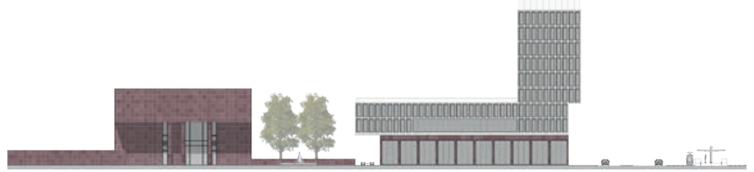


Fig. 1: Kunsthalle Extension by A. Budde

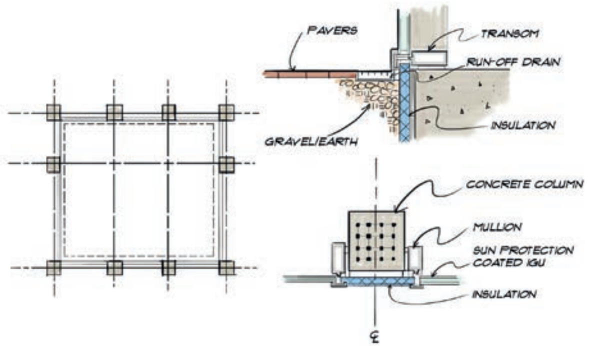


Fig. 2: Column grid by D. Mieles

Danny Mieles / Aileen Budde / Jonas Krikor

The intention of Budde's extension proposal is to provide views and natural daylight into the new gallery spaces.

Column grid (Left): Typical transom details at ground (above right). Typical mullion detail at column (below right).

Fig. 1: Elevation from Old city centre by M. Zimmermann

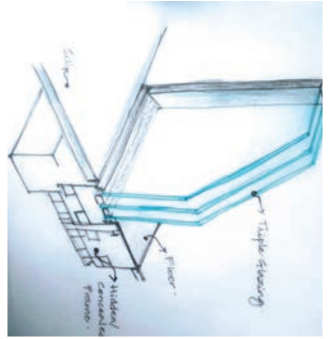


Fig. 2: View of Hidden Frame detail for Window by J. Eranpurwala

Jameela Eranpurwala / Milena Zimmermann

For the extension of the Bielefeld Kunsthalle, the architect intended to complement the stone facade of the existing building. Thus, the facade of the extension also continues to be a composition of blocks. However, to present a contrast to the existing red stone facade, the extension was to have grey concrete block work. These blocks will have varying thicknesses. The difference in the depths will give the facade an interesting 3-dimensional appearance.

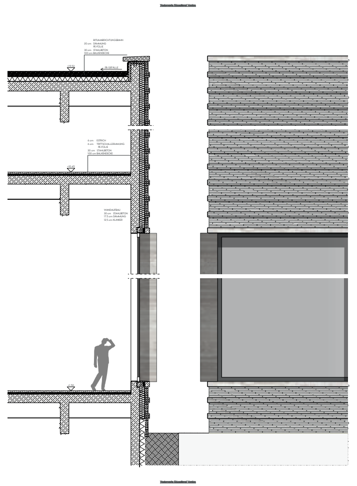


Fig. 1: Graphical Relation between the Spatial Layout and façade with approach of Light- Kunsthalle, Bielefeld by M. Mundry

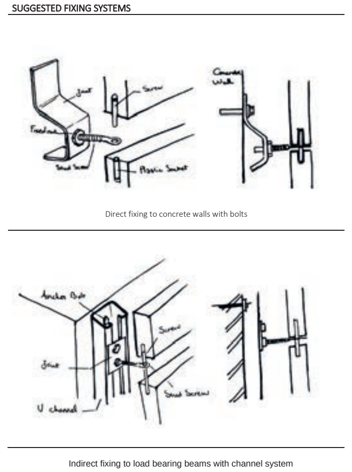


Fig. 2: Suggested fixing systems by M. Shafighnia

Melina Mundry / Mahsa Shafighnia

Investigating the Relationship of Building Envelope and Spatial Layout: The main objective of this research is to investigate an experimental methodology to find out the relation between the space inside the museum and the façade of the building, with special consideration of the daylight factor.

The detail shows two different ways of fixing the stone panels to the concrete walls

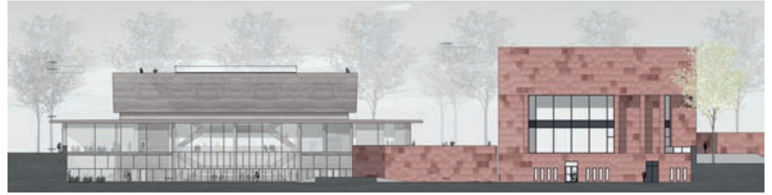


Fig. 1: Kunsthalle extension building drawings of South East elevation by Schakel

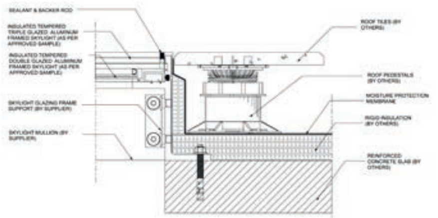


Fig. 2: Walkable skylight detail of the linking bridge between the original and the extension buildings by R. Aboulseoud

Radwa Ahmed Omar Aboulseoud / Schakel

The extension project follows a contemporary design approach, comprising eight underground floors for exhibition halls and storage spaces, a ground floor which accommodates the entrance lobby and vertical circulation, café and lounges, and two floors above ground level for administrative offices. Building spaces are lit by an atrium and a skylight, and the extension is connected to the original building by a link.

The design intended to interact and connect the extension building with its surroundings by using the roof of the linking bridge as a walkable skylight terrace from which visitors can enjoy the views of the surroundings.

Fig. 1: West elevation by NN

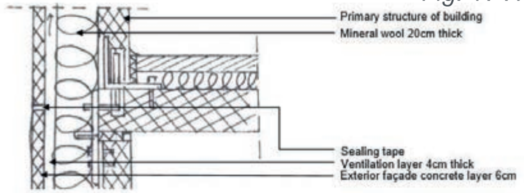


Fig. 2: Connection to primary structure by T. Rana

Tavishi Rana / NN

Contextual and sustainable design:
The choice of using recycled concrete panels made it possible to have the same context of the building and also reduce the environmental impact.

The façade is connected to the main structure by means of support and connectors.

Fig. 1: View of the proposed extension building for Kunstalle at Bielefeld by A. Holthenrich

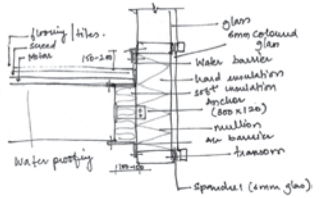


Fig. 2: Sketch showing the detail fixing of the stick system façade at slab level indicating all the important elements by U. Tuli

Urvashi Tuli / Anna Holthenrich

Daylighting in the Art Museum:
An attempt to propose daylighting for the public area in the proposed extension building for the Kunsthalle in Bielefeld which is designed for art exhibitions.

The stick system façade was introduced for the easy installation of the windows on site.

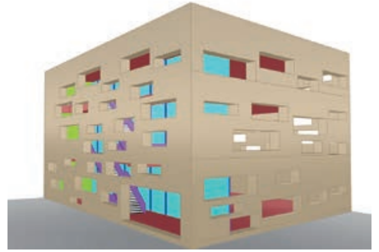


Fig. 1: Perspective view of concrete walls with rectangular punched openings. (modelled by Spencer Culhane)

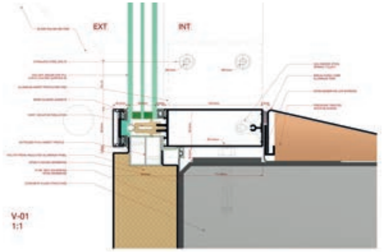


Fig. 2: Typical stick curtain wall sill section detail drawn at 1:1. (drawn by Spencer Culhane)

Spencer Culhane / Carina Fahl

The project will explore the use of insulated concrete walls with a random pattern of rectangular punched openings.

The detail shows a typical section through the intermediate floor slab edge where the stick curtain wall transom connects to the insulated slab edge cladding.

Fig. 1: Perspective of arched windows and point supported glass façade (modelled by Spencer Culhane)

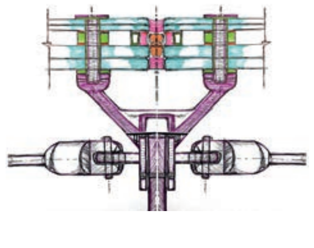


Fig. 2: Typical spider clamp horizontal section sketch (drawn by Spencer Culhane)

Spencer Culhane / Rora Oh

The building form is dictated by a formal ordering of concrete mushroom columns, wrapped on the lower level by a point supported insulated glass façade.

The detail shows a typical horizontal section through the vertical steel fin mullion and IGU spider clamp.

Notes

Dissertation Anica Dragutinovic

M. Arch.; PhD Candidate, University of Antwerp; Antwerp, Belgium
Research Assistant, OWL University of Applied Sciences; Detmold, Germany

Supervisor: Prof. Dr.-Ing. Uta Pottgiesser, Faculty of Design Sciences, University of Antwerp

Anica Dragutinovic is a PhD candidate at University of Antwerp, Belgium since 2016/17. Her PhD research is focusing on Modern architecture of Belgrade (Serbia) that is disintegrating due to disrepair or being altered beyond the recognition, and therefore urges repair and re-use strategies. She is a research assistant and a coordinator of the Master Program MIAD/MID – Facade Design at OWL UAS since 2016; and a member of the "Re-use of Modernist Buildings" (RMB) project. She obtained Master of Architecture in 2016 at University of Belgrade – Faculty of Architecture in Serbia. During the studies she has had different internships on international level, and won several prizes.

Fig. 1: Collage

Re-use Strategies for Modernist Housing Blocks in New Belgrade: Improving the Functionality of the Blocks while Preserving Their Architectural Values

Abstract
The main goal of this research is to analyze and reevaluate Modern architecture in Belgrade and its (non-) consideration as an architectural heritage. As an underrepresented heritage of the recent past, the Modern buildings are literally disintegrating due to disrepair, or being altered and transformed beyond recognition. Therefore, the buildings urge future (re)use and repair strategies, which will be the outcome of this PhD research. The main aim is to establish a new type of conservation method for Modern buildings that could be applied in practice through integrated repair strategies and different methodologies that juxtaposes tradition and transition, heritage and technologies.

1. Introduction
Contemporary society is characterized by continuously changing context. Its development is focused on technological innovation, and determined by anthropological and ecological transformation including social, cultural, economic, and technological factors. In a world that is constantly changing, heritage is perceived as a base to establish control and stability. Society has the motivation to preserve, celebrate and remember the past. However, hyper-dynamics of today's society and changes of sociocultural, political and scientific contextual values threaten the survival of architectural heritage of the recent and contemporary past.

Modern architecture worldwide, as part of the recent or 20th century heritage, is under-represented heritage on the World Heritage List[1]. Because of the complex issue platform, conserving modern architectural heritage needs its own conservation philosophy. Modern architecture was innovative at the time of occurrence. It was characterized by innovative construction methods and materials, the role of architecture in social reform, and the development of new building types and forms. Today many significant buildings from the modern era have reached the end of their physical and economic life span and require repair or replacement[2]. Belgrade's modern architecture, as a part of this larger cultural phenomenon, will be the focus of this research. The modern buildings in Belgrade are literally disintegrating due to disrepair. The European experience in renovation and the defined repair strategies so far, through the evaluation of the process and the results after the renovation, will be used as a framework for proposing re-repair strategies in the specific context of Belgrade, Serbia.

Contemporary technological innovations, which are represented in architecture by innovative, integrated technical solutions, "smart" materials and structures, "intelligent systems", etc., coexist in the space-time sequence of the present with the passive architectural heritage of the 20th century.

In order to avoid future conflict between tradition and transition, the architectural heritage of recent and contemporary past has to juxtapose with technological innovations of present or future present.

2. Key research questions and goals of research

The main motive of this research is the fact that too many valuable modern buildings are at risk. As it is stated in the "Madrid Document", they are threatened by a general lack of appreciation and recognition, and pressured by redevelopment. The contemporary status of modernist architecture, as a main motive, can be stratified through the following sub-issues:

▪ The first issue is that modern architectural heritage is under-represented heritage on the World Heritage List. There are only 24 modern properties on the UNESCO's heritage list from July 2012 "Modern Heritage properties on World Heritage List". Much of valuable modern architecture has very weak legal protection and low appreciation among the general public.
▪ The second issue is the time-related issue as a general problem of architectural heritage. Architecture considered as heritage always has had a strong relation to its native space-time sequence. Because of the strong relation to the past, heritage can't relate to the present or future, and remains as a dead zone, empty space, or a structure that exists in space without any relation to its context in time flow. At this very moment, modern architecture has reached the end of its physical and economic life span, and needs change.
The third issue is related to contemporary society characterized by constant development. In architecture it is marked by new technologies. There is a threat of a potential conflict between tradition and transition, between heritage and technologies.

Directly related to those issues the following questions arise and shall be investigated:

1. How to classify modern buildings? What are the most important values of the modern buildings related to this movement? Which specific architectural elements of modern architecture are included, and thus need to be promoted and preserved? Which architectural elements represent the occurrence of the other styles on the mainly modernist buildings, and which ones need to be replaced because of the lifecycle of materials and elements?
2. How to deal with the main problem of all modern buildings: disrepair or altering and transformation beyond recognition?
3. How to establish an adequate relation between modern buildings and structures and their time-space present and future context?
4. What would be an appropriate methodology of conservation for this kind of heritage, and how to establish it?

5. How could space integrated technical solutions be applied in the new methodology of conservation of this heritage, and how could those solutions actually improve it? How to deal with the common problem in defining renovation strategies: the conflict between energy and comfort improvement on one side, and aesthetic and architectural values on the other side?

By answering these key research questions and their sub-questions, this PhD research will contribute to science and the current knowledge on the topic by establishing a new theoretical concept. New theory will be established through inductive thinking and restructuration of data. Outcomes of the research will be new conservation concepts and hybrid architectural typologies, but it will also contribute to current knowledge on modern architecture and its consideration as heritage, and contribute to the field of architectural technical systems.

This research will contribute to the current achievements in identification, documentation and promotion of modern architecture. It will provide new methods of conservation, focusing on adaptive reuse of modern buildings. It aims to establish a specific relation, applicable in practice, between modern architectural heritage and innovative technologies while promoting long-term sustainability of this heritage.

3. State of the research and research plan

a) Statement of the problems:
- Modern architectural heritage is underrepresented heritage on the World Heritage List;
- disrepair of modern buildings in Belgrade: many of them have reached the end of their physical and economic life span and require repair or update;
- altering and transformation beyond recognition: as an attempt to solve the previous problem usually another problem appears - the problem of inadequate transformations.

b) State of the research:
- A lot of research has been done on identification and documentation of Modern Architecture in different countries – Historiography and Theory mainly;
- The methods of renovating modern buildings have not been researched in greater depth since they are heritage of the recent and contemporary past.

2016/2017	2017/2018	2018/2019	2019/2020
Theoretical study: - Research questions - Literature review - Gathering data	**Empirical study:** - Access to the field - Case study - Simulations	**Data evaluation:** - Data analyzing - Writing - Revising	**Finishing:** - Revising - Submission - Defense
⇩	⇩	⇩	⇩
Aim of the 1st year: - Prove the basis hypothesis - Define research questions	**Aim of the 2nd year:** - Examine the research questions	**Aim of the 3rd year:** - Answer the research questions	**Aim of the 4th year:** - Finish

Fig. 2

- Almost nothing is known about integrated renovation strategies for modern buildings that merge heritage and technologies.

c) Purpose of the research:
- Establish a new type of conservation method for modern buildings that could be applied in practice through integrated repair strategies and different methodologies that juxtaposes tradition and transition, heritage and technologies

d) Working hypothesis (for the first year):
- Modern buildings in Belgrade urge repair and future (re)use strategies, since they are either disintegrating due to disrepair, or altering and transforming beyond recognition while being under-represented heritage of the recent past.

4. Methodology

4.1. Methodology of the research

The methodology of the research is defined through combined strategy of theoretical and empirical study. Interaction between those studies is necessary. The approach to research is inductive-deductive. After the theory and literature study, the empirical study as a deductive process will seek to verify the hypothesis through analysis of specific examples (case study). Furthermore, the inductive process will follow it, and a new theory, general principles and methods will be established. There are several methods of research, and every method has its analytical techniques:
Method 1: Gathering data / identification and documentation
Method 2: Theory and literature studies / analysis of data
Method 3: Case study / selection, classification and analysis of the buildings
Method 4: Simulations and workshops / working on strategies
Method 5: Grounded theory / a new concept with defined principles and methods

4.2. Methodology of finding literature:

- Identification of the literature from databases;
- Screening – reading titles and abstracts;
- Adequacy – does it provide relevant information about the research;
- Inclusion – reading the whole papers / books, further analyze and include them in the list of references.

4.3. Long term schedule: (Fig. 2)

5. Theoretical study - phase 1

Modernism, as an international movement, was developed in different European countries. Since the modern buildings emerged more or less in similar times in European countries, nowadays they are also facing similar problems - they are being altered and transformed beyond recognition while being under-represented heritage of the recent past. Modern buildings urge repair and future (re)use strategies.

The context frame of the research is Belgrade, the capital city of Serbia, or the capital city of Yugoslavia at the time when the buildings were built. Yugoslavian Modern Architecture, although part of a larger cultural phenomenon, received hardly any international attention, since few related studies were internationally published. Nevertheless, Modern Architecture of the Inter-war Yugoslavia (Kingdom of Yugoslavia), and especially Modern Architecture of the Post-war Yugoslavia (Socialist Yugoslavia), represents the most important architectural heritage of the 20th century of the former Yugoslavian countries.

The results of the first phase are presented in the paper:
Anica Dragutinovic, Uta Pottgiesser, Els De Vos, Michel Melenhorst, "Modernism in Belgrade: Classification of Modernist Housing Buildings 1919-1980", unpublished paper presented at World Multidisciplinary Civil Engineering-Architecture-Urban Planning Symposium WMCAUS 2017, 12.06.2017, Prague, Czech Republic

Notes
[1] "World Heritage papers 5: Identification and Documentation of Modern Heritage", Compiled and edited by R. van Oers and S. Haraguchi, Published by the UNESCO World Heritage Centre, 2003. In the Introduction to the Programme on Modern Heritage, R. van Oers stated: "This heritage is considered to be particularly vulnerable because of weak legal protection and low appreciation among the general public."
[2] GCI – The Getty Conservation Institute

Notes

Dissertation Christine Kousa

M. Arch.; (Aleppo, Syria)
PhD Candidate, KAAD scholar, OWL University of Applied Sciences; Detmold, Germany

Supervisor: Prof. Dr.-Ing. Uta Pottgiesser, Faculty of Design Sciences, University of Antwerp

Christine Kouse earned her Bachelor's degree in Architecture at the University of Aleppo in 2011. In 2015, she obtained a Master's degree in architectural engineering. Her final thesis, "Reconstruction of Historical Buildings in Old Aleppo City – Public Buildings as a Case study" focused on the rehabilitation of Islamic and historical cities at the University of Aleppo.
During the years 2012-2016, she worked as an assistant professor and academic researcher at the faculty of architecture at the University of Aleppo. In the years 2014-2016 she also worked as a lecturer at the Faculty of Fine and Applied Arts at the university, and in 2016-2017, she worked as a coordinator of the university's affair, at the presidency of Damascus University.
In the year 2017, she started her doctoral dissertation in the Department of Architectural and Urban Conservation of old Aleppo city, at the Faculty of Design Sciences, University of Antwerp, Belgium. The focus of her current research is Post War Techniques and Alternatives of Energy in the Reconstruction of Historical Buildings – Old Aleppo City in Syria, as a Case study.

Greek period
The most important urban influences in this period were that all elements of the Greek city are available: urban planning, straight street, public square, and acropolis, all these elements remain to this day

Byzantine period
In this period there are no new architectural features of the previous Greek period, the city maintained the structure of the Greek city in terms of planning, and the changes inside the walls were confined to a movement of urban expansion towards north.

11th century
At the end of this period there was a significant change in the planning of the city inside the walls, the construction of the eastern wall, which changed the structure of the city by making the castle centralized after it was located on its old eastern wall (passing through the castle) and later it was destroyed by the Mongols.

13th century
There are no radical changes in the planning or urban structure of the city except the expansion of residential neighborhoods inside the walls towards the east up to the borders of the castle, as well as the disappearance of the old wall which passed through the castle at the end of the Mamluk era. This period has left a remarkable urban product, particularly in the architecture of mosques, madrasas and khans, however the Mamluk period is an urban legacy that must be preserved.

16th century
As a result of the economic development of Aleppo city, the buildings inside the walls moved towards the east, so that all the land were occupied inside the walls. This period has witnessed remarkable development in the major souks areas as well.

19th century
At the beginning of the 18th century, there was interest in the old city inside the walls especially the souks area. The area of the city souks was doubled, and a large number of small khans were built to the south. However, by the 19th century, all attention was focused on the urban development of the Aleppo city outside the walls. Neighborhoods and huge areas spread radially outside the boundaries of the walls of the old city, thus the population was distributed according to religion or nationality.

Fig. 1: The Development of Aleppo according to Sauvaget Hadjar, Abdallah, Historical Monuments of Aleppo, March 2000, Aleppo.

Post-war Techniques and Alternatives of Energy in the Reconstruction of Historical Buildings Old Aleppo City-Syria. As a Case study

Abstract
The Syrian Civil War has destroyed most of the historical core of Aleppo; the oldest continuously inhabited city in the world protected by UNESCO World Heritage Sites. The housing situation deteriorated dramatically by the increase of population migration out of the old neighborhoods before, during and after this war. Nevertheless, its traditional architectural typologies still have a good ecological footprint due to their longevity and passive design strategies. This could play a crucial role in the future reconstruction process by reducing the environmental impact and maximizing the energy efficiency in buildings and historic residential areas. The thesis will analyse, describe and evaluate the local character and state of housing estates in Old Aleppo City before and after the Syrian Civil War (e.g. context typology, infrastructure, energy consumption, destruction and the subsequent social and physical fragmentation, etc.) that will face the reconstruction process after the civil-war. In this context the traditional courtyard housing in Old Aleppo City is considered as authentic housing in harmony with all the components of social life, as well as with the climate of the city- the arid continental climate with hot summers. With these characteristics, the traditional residential architecture is considered as a good mirror of climate-friendly construction in Syria. Thus, this research will investigate, on the one hand, the relations between local materials, building techniques, climate conditions and the possibilities of using renewable energies. On the other hand, it will develop criteria for intervention (conservation, restoration, enhancement and eventual reconstruction) on this damaged residential architecture to develop housing on this World Heritage Site in Old Aleppo City. As such, this thesis aims to articulate a strategy and guidelines for design solutions for intervention in the historical residential parts of Aleppo based on locality, the authenticity of traditional architectural typologies, and to combine them with the ideals of energy efficiency.

Aleppo within the walls of the late 19th century

Aleppo within the walls in the thirties of the 20th century

Fig. 2: The layout of Aleppo within the walls of the late 19th century and the beginning of the 20th century; Scientific Report of UNESCO 1980

Master Plan scheme by Andre Gutton 1954 showing main road pattern

The implementation of master plan by Andre Gutton 1954

Fig. 3: Development plan of Aleppo

Introduction

The proposed new design solutions derived from the conceptual design of the traditional architectural typologies which are considered successful environmental examples could play a crucial role in the environmental architectural contemporary framework, through balancing the relationship between local materials, building techniques, and climate conditions to reduce the environmental impact and improve energy efficiency in buildings. In addition, the adaptive re-building and re-use of heritage (for their original or similar purpose or even to fulfil different functions) is an effective strategy, as it does not only extend the life cycle of the buildings, reduce its carbon emissions and improve cost efficiency, but also conserves significant heritage values.

In this context, the Syrian city of Aleppo, with its arid continental climate with hot summers, has a rich variety of building types, including the old city which is characterized by several types of constructions, such as houses, madrasas, hammams, souks and religious buildings, all of them exposed to extensive destruction as a result of the Syrian war and waves of terrorism during the previous years. This destruction has affected various aspects of life (housing and infrastructure), not to mention the loss of cultural heritage, history, Syrian collective memory and identity.

In terms of adapting to the current situation in Aleppo City, the different approaches of post-war Aleppo city reconstruction should consider its old city (listed by UNESCO as World Heritage at risk); preserve the cultural identity of the city and at the same time attempt to benefit from international pioneering experiences in energy efficient technologies and the spatial code for historical buildings, considering the Syrian situation.

Typologies of historical periods in Old Aleppo City:

Various types of constructions are found in the Old City of Aleppo which composed of the ancient city inside the walls and the old cell-like quarters outside the walls- an approximate area of 350 hectares housing with more than 120,000 residents. In this term pre-war historical, social, and urban development of old Aleppo city represents a continuation of the oldest inhabited city in the world as follows:

Aleppo's organizational plan can be divided in terms of city development and expansion study at the city level as a whole, from the beginning of the French Mandate in 1920 until the present time to three basic periods: the period of the French Mandate, the period from the 1940s to the 1980s, and the period from the 1980s to the present. However, in these plans, we will only review the changes that relate to the Old City within the walls, without talking about the expansion outside the walls.

The period of the French Mandate between 1920- 1946:

It can be said that during the first four decades of the 20th century, the city did not experience significant changes at the level of the urban fabric of the old city within the walls. By comparing the plans of Aleppo in the late 19th century with those of the beginning of the 20th century, we noticed that the changes that occurred did not exceed the development of some areas within the walls, such as the central souks, and the appearance of the buildings south of the citadel. Thus, the city within the walls is still closer in its urban structure to the city in the late Ottoman rule. (Fig. 2)

The proposed plan of Bunchoya shows the streets and service axis that lead to closed squares 1969

plan of Aleppo inside the walls after the implementation of part of Gutton and Bunchoya Proposal 1974

Fig. 4: Scientific Report of UNESCO 1980

The period from 1946 to 1980:

The modern and wide streets such as the northern axis penetrated the traditional fabric. Another penetration at Khan al-Wazir to reach the administrative center at the foot of the citadel, and the southern axis was stopped at Bab Qnnesrin and thus prevented the penetration of the old city. The north-western part of the city within the walls was mostly exposed to removal, and the towers of al-sabaa Bahrat on both sides of the vertical axis on the axis of Bab al- Jinan, thus distorted the huge features of the Old City inside the walls. (Fig. 3, 4)

Fig. 5: Cultural heritage damage assessment in Old Aleppo City overlaid general infrastructure damage density analysis by UNOSAT The United Nation's Institute for Training and Research satellite imagery program-UN

Period from 1980 to 2011:

This period is more stable in terms of the urban structure of the old city, in this time there was no attempt to penetrate the old fabric of the city, especially after the city had been registered as a World Heritage Site, however the most important changes of the Old City within the walls focused on the change in the functional structure of many sectors, such as the development of the central souk area to include areas of neighboring residential areas, that led to the expansion of commercial functions at the expense of housing functions, such as the conversion of housing to ateliers or warehouses, as well as converting parts of the residential facades overlooking the traffic axis to shops. Also, the old city lacked many facilities and modern services, and not to mention the carelessness in many respects.

Period from 2011 to present:

Since the beginning of the Syrian revolution in March 2011 the urban structure of old Aleppo city has sustained extensive physical damage which was valued according to UNESCO reports in 2017 as follows: 60% of the old city was severely damaged, and 30% was completely destroyed.[1] (Fig. 5)

Historical Building Typology in Old Aleppo City:

This part examines the architecture of the old city in Aleppo, according to the functional classification of the buildings that were constructed in the different periods. These buildings are divided into seven main types: firstly the residential buildings such as palaces and traditional houses, the second,the commercial buildings such as souks, khans and qaysarias, the third type are the educational buildings such as madrasas, and the forth type includes buildings for health and social services such as Bimaristans and hammams, and the fifth type is the religious buildings including mosques with their attached buildings, and churches plus the sixth type with the administrative buildings, finally the military buildings such as castles and barracks. (Fig. 6)

Pre-war Housing Typology:

Inside the walls of the Old city there are five major areas that can be identified which cover 71 hectares and form about 38% of the surface area. As well as outside the wall the housing is divided over four major areas. It occupies about 107 hectares and covers approximately 63% of the surface area of the extramural Old city. Thus, housing covers a total of 178 hectares in both parts of the Old City. Therefore, housing areas including minor streets only add up to 50 % of the total surface area of the city.

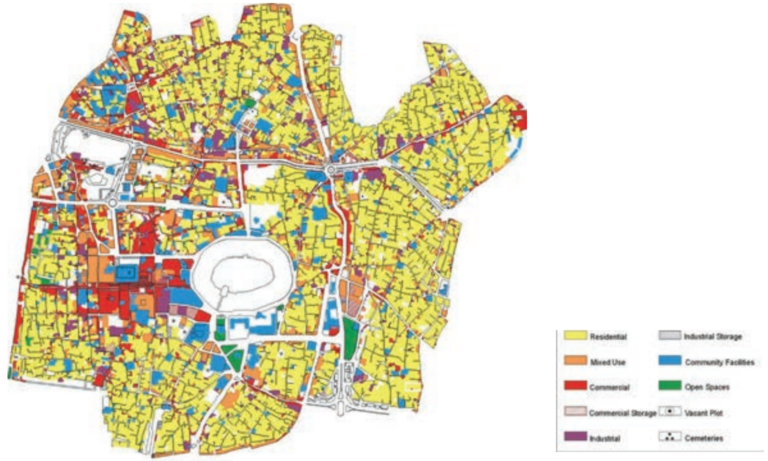


Fig. 6: Land use plan of the Old Aleppo City; Development plan of Aleppo

The intramural and extramural Old city areas are almost identical in surface area. However, housing areas are disproportionately distributed. Larger housing areas are situated in the extramural area due to the fact that many of the important city functions are located in the intramural: the Citadel, the traditional market (mainly the Old Souk), and the main administrative area (the Justice Palace and the Seat of the Governor). Furthermore, the intramural area contains many open spaces: planned green areas and sites for future urban projects (e.g. Bab al-Faraj area, the Joubailah graveyard, the Old Jail House site). Another reason is that the housing areas, adjacent to the intramural markets, were partially transformed into mixed use areas. Markets in the extramural are not as concentrated.[2]

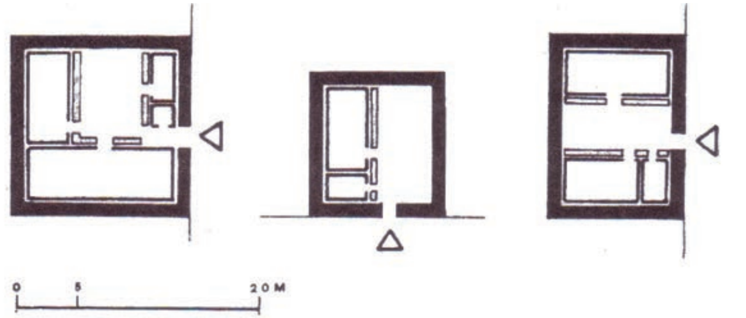


Fig. 7: Haretani, Mahmoud: The Old City of Aleppo - Degradation and Rehabilitation Attempts, Shuaa Publishing and Science - Syria - Aleppo, First Edition 2005.

The traditional house is composed of three parts:[3]

- a basement floor
- a ground floor comprising the main living areas called Al Salamlek,
- a first floor comprising the private areas called Al Haramlek

In this context we can classify traditional housing in old Aleppo city according to size as follows:[4]

1. Collective housing:

These buildings are kept for the poorest classes. These houses are called qaysarias; they include large areas covered with two or three modest rooms, the general central courtyard.

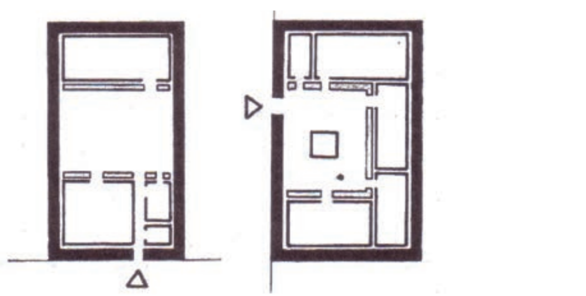


Fig. 8: Haretani, Mahmoud: The Old City of Aleppo - Degradation and Rehabilitation Attempts, Shuaa Publishing and Science - Syria - Aleppo, First Edition 2005.

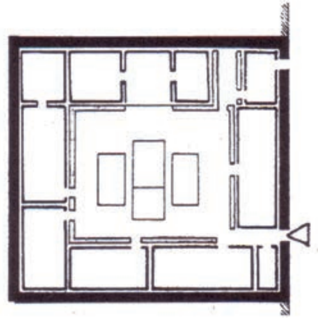


Fig. 9: Haretani, Mahmoud: The Old City of Aleppo - Degradation and Rehabilitation Attempts, Shuaa Publishing and Science - Syria - Aleppo, First Edition 2005.

2. Small housing:
The size of dwellings in this model inside the walls is 50-83 square meters. The internal courtyard usually occupies about 34% of the area and the living rooms occupy 66%, the courtyard outside the walls occupies more than 36%. The rooms in these houses can be

Fig. 10: Haretani, Mahmoud: The Old City of Aleppo - Degradation and Rehabilitation Attempts, Shuaa Publishing and Science - Syria - Aleppo, First Edition 2005.

put to different uses, the kitchen and the toilet are separate and are usually located in the courtyard near the entrance. The dwellings are similar to this model in terms of the number of rooms and do not differ from each other except the area and location of the house and its relationship with the street. These houses are kept for population who has a low-income. (Fig. 7)

3. Intermediate Housing:
The average area of dwellings inside the walls is 189 square meters, the courtyard occupies 34% and 66% of the rooms. The functions of the rooms are the same in small dwellings. (Fig. 8)

4. Large housing:
These houses represent the homes of the rich merchants. The average area of this model inside the walls is 400 square meters distributed as follows: 38% of the courtyard and 62% of the housing rooms we can note in this model an increase of average built area for the courtyard area. (Fig. 9)

Three-courtyard dwelling - Qatar Agassi residence.

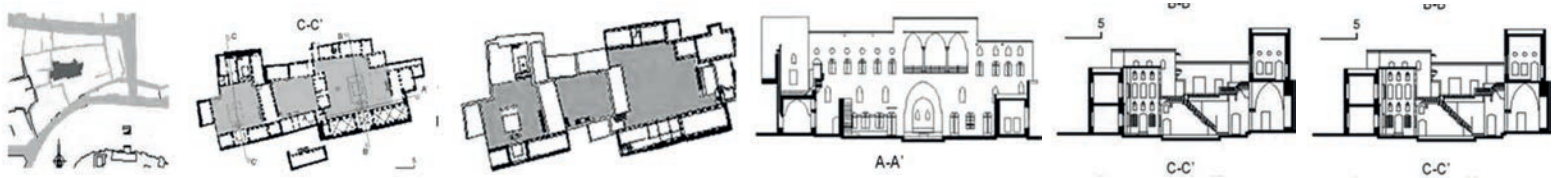


Fig. 11: Archive of the Directorate of Old Aleppo.

Two-courtyard dwelling - The House of Zimriya

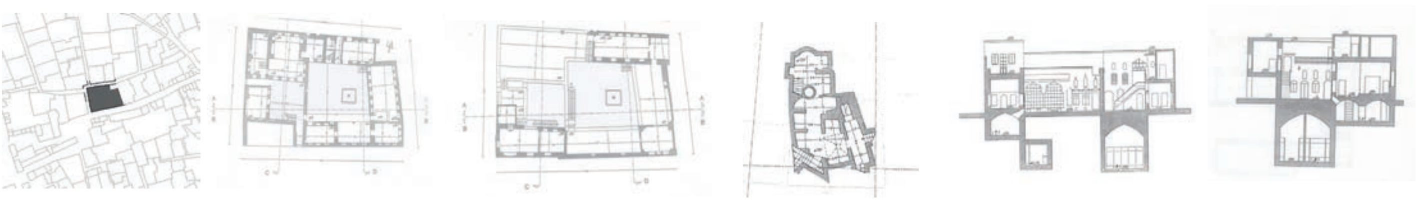


Fig. 12: H. Ogli Mamu, Mohamed Thaer: The Local Experience in the Restoration and Restoration of Historic Buildings. Diploma note - Aleppo - 1998

One-courtyard dwelling - One of the properties on the western fence.

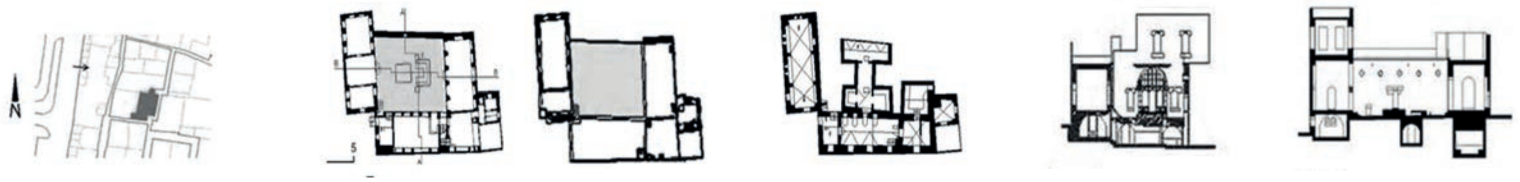


Fig. 13: Archive of the Directorate of Old Aleppo.

5. Palaces
The rooms are spread across two courtyards plus a smaller courtyard for services, including a garden, a bath, and stables. The built-up area of this model, excluding gardens and non-built area, covers 900 square meters. (Fig. 10)

The courtyard is an essential typological element of a residential building in old Aleppo city and an important functional environmental element as it supplies natural lighting and ventilation. In this regard, the courtyard typology forms an appropriate layout in old Aleppo city, which achieves two crucial functions: preserving the cultural heritage of the city and promoting the thermal performance of the buildings. Against this background we can classify traditional housing in old Aleppo city according to the number of internal courtyards of which a number of examples are presented.

In addition we can classify traditional housing in old Aleppo city according to its heritage value as follows:
- the most important historical residential buildings
- the important historical residential buildings
- the residential buildings which include important historical landmarks
- residential buildings that do not have any historical significance.

Typology of Pre-war Commercial Buildings:
1. Mixed Business Areas:
Inside the walls of the Old city we can find five major Mixed Business Areas covering a total of 33 hectares or 18 % of space. Outside the wall there is also mixed-business use in one area with a surface area of 13 hectares or 8%. Mixed use covers a total of 46 hectares in both intramural and extramural parts of the Old City. This refers to 13% of the total surface area.[5]

2. Commercial Areas:
There are two main types of commercial use areas in the Old City. The first is primarily a commercial area with the traditional souks and their expansions which cover 25 hectares. The second consists of the commercial axes alongside the main street crossing through the Old City, covering 50 hectares. Most of these axes are modern streets. The two types of commercial use areas cover an area of 69 hectares or approximately 20 % of the total surface area of the Old City. For an example, see also:[6]

Traditional souks:
These include the longest covered souk in the world and cover 12 km[7]; they have been active and dynamic from ancient times. Commercial activities and crafts eventually expanded to cover 16 hectares of the city and at the same time the center of Aleppo's old center inside the walls. Pre-war the souks housed about 6000 shops, 2000 of which are distributed along the main road extending from Bab-Antakiya to souk al-Zarb, and 4000 are stretched over 37 souks, 15 khans and ten of qaysarias, all of which provide both the old and modern city of Aleppo with different goods. However, this does not include permanent residential buildings[8].

This main axis is an uncovered souk up to the Bahramiya mosque. After this mosque the axis is divided into several parallel souks of up to four souks, all of them covered with stone. In the eastern part

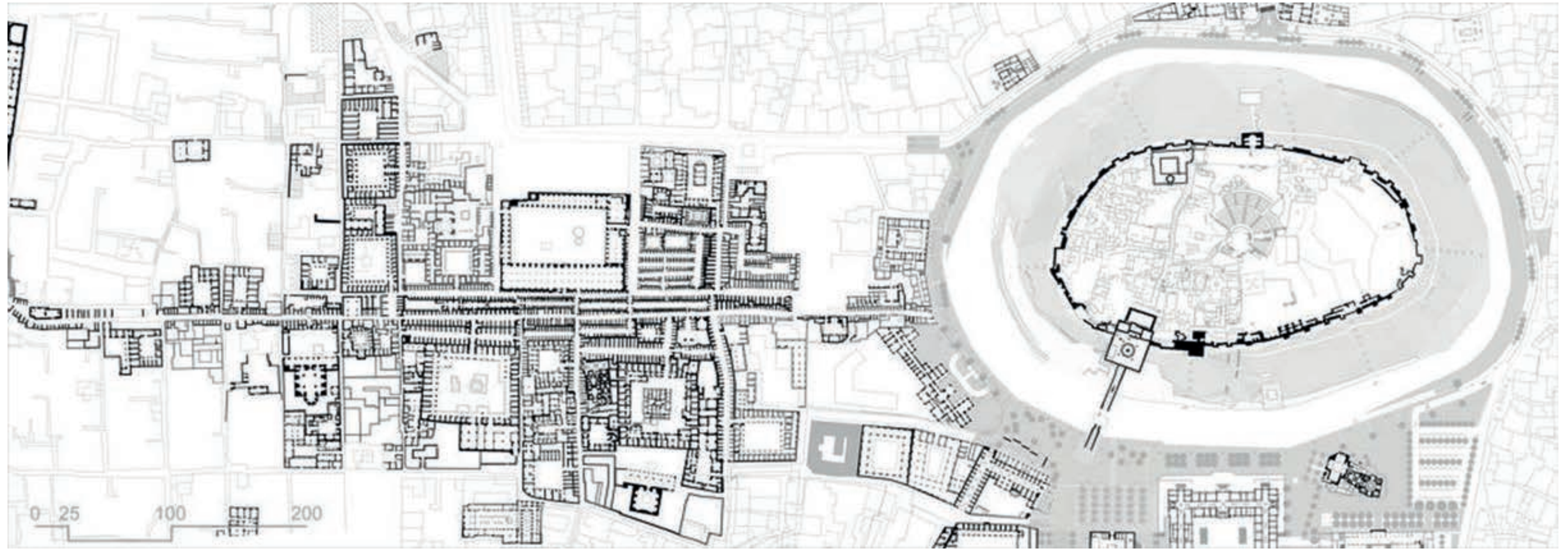


Fig. 14: Tradional souks and Khans in Old Aleppo City; Gaube

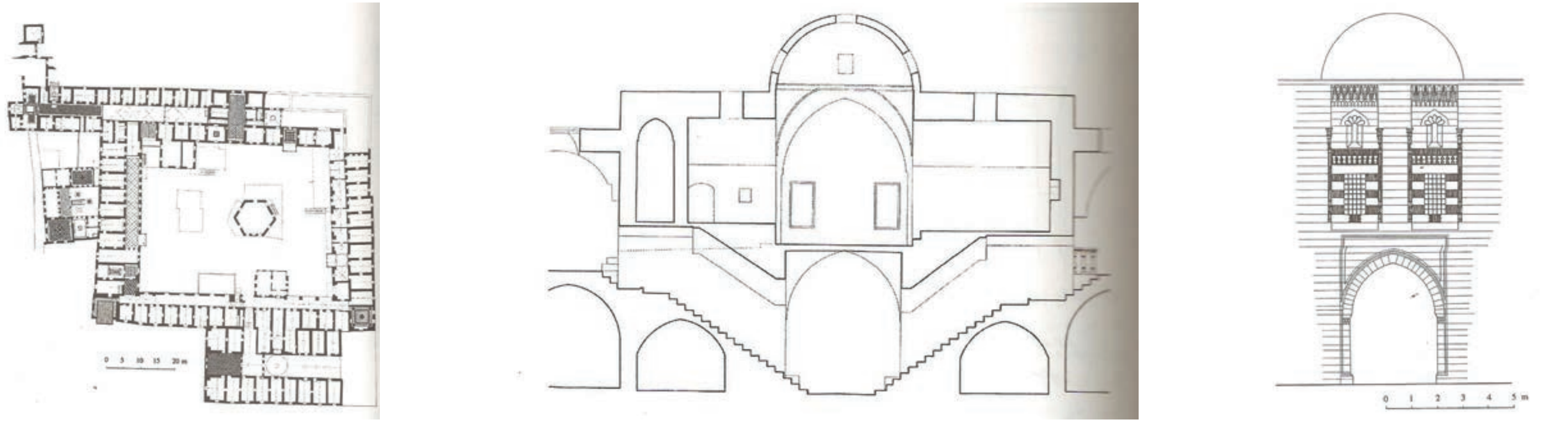


Fig. 15: Khan al-Jumruk; Haretani, Mahmoud, Aleppo City Markets, Shuaa Publishing and Science, Aleppo, 2006

of the Umayyad Mosque, the oldest in the souk, there is a series of six Souks that form coherent groups that were established and developed near the main axis; they include also khans and multiple Caeserias in the middle. (Fig. 14)

The roofs of the souks are prominent from any nearby viewpoint, such as the minaret of the great Mosque, or from the western side of the citadel. They make an attractive sight with their domes and many ventilation holes from the roof to provide light and air to the markets. The floors are paved with concave basalt slabs, and there are channels on either side of the thoroughfares to allow rain water to run towards the drainage holes.

The Khans (Caravanserais)
The khans complement the souks, the oldest of which date from the Mamluk period. The typical khan consists of a large courtyard with a small mosque in the center. The courtyard is encompassed by two-storey shops and rooms. The upstairs room, where merchants used to stay, are often reached by a staircase near the main entrance of the khan. The goods were displayed downstairs. On the first floor, there is a gate a with a finely-decorated façade looking on the inner court, with the large gate of the khan. (Fig. 15)

The Caeserias:
They are smaller than khans in their sizes and functioned as workshops for craftsmen.

Pre-war educational buildings typology:
Madrasas of Old Aleppo City contain inner courtyards. The ratio between built-up areas and the courtyard in the Madrassa provides it with light and ventilation in a suitable manner, despite the multitude of various architectural elements. Examples are the various types of madrasas found in the old city of Aleppo, especially in the Ayyubid, Mamluk and Ottoman periods which we can classify according to the time of construction and the characteristics of each era:[9]

1. Madrasas in the Mamluk era:
Schools of mosques dominated in this period, which are characterized as follows:

In terms of design
Disturbance of the horizontal plan and absence of common characteristics, however the general features are as follows:
- Small size and scale
- Free scheme thus non-symmetrical design
- The lack of some basic elements in the planning of schools such as adjacent rooms, al-riwq, the burial and al-Iwan

In terms of architectural elements:
- Entrance
- the courtyard
- the Tribal

The number of schools in the Mamluk era was 24:
- 18 scattered or unknown schools
- 6 remaining schools
- 8 schools were established in the Maritime Mamluk period
- 9 schools were established in the Tower Mamluk period
- 1 Unknown School

2. Madrasas in the Ayyubid era:
Over 30 madrasas covered most of old Aleppo city, inside and outside the walls and are characterized by good planning. Thus, we can summarize the most important advantages of architecture from that era in terms of design as follows:
- Its rectangular or square plan, small size inside the walls and relatively large outside.
- Symmetric planning
- include all elements of the basic school: tribal, classrooms, adjacent rooms, Iwan, courtyard, riwaq, cemetery, and minarets.
- Some schools were found including two opposite Iwans and orthogonal Iwans around a courtyard covered by a dome.

3. Madrasas in the Ottoman era:
Madrasas in this era can be classified on levels and different style according to area and original use as follows:
- Large and medium Madrasas: Complexes of building including a mosque, a madrassa, a lodge, a kitchen, square / rectangular tribal, riwaq, iwan, and domes, such as the madrassa al-khosrofiya (Fig. 16)

Small Madrasa: Simple Madrasa with one or two floors consisting of square / rectangular tribal, and rooms. Such as Madrasa Kawakibiya

Residential buildings converted into Madrasas
Mosques were converted to Madrasas with the addition of rooms adjacent to them, such as the Madrasa of Mosque Ahmadi

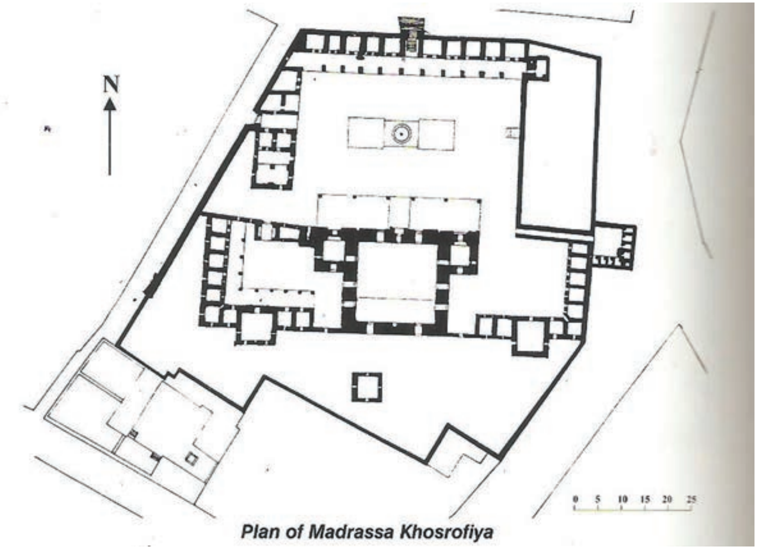


Fig. 16: madrassa al-khosrofiya; Hadjar, Abdallah, Historical Monuments of Aleppo, March 2000, Aleppo.

Typology of Pre-war service buildings (Hammams and Bimaristan):
1. Hammams Typology:[10]
Aleppo was home to 177 hammams during the medieval period, until the Mongol invasion when many vital structures in the city were destroyed. Pre-war, roughly 18 hammams were kept in serve in the old city. In the city of Aleppo 24 archaeological baths still remain inside the walls, as well as 10 baths outside the walls and all of them are characterized by belonging to different historical ages.

Hot air passing through corridors under the floors of the bathrooms and in particular under the hot room was the heating method; the

Fig. 17: The shape of the domes covering the roof of Hammams Moawad, Mansour Mohamed Abdel Razek, Public baths in Aleppo from the beginning of the Ayyubid era until the end of the Ottoman era, Arab Knowledge Office, 2013, Aleppo

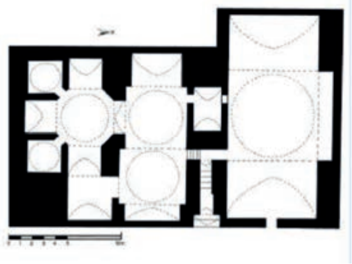


Fig. 18: Hammam in old Aleppo City; Moawad, Mansour Mohamed Abdel Razek, Public baths in Aleppo from the beginning of the Ayyubid era until the end of the Ottoman era, Arab Knowledge Office, 2013, Aleppo

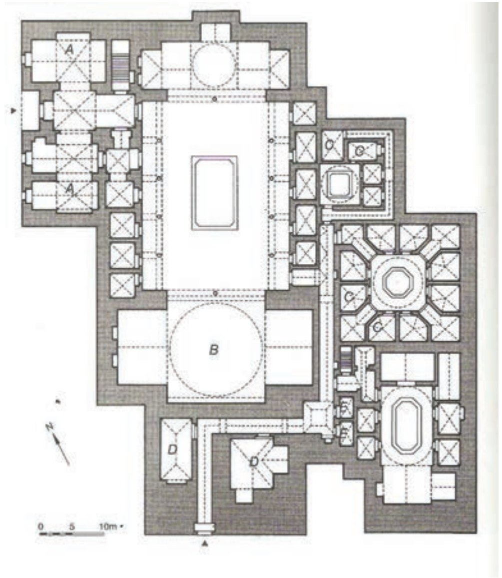


Fig. 19: Bimarsitan Arghun al-Kamili Hadjar, Abdallah, Historical Monuments of Aleppo, March 2000, Aleppo.

water was heated in the same way. Public baths were one of the main service facilities serving the souks and Masjed. (Fig. 17)

The hammam is divided into 3 sections:
- The inner chamber (Iuwani) contains the warm rooms and the hot rooms. The warm rooms are designated for a short relaxation before taking a bath. The hot rooms are designated for a full body wash and steam bath.
- The middle chamber (Wastani) is designated for a massage after the body wash.
- The outer chamber (Barrani) is the largest part of the hammam, Here, bathers can take a period of relaxation around the pond.
- Iwan and domes
(Fig. 18)

2. Bimaristan typology:[11]
Bismaistan typology consist of many wards including rooms (waiting rooms and consulting rooms) distributed over one or two floors along with iwan, a courtyard, riwaq, a staircase and rounded dome allowing for ventilation and light. It was used to house the poor and for treatment. (Fig. 19)

Research Question of my PhD-project:
Social and economic reasons led to the development of a rich class which left the old city neighborhoods to live in the modern neighborhoods which began to be established in the north and west of the old city in the 1950s and 1960s. The residents considered multi-story apartments more comfortable (to have a better supply of bathrooms, water and electricity) than the large courtyard houses. Modern housing represents a symbol of rich housing, while traditional housing is associated with the poor class. There are also the facts that family sizes are declining and the role of women is changing as women have started to work outside their homes, and there is of course also the increase in population migration to the old neighborhoods after the Syrian war. In other words, a lot of people moving out Old Aleppo City are looking for modern housing. Now, I am proposing ways to bring back housing to the world heritage site of Old Aleppo City and I am considering what might encourage people to live there.

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Development plan of Aleppo.
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Notes
[1] UNESCO report, date, 2017.
[2] Development plan of Aleppo
[3] Zein al abidin, Mahmoud, Courtyard Housing Past, Present & Future, The courtyard houses of Syria page 31, 2006
[4] Haretani, Mahmoud: The Old City of Aleppo - Degradation and Rehabilitation Attempts, Shuaa Publishing and Science - Syria - Aleppo, First Edition 2005.
[5] Development plan of Aleppo
[6] Development plan of Aleppo
[7] A. Gutton
[8] Hadjar, Abdallah, Historical Monuments of Aleppo, March 2000, Aleppo.
[9] Al-Jasser, Lamia, Aleppo Historical Schools History and architecture, Aleppo, 2000.
[10] Moawad, Mansour Mohamed Abdel Razek, Public baths in Aleppo from the beginning of the Ayyubid era until the end of the Ottoman era, Arab Knowledge Office, 2013, Aleppo
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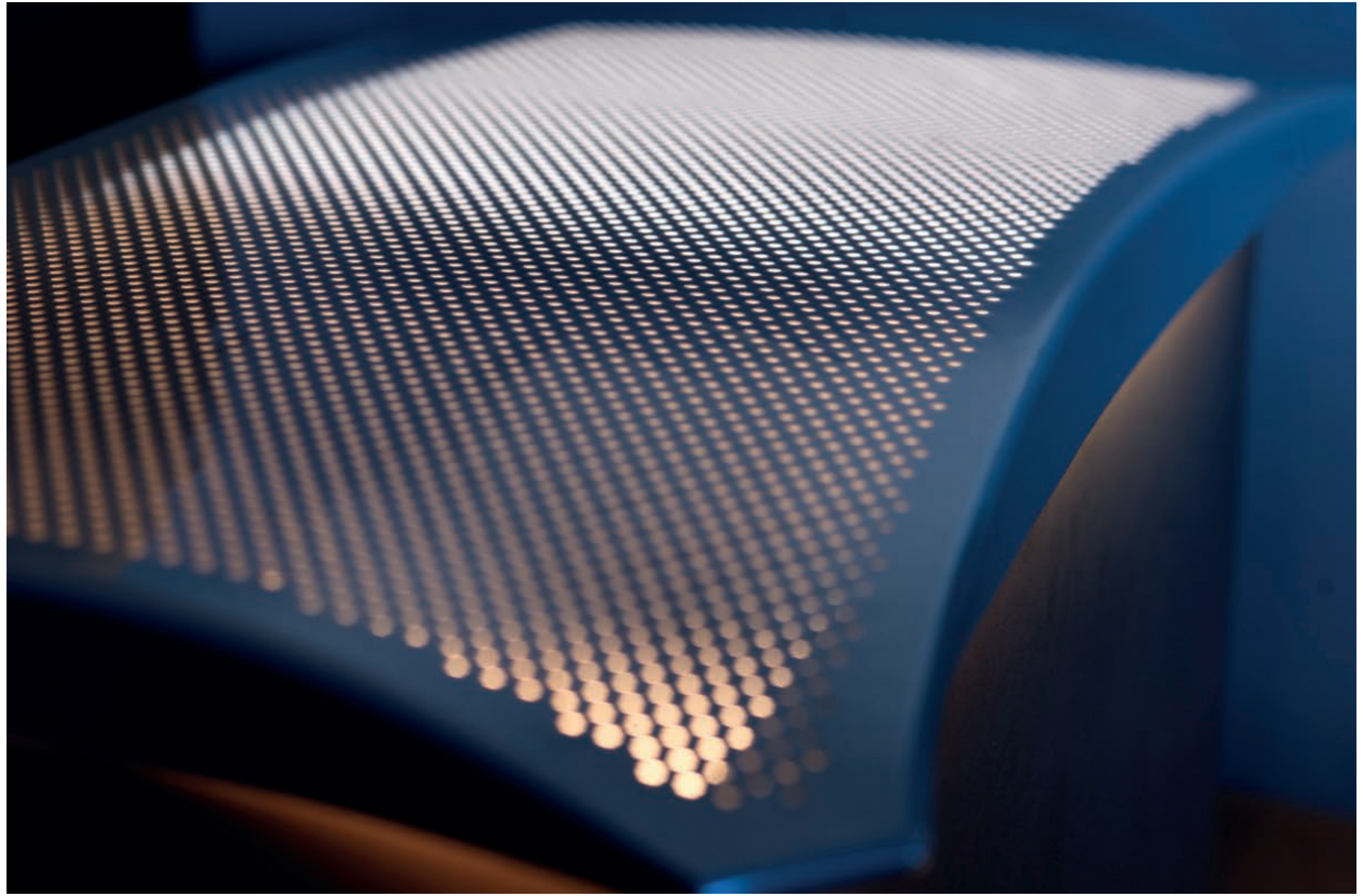

Fig. 1: Prototype

Developing Sound Absorbers for Health Facilities

How to meet hygienic and acoustic Requirements in one Product

Prof. Dr.-Ing. Uta Pottgiesser, Dipl.-Ing. Christoph Kirch

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Design to Thrive

Abstract

The hygienic requirements in health facilities, in particular in hospitals, lead in most cases to hard and high reflective surface materials and subsequently to long reverberation times. The noise level is high and the resulting speech intelligibility is low – both indicating poor room acoustics with stress-increasing impacts. In contrast, good room acoustics will help staff members to work more concentrated and with less mistakes and patients will profit from a better prevention, regeneration and healing.

Sound absorbers generally reduce reverb and create a comfortable acoustic environment. Additionally, sound absorbers for health facilities and hospitals need to reach the hygienic requirements on cleaning and disinfecting surfaces. This means in general, that surfaces need to be non-porous and smooth to implement the hygienic requirements, however, porous materials like foams are regularly used for sound absorbers. The purpose of the project was to develop a sound absorber that can be disinfected easily and with material that is chemically resistive to the usual disinfecting products. Constructive and acoustical solutions were developed and evaluated to meet the requirements of a high effective sound absorber with an aesthetic non-technical appearance to be used in common patient rooms and for specific applications in health facilities.

Product development // Sound Absorber // Health Facilities // Hygienic requirements

Introduction

The disinfection of surfaces in clinics and mass catering institutions not only serves the cleanliness, but also the personal protection or the protection of health to prevent infection. For this reason, rooms, machines, all installations and component surfaces (walls, ceilings, floors and in particular acoustic elements) must be cleaned and disinfected on a regular basis.

According to the "Requirements on Hygiene when Cleaning and Disinfecting Surfaces – Recommendations by the Commission for Hospital Hygiene and Infection Prevention of the Robert Koch Institute" (RKI, 2004) the surfaces of installations (ceilings, doors, walls) must be as smooth as possible, wipeable, joint-tight and cleanable with disinfectants and disinfecting procedures. Porous materials, mostly used for sound absorbers, have neither a smooth, closed surface nor can they be easily disinfected and therefore do not meet the increased requirements of the hygiene sector.

As a rule, the hygiene requirements in medical facilities lead to reverberant building and finishing materials, and thus to unfavourable room acoustics. The long reverberation times lead to a noisy environment with a low speech intelligibility (DIN 18041, 2015). Thus communication and concentration is disturbed even at low noise levels, resulting in reduced performance and increased frequency of errors. Regeneration (sleep) and healing are already adversely affected with very low noise levels. Both aspects are of great importance especially for patients (regeneration) and personnel (concentration) in medical, nursing and care-taking facilities (Notbohm and Siegmann, 2012).

In the presented research, the development, layout and design of a porous sound absorber was carried out which is to allow reliable cleaning and disinfection measures for the use in rooms of the healthcare environment, such as clinics and nursing facilities, as well as kindergartens and associated kitchen areas.

Conception

Since a modular design and a high and broadband efficiency should be maintained, the system needs to be encased in order to prevent microorganisms from penetrating the porous absorber's core. This protective layer should also remain acoustically transparent over the entire frequency range relevant for room acoustics.

At the same time the mechanical robustness should be as high as possible for the daily clinic routine so that it is not damaged easily by scratches. The materials and surfaces must be selected in such a way that they are resistant to cleaning and disinfecting agents when applied in specific doses and cycles. Liquids or humidity should not penetrate the porous absorber's core since there are a variety of active substances and substance combinations in cleaning and disinfecting agents with the following macro-families: alcohols, aldehydes, surface-active compounds (surfactants), halogens, oxidizing substances and acids and bases (Kramer and Assadian, 2008). Resistance data provided by the manufacturers are only suitable for a rough assessment and must be followed by practical tests.

The sound absorber must be designed and optimized in terms of optimal cleanability. This refers to the shaping (geometry), its connections and joints, its installation and assembly elements and the surface finish and its tightness against internal areas, e.g. by avoiding gaps, seams, sharp edges.

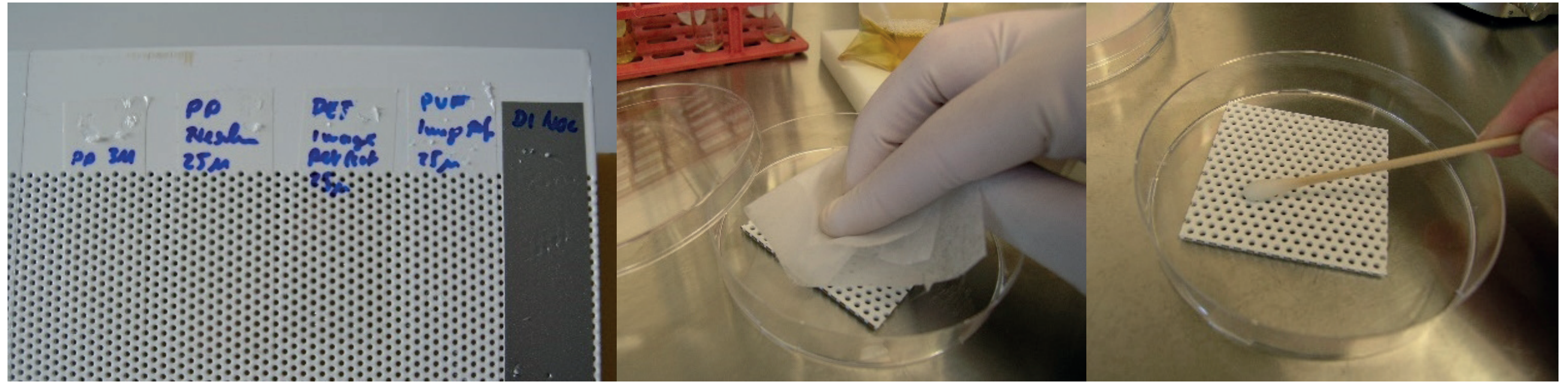

Fig. 2: Testing for scratch resistance/mechanical stability of plastic foils as well as the chemical stability and desinfectability of materials.

Approach

Identification and selection of surfaces and construction materials with optimum acoustic properties and compliant with hygiene requirements.

First, materials had to be sought which show resistance to disinfectants, since the surface always has to be resistant against the constituents of surface disinfectants. Since practical tests are essential (Ehrenstein and Pongratz, 2008) though very time-consuming (e.g. through adjusting the wipe disinfection over a longer period), both the construction materials and the disinfectants had to be reduced to a small number by means of pre-selection so that the chemical stability of the materials could be established. On the basis of literature references and manufacturers' specification as to material compatibility (Sastri, 2010), a conventional cleaning agent on the basis of quats and a fast-acting detergent were selected as well as construction materials for practical tests.

Acoustic transparency depends on (low) sound density or mass, and their stiffness. Stainless steel which is often used in medical devices is not available in the form of the required thin layers with sufficient width (of perforation?). The same applies to glass foil, particularly since the latter is also unpractical and expensive for the use in sound absorbers. This meant that only plastic materials were suitable to provide the microbiological barrier.

For the daily routines in hospitals, a certain mechanical robustness and scratch-resistance is necessary, especially when foils have to be applied on the outside, around the cassettes. Various types of plastic materials showed strengths, which did not only depend on the thickness of the layer, but on the material itself. But also, the processing of the material matters, e.g. polypropylene (PP) foil appeared initially to be rather soft for the purpose as it scratches

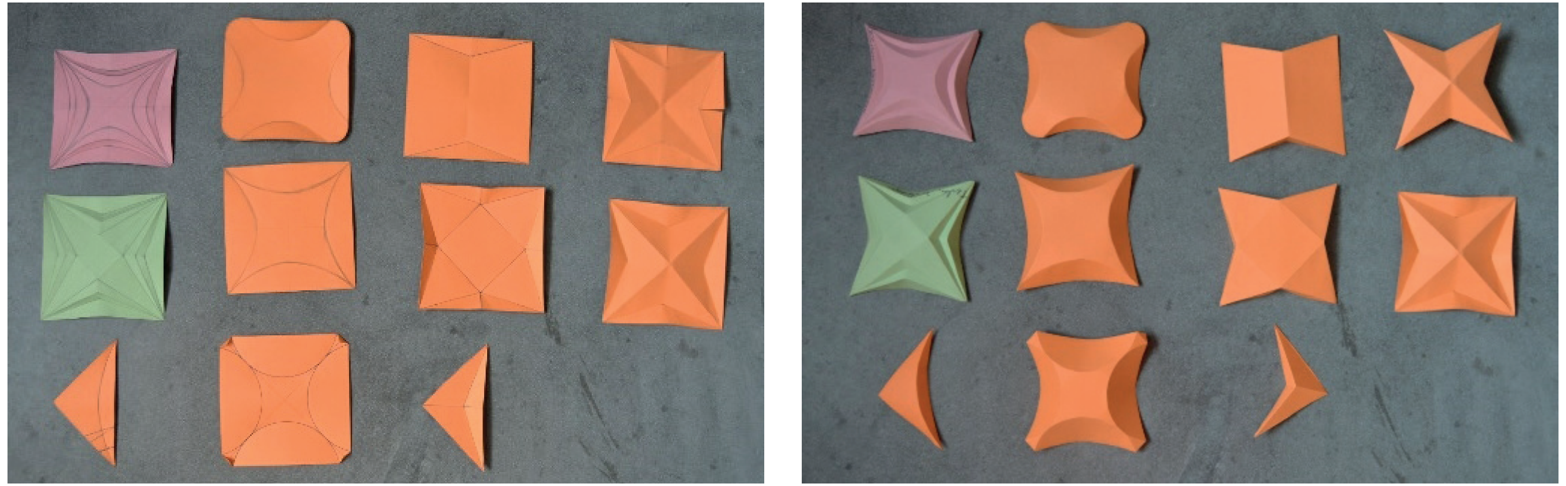

Fig. 3: Samples of schematic models for the housing: Geometries of volumes, folded from one face

easily by contact with fingernails, however as a stretched version (O-PP) with surface treatment, the mechanical strength is significantly higher. A (stretched) PET foil presented much better characteristics, while PVF foil, though chemically highly resistant, turned out to be less suitable due to low mechanical stability, and moreover it is rather expensive. After sampling various foils, some were selected for acoustic tests. Additional tests (Fig. 1) examined chemical stability, the microbiological barrier and disinfectability (Gebel et al, 2001).

After analysis of the test results, the PET foil Mylar A with a thickness of 50 µm was chosen. This foil proved to be chemically stable and it provides a sufficient microbiological barrier. Measurements of the acoustic absorption properties provided satisfactory results i.e. covering the core of the absorber impaired the absorption only insignificantly [Kirch and Pottgiesser, 2016].

To meet the regulatory hygiene requirements on the sound absorber, certain aspects needed to be considered [Kramer et al, 2012]. On the side which requires disinfecting treatment, there must be no cuts or overlapping of foil. Overlapping creates areas which cannot be reached, while cuts might cause leaks. The edges of the foil or bonding layer need to be placed in an area where no disinfection takes place. Therefore, the approach was to develop a geometry for the housing which would allow mantling with foil which would require neither overlapping nor folding. This would be given by using a folded volume from one surface. The surface would thus remain intact. The housing can be wrapped without any cuts or overlapping and without the need to shrink-wrap the foil, a measure which always leads to ripples. The edge of the foil is moved to the

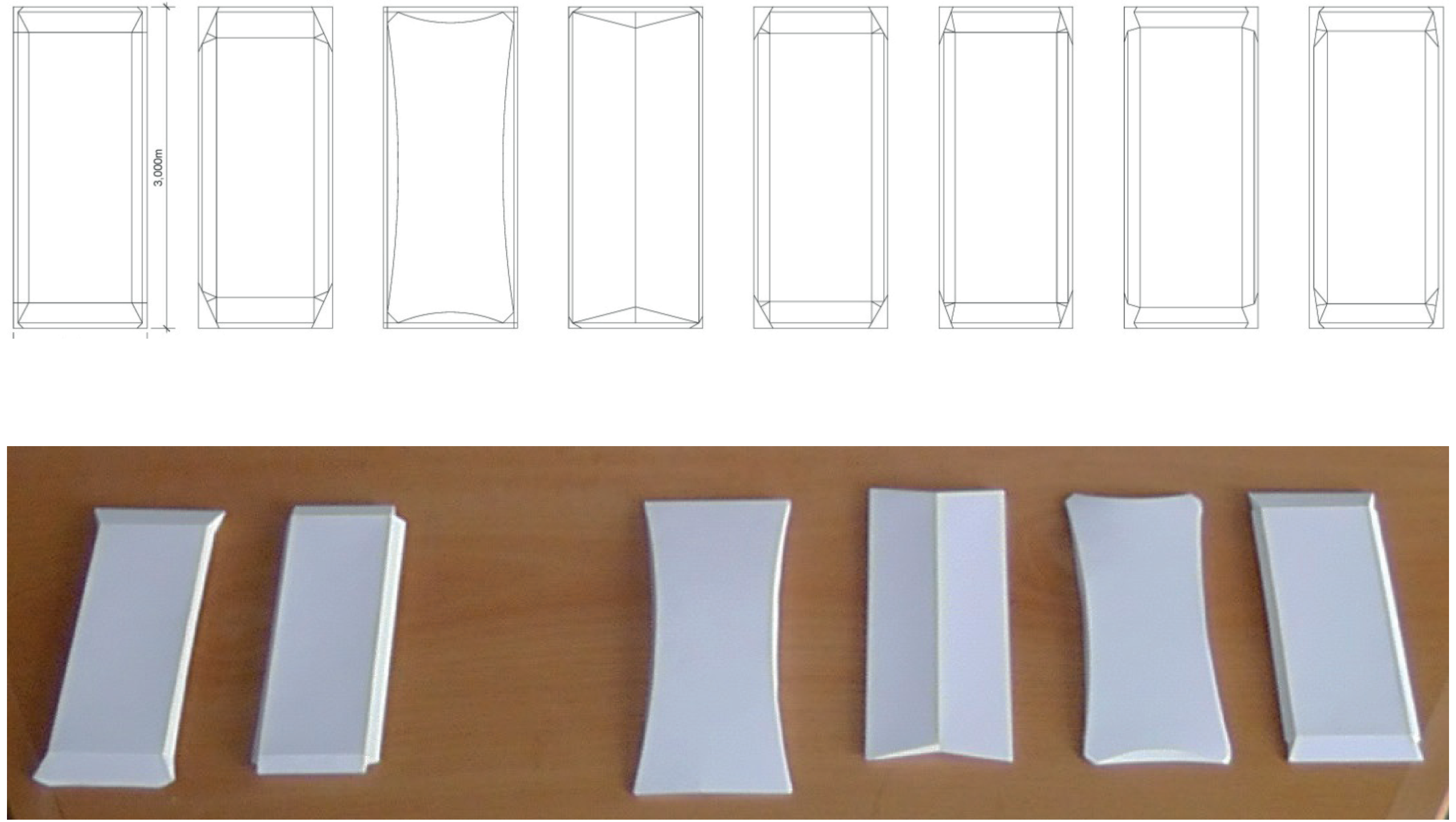

Fig. 4: For the sound absorbers, geometries that can be folded from the surface in the process (above) and as folded paper models of the geometries (below).

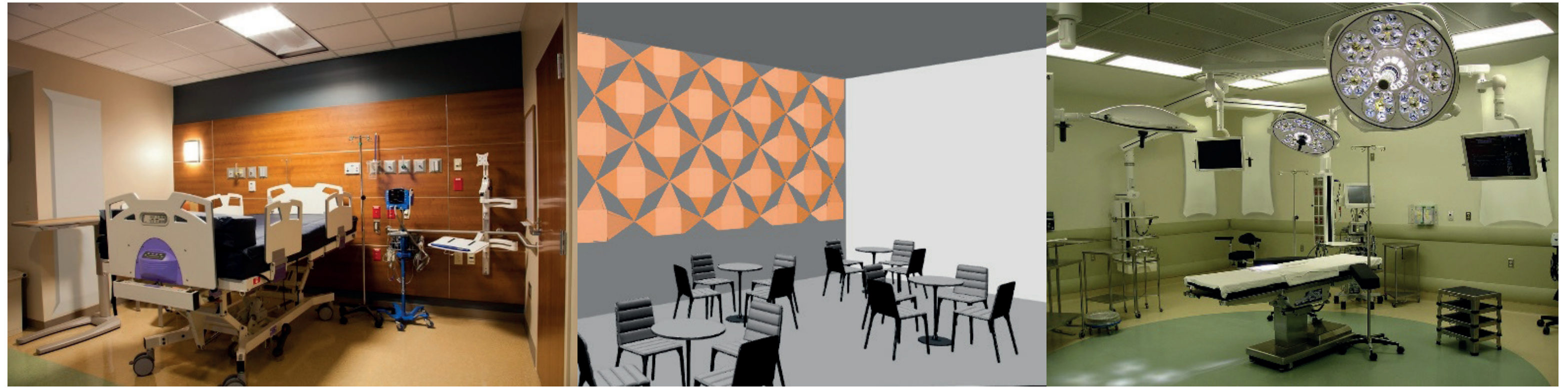

Fig. 5: Sample visualizations of different installation options of the sound absorber cassettes

rear area so that after wall-mounting and sealing of the joint, an area remains on the front with an intact surface that can be disinfected. This means that the disinfectant does not come in contact with the adhesive at the foil edges. It is important hereby that the edges all rest on the wall. After experimenting with this principle, geometries were worked out in detail and converted to paper models. (Fig. 2, 3).

Designing an architectural integration based on status analyses

Medicine has developed into a service sector and health services have turned into consumer products. As a logical consequence, the trend in hospital architecture is towards more comfortable rooms with hotel character, a trend which should influence the design of sound absorbers. This allows for absorbers to be integrated easily at a later stage and for an uncomplicated retrofitting, the installation of the sound absorbers as a model was requested by the project partner.

Existing clinical architecture was analyzed with regard to the formal design and available areas for later installations, to show which installation options would typically lend themselves for the purpose. Installation variants were tried out with visualizations, which showed designs for sound absorber housings and their layouts. Here it was possible to try out how the different geometries and their arrangement could be included in various logical spatial contexts and also their effect (Fig. 4).

Implementation of the design

After development of the form, the search started for suitable materials and methods for the production of the sound absorber housing. Deep-drawing of metal was no option for economic reasons, since the tool production would only amortise over high-volume production numbers. This led to the attempt to manufacture the housing from simple folding plate materials. Not only should the material allow folding, perforation should also be possible to let sound enter the cassette. Plate materials, in particular sandwich plates can be routed from the back to define the folded edge. This is

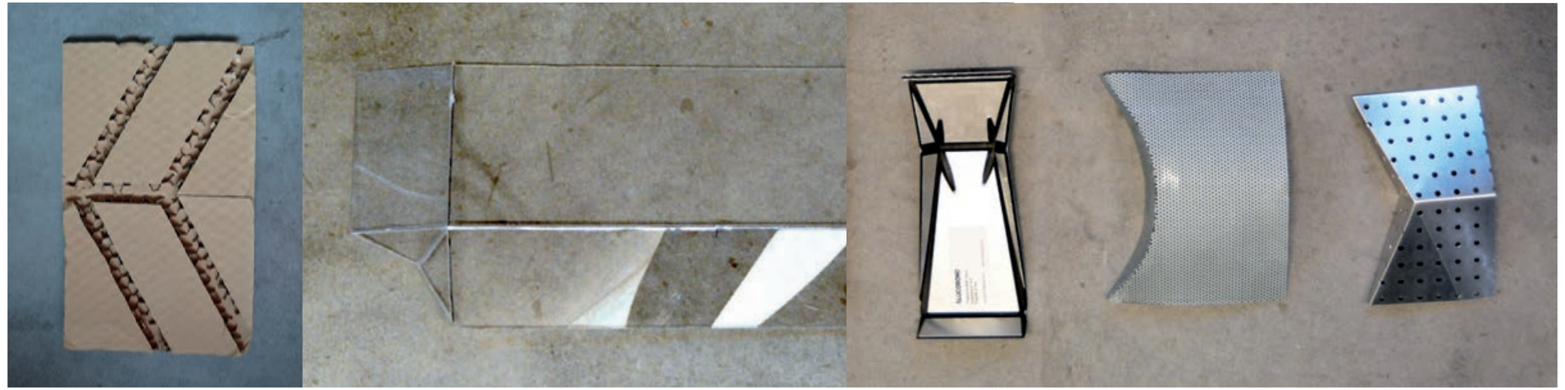

Fig 6: Functional model for different types of foldable housing materials.

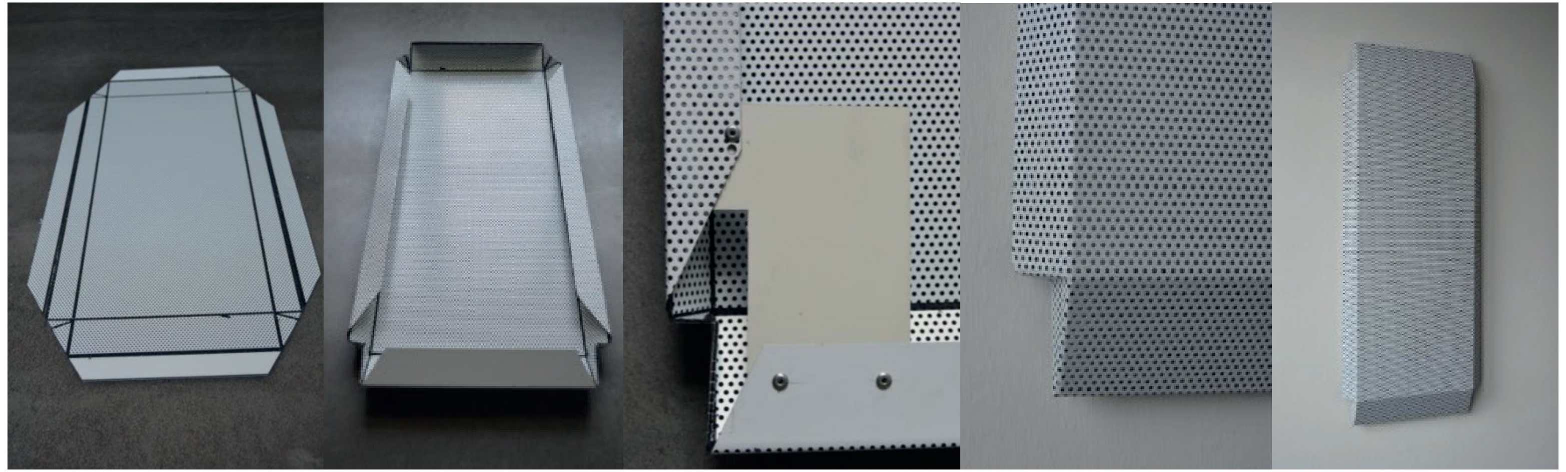

Fig 7: Prototype made of aluminum composite sheets, with routing and folding technology and corner bracing.

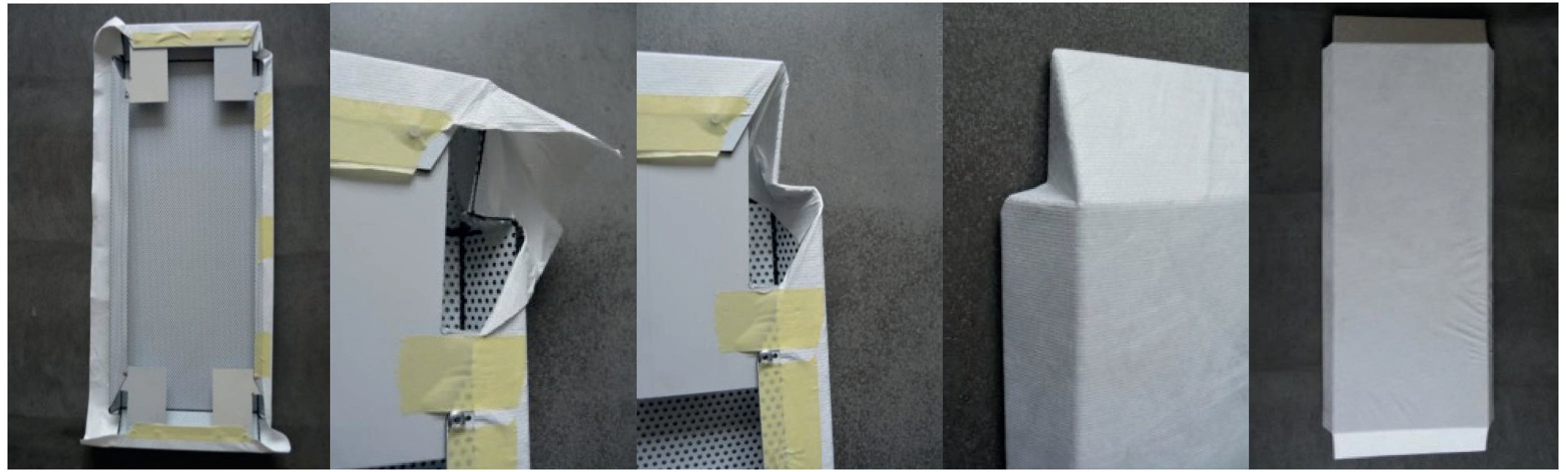

Fig. 8: Covering the prototype with PE fleece, with details of the inward fold of the foil at the inner corner (bottom). The bonding surfaces/foil edges have been moved inwards.

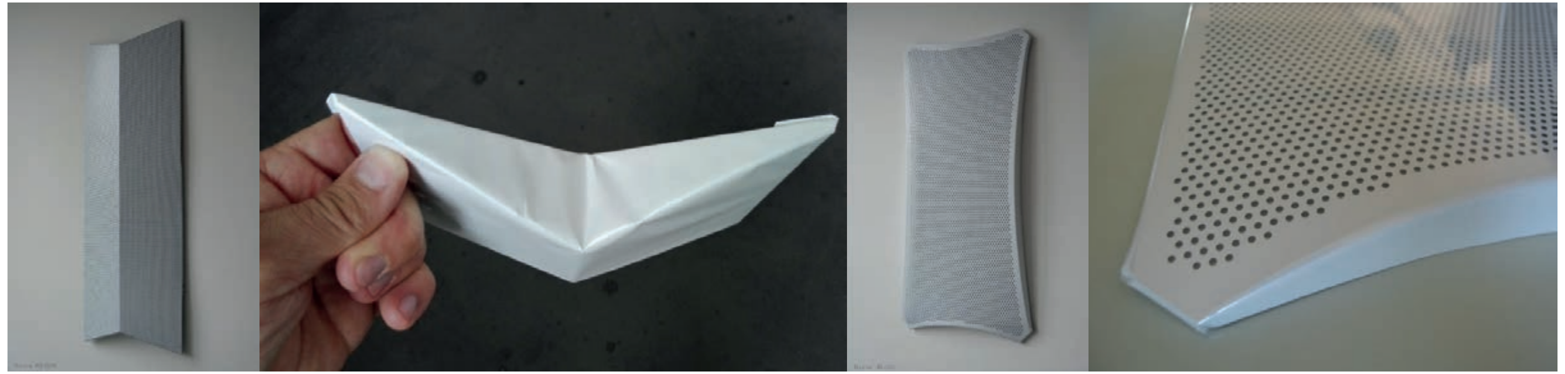

Fig 9: The edges which are turned inwards cause unevenness (left). Variant with arched edge with foil cover (right).

Fig. 10: Detail of corner solution for the foil wrapping. The foil is drawn inwards through the open corner.

known as routing and folding technique and is used e.g. for façade cassettes in aluminium compound sheets (Dibond). Tests were also carried out with aluminum sheets and plastics materials suitable for cold-bending (PC and PET-G) and where material thickness was routed (Fig. 5).

After tests with functional models, scaled-down proto-types of folded cassettes were produced from aluminum composite panels, to test the suitability for the production of housing. (Fig. 6, 7).

At the cassette, a fold is created by the material thickness where the foil is turned inwards at the edge and there it cannot be smoothly wrapped also because of the tough, rigid foil materials. This was easier to solve with the curved variant (Fig. 8).

Since the edges of the cassette rest on the wall with a 90° angle, a flap is missing at the rounded edge to facilitate the mounting, which is only possible with the variant with the straight edge. Moreover the composite sheets led to spring tension effects at the folding edges which led inturn to retraction and imprecise geometry. The folding process also causes problems: All folds need to be achieved at the same time – a process which is not possible to carry out manually with the required precision and not doable at all at standard turning benches or in a press brake process. This would require a special 5-axle controllable robot which does not promise to be a cost-effective solution.

All these reasons led to a new approach: the housing will be made in cubic shape which allows an efficient manufacturing process with simple edging tools. The housing will remain open at the short edges so that the foil wrapping can be drawn inwards there. (Fig. 9).

Since joints have to be sealed anyway at the point where the housing meets the wall, this joint needs only to be extended around the short housing edges where the foil turns inwards. In this way, it is possible to choose a tried and tested manufacturing process for the housing in order to wrap the same later with foil, without causing pleats or overlaps. Special adhesive tape needed to be found for the fixing of the foil to the sound absorber cassette, in particular since the powder coating of the cassette has poor adhesive

Fig. 11: Installation of a sound absorber in the technology centre of the department of Life Science Technologies at the University of Applied Sciences OWL.

properties and the adhesive tapes came off after a short while when put under tension during mounting. Good results were in the end achieved with an adhesive tape usually used for vapour barriers in buildings. This tape can be stretched lengthwise but not laterally. This is advantageous when wrapping the cassettes by hand with PET foil, which means that the inelastic PET foil can be applied without creating overlapping folds. Since the perforated sheet used for the housing shows a different thermal expansion coefficient than plastic foil, an additional foam adhesive tape is used on the back which offsets to some extent the different tensions.

The sound absorber has to be mounted tightly to the wall, according to RKI recommendation, this is to be done by applying a silicon sealant. Since the selected PET foil is a synthetic material, a sealing compound had to be found which is suitable for plastic materials. According to manufacturers' specifications (suitable for use in laboratories and food processing companies) silicones and an MS joint sealing compound were identified and purchased for suitability tests, in particular to test resistance to cleaning agents.

Trial results in real life settings

At the technology centre of the Life Science Technology department of HS OWL, it was possible to carry out a practical trial (Fig. 10). After a successful installation and sealing of joints with silicone, the influence of reverberant time could be measured.

Conclusion and Outlook

With a thin technical membrane, issues of acoustics and hygiene can be solved and suitable geometries allow efficient disinfection. It was possible to develop a product which complies with the requirements

of hygiene, acoustics, material stability as well as design and construction and which thereby allows to optimize room acoustics in hospitals. There is increasing noise pollution in hospitals, nursing staff are retiring prematurely and there are multi-resistant germs, the spread of which should be prevented with consistent hygiene concepts. The same applies to office areas where noise pollution leads to a growing number of incidents of stress and burnout.

With better room acoustics (reduction of reverberation) more calm and better speech intelligibility can be achieved which in turn lead to fewer mistakes caused by stress and communication errors and to a lower basic noise level. [Fuchs, 2007]. Since sudden events and peaks are most distressing, it is possible to add soft(!) artificial noise in acoustically calmed areas which reduces the distance between background noises and sound peaks (i.e. sound masking) resulting in less stress. [Stanchina et al, 2005]. In hospital rooms these measures can result in better sleep quality and faster recovery.

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An Analysis Tool to match Home environmental Interventions to the specific Needs of People with Dementia

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PLEA 2017 EDINBURGH
Design to Thrive

Fig 1: Home environmental interventions support the autonomy of people with dementia

Abstract

Background: The number of people with dementia will increase tremendously within the next decades.

Aim: The aim of the project was to develop an analysis tool that matches home environmental interventions to dementia-related needs.

Methods: A systematic literature review was conducted to evaluate possible home environmental interventions for community-dwelling people. The analysis tool was developed taking into account current German health care regulations and dementia-specific needs that might be influenced by interventions in the built environment, in particular the domestic environment.

Results: The analysis tool is an aid to help with better decision making when planning home improvement measures for people with dementia and shows the spectrum of possible interventions to meet individual needs.

Conclusion: The main precondition for the use of this analysis tool is the need to assess the specific situation and the individual abilities of people with dementia. The complexity of the domestic environment can only be illustrated if personal and environmental requirements for the respective intervention are determined. The detailing of these factors will follow in a further study.

Dementia // Home Environmental Modification // Fit //Dementia-Related Needs // Instrument // Analysis Tool

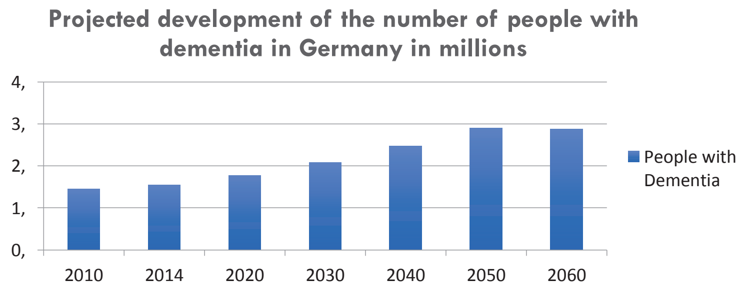

Fig. 2: Dementia in the age group 65 and older in Germany, 2010 – 2060 (German Alzheimer Society, 2014)

Introduction

Advances in medicine, a decline in birth rates and increased longevity all contribute towards demographic changes and an ageing population in Germany. According to current population projections by the German Federal Statistical Office the percentage of the population aged 65 and above will increase from 21% (2013) to 28% (2030) and 33% (2060). In particular, the number of people aged over 80 will go up from the current 5% to 8% (2030) and about 13% (2060) (Pötzsch et al., 2015).

With increasing age, the probability of a progression of age-associated diseases such as dementia rises, too. Dementia is a syndrome associated with progressive memory loss and impaired cognitive and physical ability. The progression and reduction of abilities vary greatly from person to person. After 60, the probability of developing dementia doubles every 5 – 6 years (Ziegler et al., 2009). According to projections by the German Alzheimer Society the number of people with dementia will increase from the current 1.5 million up to 3 million in the year 2050 (Fig. 2) (Bickel, 2014).

The majority of people with dementia live in in their home environment. Restrictions that may occur due to dementia – such as a decreasing ability to make logical decisions or impaired perception and orientation – can jeopardize the ability to lead an independent life. With progressing dementia, the dependence on personal support increases and with lower ability to cope with everyday challenges, caring relatives often feel burdened by more care dependency and incidences of challenging behaviors. These reasons are often reported when care in the familiar environment can no longer be maintained (Schäufele et al., 2005).

Measures to improve the domestic environment for people with dementia

Home adaptions include a number of building- and structural measures in the familiar environment, usually for people requiring care or for disabled people. The guidelines for living space interventions eligible for aid are defined in the German Social Code (SGB XI) which states that nursing care funds can subsidize improvement measures in the home if these substantially facilitate care or allow a person to mainly live independently again (sect. 40 SGB XI, 2017). Due to the loss of competences associated with dementia, the demands on the environment go up as the symptoms progress and it gets continuously harder for the afflicted to adjust to their surroundings. Studies with people with dementia have shown that adjustments to the built environment can compensate for individual losses by making the right adjustments for the needs of people with dementia (van Hoof et al., 2010).

The adjustments to the environment should compensate for building defects or restrictions on the one hand (Soilemezi et al., 2017), but also make up for the individual restrictions of the residents and thereby improve the home situation in view of the special requirements caused by specific physical and cognitive impairments (BMFSFJ, 2002). The corrections to defects in the homes are made to allow people with dementia to lead a safe and independent life (Struckmeyer et al., 2016), to make life easier for those providing care and to allow them to remain longer and better in the own home. Achieving these objectives means interventions that are directed at the individual needs of people with dementia (van der Roest et al., 2007).

Development and objective of an analysis tool

There are a great number of different improvement measures for homes but most focus on the spatial problems rather than on the needs of the persons concerned and least on the special needs related to dementia. The lack of linking interventions with the requirements of the afflicted persons makes it difficult to assess if the measure is appropriate or not. Against this backdrop the following questions directed the development of the analysis tool:

a. Which dementia-specific needs can be met by special improvements to the home?
b. How can a building intervention be matched to individual problems?

The analysis tool systematically links dementia-specific problem areas with structural interventions that are as much as possible evidence-based. Residential consulting offices, which can be found in many German communities, are envisaged as the users of the tool as they can implement the tool in the course of their advising activities; they can point out or recommend possible building adjustments. It is also conceivable that the Health Insurance Medical Service (MDK) uses the tool in the course of assessing a person's nursing care needs.

Background on the legal and domestic situation

The starting point for the development of the analysis tool is the reorientation of the term "in need of care". In January 2017, the Second Nursing Care Act [Pflegestärkungsgesetz] came into force. With the passing of this law, the understanding of what constitutes "requiring nursing care" changed in as much that now for the assessment of the degree of required nursing care no longer the amount of time needed for the support due to physical impairment was considered but instead the ability to lead an independent everyday life is reviewed. This competence-based view is of particular relevance for people with dementia since they might often still be physically able to perform certain tasks but are hindered due to cognitive and motivational restrictions to cope independently with complex situations of daily life. This new approach allows to assess the individual needs of a person and to gain a holistic view of a person in everyday life.

Most older people prefer to stay as long as possible independently in their familial environment even if there are impairments. Moreover,

Fig. 3: The six areas of life and two additional areas for the determination of independence. Own diagram based on (NBA, 2015)

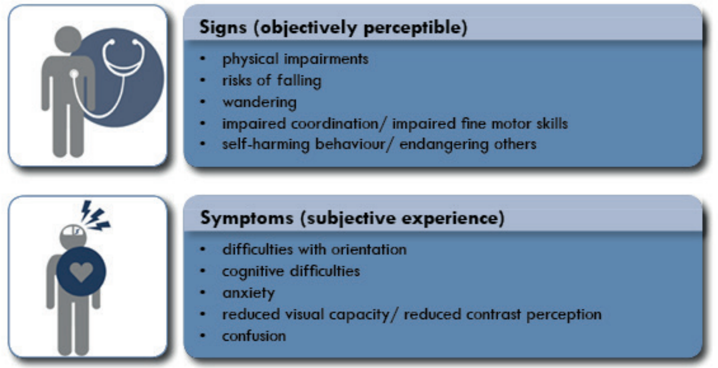

Fig. 4: Relevant signs and symptoms of people with dementia calling for structural interventions

it is the national and international objective of policy discourse in this field to rather provide ambulatory than stationary care. However, 95% of existing homes of elderly people lack appropriate facilities for nursing care needs (BMFSFJ & BMGSS, 2005). This assessment is further supported by regional surveys, which show that 26% of owners and 46% of renters mention the need of improvements in their home environment (Balderhaar et al., 2006). For people with dementia it is difficult to compensate for inadequate facilities due to their cognitive and physical restrictions. Therefore they are especially dependent on a suitable built environment, which is appropriate to their individual needs.

Lawton and Nahemow established the relationship between the level of individual competence and the environment in 1973 in their “competence-press-framework”. This model describes an individual’s ability to cope with the environment as depending on the individuals’ degree of competence and the demands of the physical and social environment (Lawton et al., 1973). When the environment exerts significant pressure then the individual is forced to adapt. Failure here leads to discomfort and unease. In particular, in old age and with impairments due to chronical illnesses such as dementia, the dependence increases on an environment that is suitable the individual competences in particular regarding the physical, social and infrastructural features of the environment (Gitlin et al., 2003). Thus it is necessary to adjust the environmental aspects to the (remaining) abilities of the individual in the best possible way (Schneekloth et al., 2005).

Methodological assessment of areas of life, dementia-specific needs and home environmental interventions

In the eleventh German Social Code (SGB XI) the following six criteria are considered authoritative for the presence of health-related impairments (i.e. in need of nursing care): mobility, cognitive and communicative skills, behavioral and psychological problems, self-sufficiency, coping with and dealing independently with illness- and therapy-related requirements and burdens, structuring every-day life and maintaining social contacts (§ 14 SGB XI, 2017). In addition, the assessment should also include the abilities concerning activities outside the home and housekeeping, to enable planning of care and services (§ 18 SGB XI, 2017). For the assessment of the extent of care required, the newly defined German assessment (NBA) includes these areas and defines individual modules as illustrated (Fig. 3).

In a systematic review of literature interventions were identified which would support people with dementia by independently carrying out the activities of daily living in their domestic environment. The analysis tool included 84 – mainly structural and technical interventions – to support an independent, self-sufficient life of people with dementia. Typically, the needs of people with dementia differ considerably in scope (Riesner, 2010). Many investigations on the appropriateness and fairness of interventions focus on the care-providing relatives. Only rarely the needs of people with dementia are focused in the context of interventions to improve their home environment. In order to plan and implement interventions with a view on maintaining and supporting resources, need-based and justice measures are of major relevance (van Hoof et al., 2010).

People with dementia often do not only suffer from restricted mobility and physical restriction but they also show signs of cognitive impairment such as problems of perception and orientation. To categorize situations and conditions that trigger the need for support, we used the “signs and symptoms” theory coined by MacBryde and Blacklow (1970) for the analysis tool. Signs are objective, physical manifestations and can as such be measured and observed. Symptoms, however, are subjective experiences (such as pain or hunger) and can only be experienced by the person concerned (Cacioppo et al., 1989).

Vague descriptions of symptoms or the limited ability of expression by those concerned can lead to wrong interpretations of needs. There is also the fact that self- and outside assessments by people with dementia and their relatives often differ in regard to the remaining abilities and self-sufficiency (Riesner, 2010). In spite of the challenges of detecting and interpreting symptoms, as mentioned above, the analysis tool integrates the experience of symptoms of the people with dementia and allows a better understanding of the individual situation so that interventions can be targeted directly to the individual needs of the person and the respective stage of dementia (Pynoos et al., n.d.). Fig. 4 shows the categories of typical signs and symptoms of dementia that the analysis tool addresses, on a higher level. The systematic assignment to the dementia-specific needs was made by taking into account the objective of an intervention and the potential effect.

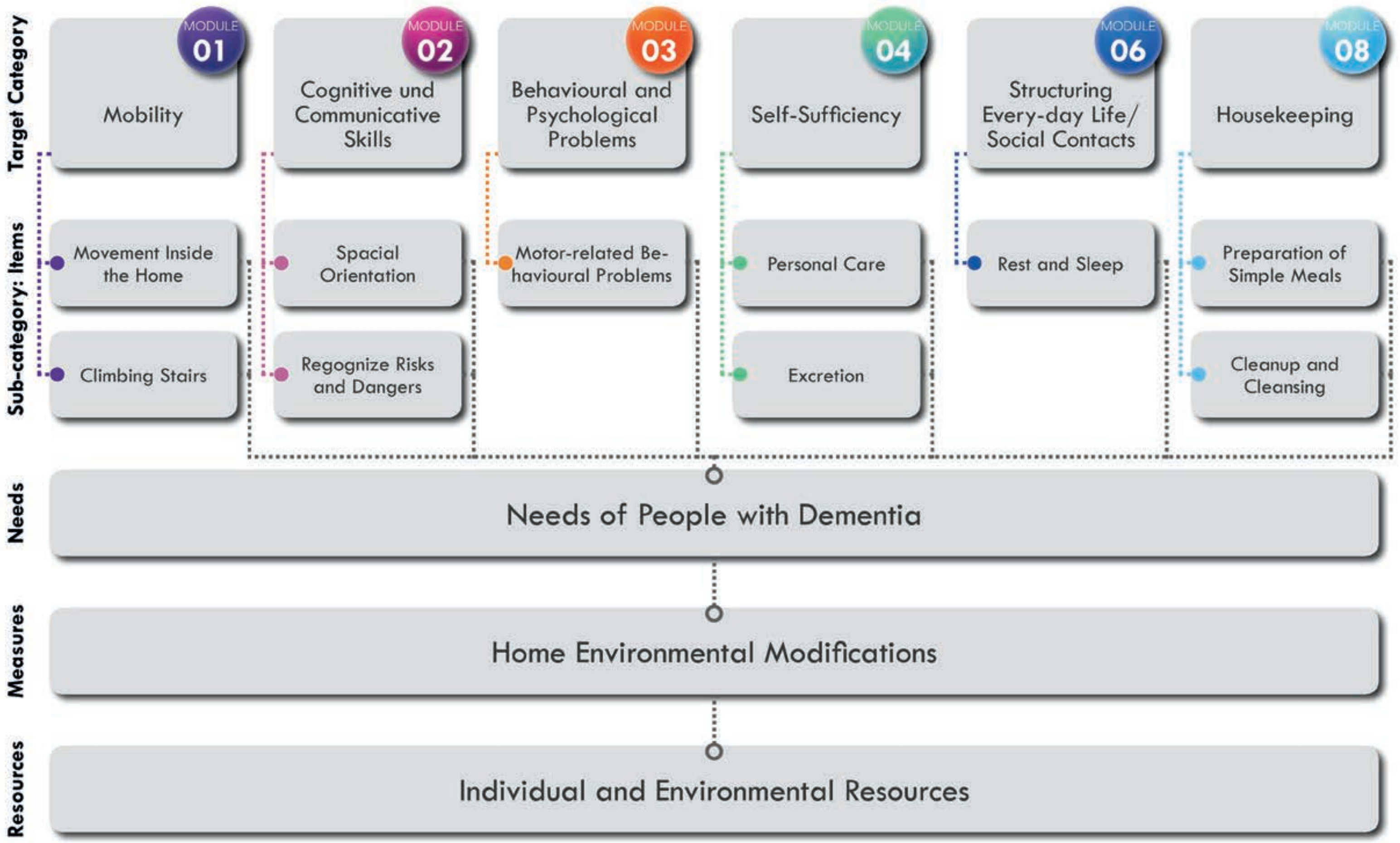

Fig. 5: Base structure of the analysis tool for the assessment of the suitability of measures to improve the domestic environment.

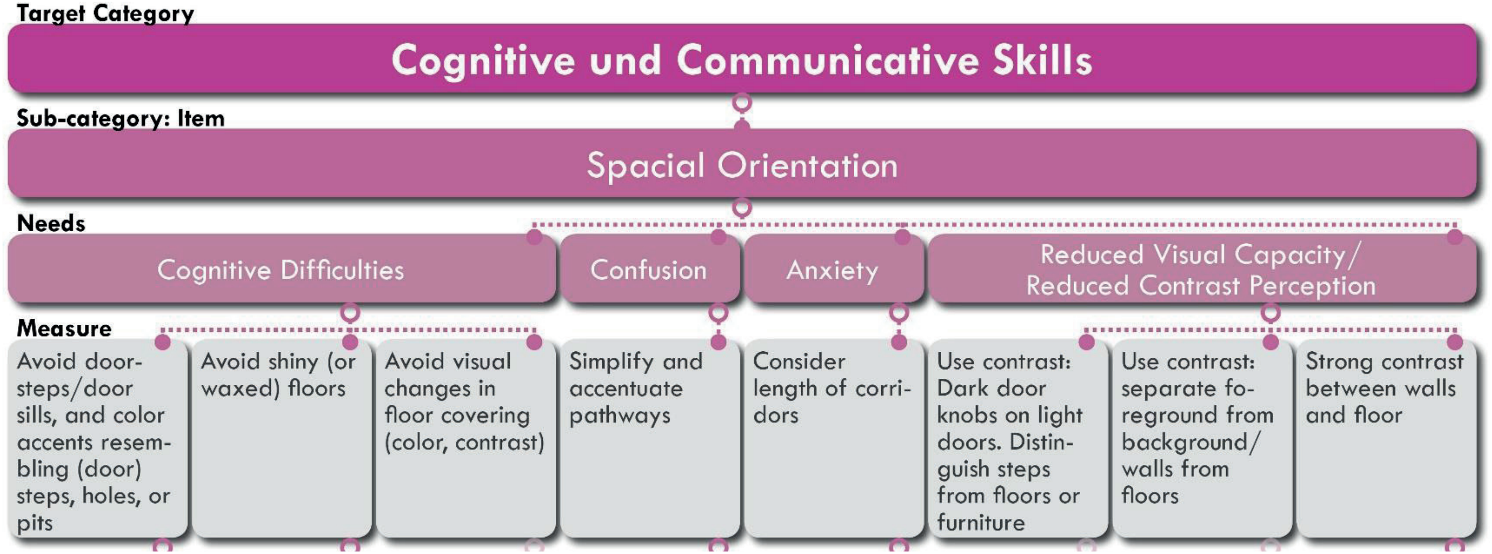

Fig. 6: Home improvement measures to help with spatial orientation

Results and structure of the analysis tool

Therefore the analysis tool is organized hierarchically (Fig. 5). The top level is made up of six target categories, according to the six previously identified areas of life and NBA-modules (1,2,3,4,6,8). On the second level, those items from the sub-categories of the NBA-module are collected which are relevant for structural interventions (e.g. movement inside the home). Below, on the third level are the needs arising from the signs and symptoms of dementia which are linked, on the fourth level, with measures to improve the domestic environment. In order to give consideration to the contextual conditions, the interventions are linked to the individual and environmental resources. On the lowest level of abstraction there are tables which assign all the interventions included to the respective needs and categories (see Fig. 6).

Each intervention for the improvement of the domestic environment aims to meet one – or possible several – specific needs and issues. Therefore, explanatory notes have been prepared for all home improvement interventions that are included. The following figure shows an example of the structure of these overviews. For each sub-category of the analysis tool, the specific needs of people with dementia, possible measures to meet the specific needs resulting from the issue and relevant explanations are included.

Discussion

The analysis tool is an aid to help with better decision making when planning home environmental interventions for people with dementia and shows the spectrum of opportunities to meet individual needs. Together with the consideration of personal and the environmental circumstances the tool can serve as a decision-making guideline for user-centred needs-based justice and appropriateness of building interventions.

The selection of building interventions is made by matching needs with interventions. The main precondition for the use of this analysis tool is to assess the specific situation and the individual abilities of people with dementia. The determination of individual needs – including both self-assessment and external assessment – will have to be made in future, too, by those concerned, people with dementia, their relatives and professionals. For people with dementia it is difficult to precisely communicate symptoms so that they are constantly on the risk of misinterpretation (Cacioppo et al., 1989). As a result interpretative skills are more important in the determination of the needs of people with dementia than those of people without cognitive and communicative impairments (Riesner, 2010). It is therefore a central condition that those interpretative skills are systematically acquired for the successful application of the tools and they will have to be further developed in future.

Due to the various influences that domestic interventions are subject to, it is difficult to narrow down cause-and-effect relationships, a problem that still exists when the analysis tool is applied. Whatever effects that occur after a home adjustment, cannot be attributed solely to the interventions. There is also the individual disease progression or social changes due to the interventions that can have an influence on the results. The analysis tool does, however, offer a frame for comparison of the effects of interventions in the home environment and a generalization of results might be possible.

Outlook

The complexity of the domestic environment can only be illustrated if personal and environmental requirements for the respective intervention are determined. By adding the environmental resources, the various influencing factors of the built environment can be narrowed down and examined. Linking the measures with the relevant necessary personal requirements is of relevance in terms of improving needs-based justice.

Moreover, the targeted observation of the correlation of dementia-specific needs and requirements for possible interventions allows an exact assessment of potential effects of home environmental interventions on the independence of people with dementia. In a further study the detailing of these requirements will follow.

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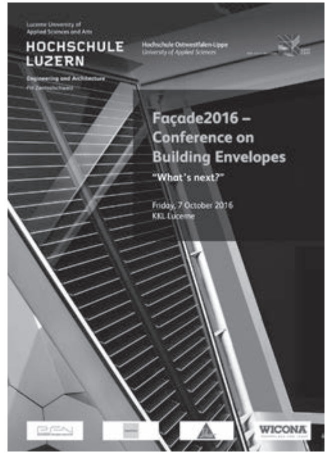
Acknowledgements and Previous Conferences

This publication and the conferences would not have been made possible without the concentrated and reliable support of our team members.

We like to thank them all for their trustful cooperation, in particular Janina Hoermann for coordination and finance.

Have a look to the previous publications:

facade2016	What's next?	Lucerne
facade2015	Computational Optimisation	Detmold
facade2014	Adaptive Building Envelope	Lucerne
facade2013	Design vs. Development	Detmold
facade2012	Challenge for engineers	Lucerne
facade2011	Super Green	Detmold
facade2010	refurbishment. hitech - lowtech	Lucerne
facade2009	facade technologies	Detmold
fassade2008	Innovations	Detmold
fassade2007	International Facades	Detmold
fassade2006	Rehabilitation and Renewal	Detmold
fassade2005	Energy - Material - Construction	Detmold



facade2016 - What's Next?

"What's next?" What developments in the area of façade engineering are expected in the next years? How do energy-efficient building envelopes work in the future? Will they be the adaptive high-tech component? Does the use of digital planning and manufacturing methods have an impact on the realization of our building envelopes? These questions and more will be part of interesting discussions at the international conference Façade2016. Renowned engineers and architects will introduce newest trends, developments and technologies related to the building envelope. The conference is conducted within the framework of the European Facade Network (EFN) and the European research project COST TU1403 "Adaptive Facades Network". The last conference at the KKL Lucerne in 2014 attracted some 200 engineers, architects and façade planners, who were treated to some highly relevant presentations and took part in lively discussions. After the presentations, we will meet for networking and refreshments on the Rooftop Terrace of the KKL.

facade2015 - Computational Optimisation

In the last few decades, information technology has brought about lasting changes to design and production processes. At the same time, our demands on design and building processes have increased in line with technical possibilities. Aside from unprecedented geometrical freedom, there is huge potential to optimize functions, energy and performance of constructions, buildings and services. Buzz words like Big Data, Industry 4.0 and The Internet of Things already point towards the next Digital Revolution. So what does this mean for building envelopes and their planning and building processes? How can an ever increasing network of information contribute to an optimization of today's designs and constructions? These issues was addressed at the conference facade2015 which was following the same sequence, as the main phases of building development: planning, construction and operation. The potential, chances and risks of progressive digitalization with respect to the the building envelope was at the center of conference discussions.

facade2014 - Adaptive Building Envelope

For the third time, the international conference "Fassade 2014" took place in Switzerland, organised by the Competence Center Facade and Metal Engineering of the Lucerne University of Applied Sciences and Art and the University Ostwestfalen-Lippe in Detmold (D) in cooperation with the Schweizerische Zentrale für Fenster und Fassade (SZFF).
Internationally renowned engineers and architects introduced newest trends, developments and technologies related to the building envelope.
This event themed "Adaptive Building Envelopes" was dedicated to a still relatively new technology. The conference was conducted within the framework of the European Facade Network (EFN) and the European research project COST TU1403 „Adaptive Facades Network". Scientists, engineers, architects and industry partners from more than 20 countries participated in the programme.

facade2013 - DESIGN VS. DEVELOPMENT

The 9th annual facade conference was held again at the Hochschule Ostwestfalen-Lippe in Detmold, Germany. With the title "Design vs. Development", the conference questioned where innovation comes from. This question is a very current discussion, challenging whether new developments are initiated by Designers and Planners or if it comes from the industrial partners, providing technical possibilities.
With industry support from MHB and Industrieverband Gitterroste, and run in conjunction with Hochschule Luzern, the conference negotiated this question between representatives of both sides.

http://www.hslu.ch/technik-architektur/t-forschung-entwicklung/t-forschung_entwicklung_bautechnik/t-forschung_entwicklung_fassaden_metallbau/t-facade2012.htm

facade2012 - Challenge for engineers

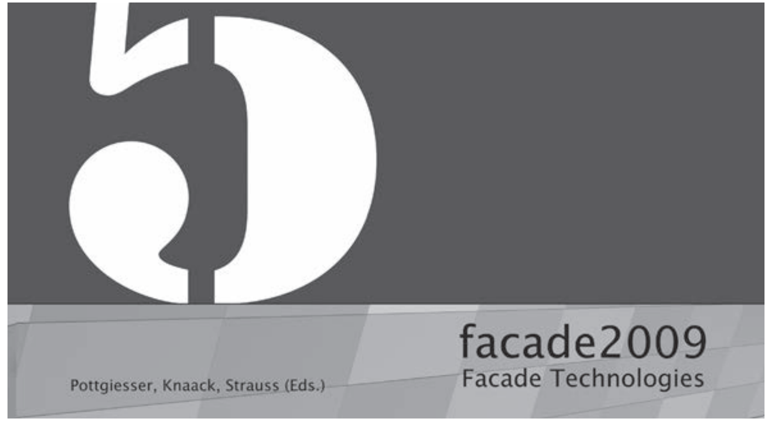
The conference "façade 2012" is the 8th edition of an international conference series. For the second time in its history, this year's event will be held in Switzerland. (...) The conference aims at providing participants with information on the latest trends, developments and technologies by inviting internationally renowned architects and engineers to present their thoughts and visions. The conference is a part of the European Facade Network (EFN). This year's contributions, which, inter alia, discuss topics such as solar-active facades, energy extraction and energy-efficient facades, the use of Building Information Modelling (BIM) in the building envelope as well as the realization of complex steel and glass facades reflect the spectrum of engineering and technical challenges around the building envelope. Part of the event will focus on a topic that is gaining importance in the future - Embodied Energy and sustainability in the design of building envelopes.

facade2011 - Super Green

The 7th conference on building envelopes at the University of Applied Sciences in Detmold, Germany - Hochschule OWL - dealt with the topic of sustainability and its related questions about evaluating and ranking buildings and facades. Building-owners and constructors have to develop a new awareness of the impact regarding our environment and society of tomorrow, when it comes to decision taking in the named context.Global warming is reality and scientifically proven. CO2 emission is one source for the ongoing change.
"Green Building" is booming in a big way, so are the different labels and perceptions of it in the different countries. How do architectural offices react on this, what does the industry contribute. The conference discussed on solid existing strategies, as well as the methods of approach of the participating parties involved in the building process.

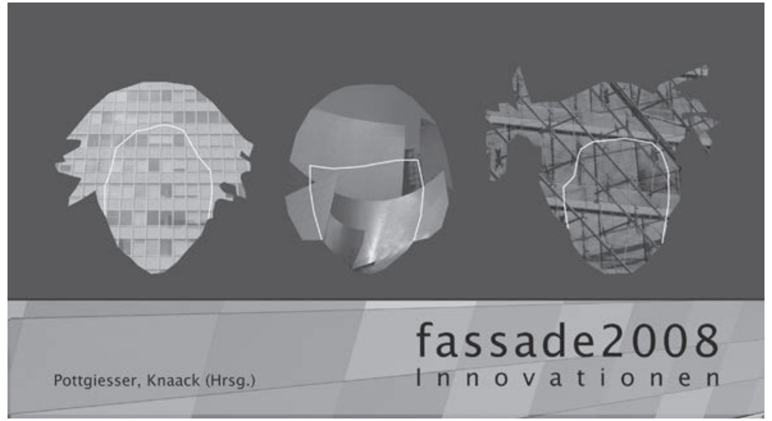
facade2010 - refurbishment hightech - lowtech

Contributing to the establishment of a European Competence Network Centre, the half-yearly Façade symposium is being held in Lucerne for the first time. It is being hosted by the School of Engineering and Architecture – which is part of Lucerne University of Applied Sciences and Arts (Lucerne UASA) – in association with the Swiss Centre for Window and Façade Construction (SZFF).
The symposium is exploring innovations in façade construction with the twin focus on new build and remediation.



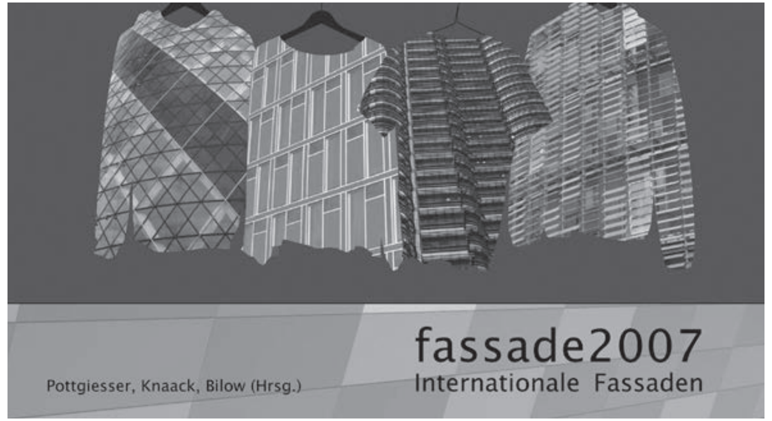
fassade2009 - Facade Technologies

The 5th symposium at Detmold School of Architecture and Interior Design – a department of Hochschule Ostwestfalen-Lippe, University of Applied Sciences in Detmold / Germany, deals with the technical construction of facades illustrated with case studies. Facades for offi ce and commercial purposes are often very specialised and custom-made solutions that differ from standardised products. Planner and executing companies are reporting about those individual solutions and how they are designed, starting with ideas and sketches and developing it with simulations and prototypes until an effi cient system is found. Creative, interdisciplinary and process-orientated operations are premises for optimised planning and production processes.
This conference volume also gives an overview about the research activities that take place at the University, especially within the research focus ConstructionLab.



fassade2008 - Innovations

The 4th symposium at Detmolder Schule für Architektur und Innenarchitektur - a department of the University of Applied Sciences in East Westphalia Lippe - is concerned with innovative technologies of building envelope.
On the technology side there is the use of synthetics, translucent composite materials and bonded joint. On the side of process there is the change of planning and building processes by new technologies like parametric design, simultation and logistic advancement. In line with impulse speeches there is an introduction on both sides - the technology and the planning one. Single papers take a step forward and deepen some exclusive topics.



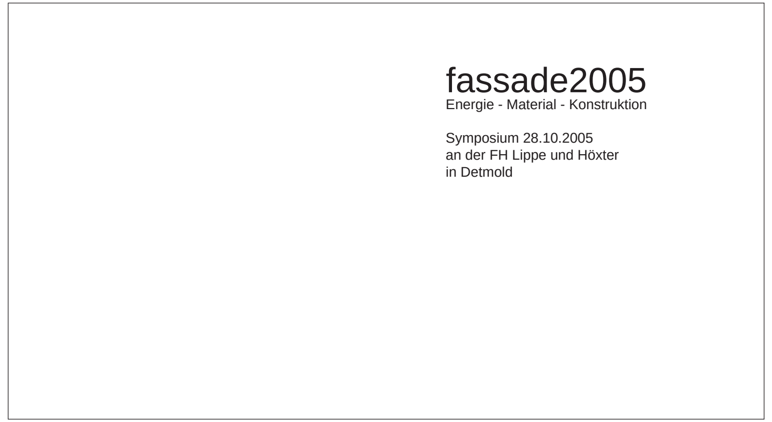
fassade2007 - International Facades

The symposium fassade2007 at Detmolder Schule für Architektur und Innenarchitektur of FH Lippe and Höxter is the third of it´s type and is concerned with facades in the international market. Thematically there should be a presentation and discussion about technically-constructive and climate requirements, the potential of german facades for export and the task of architects and some other experts on international projects. The Explanation of the dimension of cultural condition and tradition of the leading building techniques in regard of an new ecological reasonable building envelope is a big topic as well. Especially there is the question of assignability and adaptability of single facade solutions on the international context. The individual modification on the predominant climate or specific building techniques is a big challenge - also for local planners.

fassade2006 - Rehabilitation and Renewal

On October 20th 2006 the second conference facade2006 was held in Detmold. Representatives from various colleges provided results of current research approaches and projects. Other focal points of the conference were the comparative presentations of concepts and monument restoration and nursing experience. The lectures in the block redevelopment concepts put the issue from a planning perspective and set the conceptual approach to the foreground.

The holistic view of the problems in the facade renovation was clarified. In the field of facade and monument, posts from the practice both creative and constructive, as well as building physical aspects were included. The projects were presented in their historical and thematic context.



fassade2005 - Energy - Material - Construction

The first conference was held in FH Lippe und Hoexter in Detmold on 28th October 2005 with 150 participants. This event is understood as a prelude to a planned international master degree program with a focus on facade. It was also the first event in the context of continuing education for architects at the FH Lippe and Hoexter. The symposium was divided into the areas of research, innovation, energy, materials, and construction.

Editors

Michel Melenhorst (*1964) studied at Delft Technical University and the Politecnico di Milano. He worked as an architect for the offices of Wiel Arets (1991-1995) and Rem Koolhaas OMA (1995-1999) before starting his own office M in 1999. 2005 he became a partner in DAAD Architects till he made the switch in 2012 to Detmold Germany to hold the chair for Contextual Design, building transformation, re-use and cultural heritage at the OWL university of applied Science (HS OWL) since 2012. Michel Melenhorst is member of Docomomo international and is active in the Docomomo Deutschland workgroup education. At HS OWL he is coordinating the Master Architecture, is speaker for the research group Construction Lab and is a member of the Urban Lab. Until 2012 Michel Melenhorst was in the editorial Board of the web platform "the Netherland will change", a professional platform for knowledge exchange and a database with best practices on new and experimental developments in spatial planning and architecture. He has been lecturing in several countries and universities in Europe and in other continents.

Uta Pottgiesser (*1964) is Professor of Interior Architecture at the Faculty of Design Sciences of the University of Antwerp, Belgium, since 2017, teaching in the master program of interior architecture and is a member of the Henry van der Velde Research Group. From 2004-2017 she was Professor of Building Construction and Materials at OWL, University of Applied Sciences (HS OWL), Germany. She was trained as an architect at TU Berlin, Germany, and graduated in 1991. After her degree, she worked as a practicing architect, for office, administration and public buildings. Her academic career started as research assistant at TU Dresden where she obtained her PhD in 2002 with the topic "Multi-layered Glass Constructions. Energy and Construction". She is internationally active as a board member and reviewer of international journals, in PhD commissions and organiser of several conferences and seminars. As Chair of the DOCOMOMO International Scientific Committee of Technology (ISC-T) she is concerned with the protection and adaptive reuse of Modern Movement Architecture. She is a co-founder of the European Facade Network (efn).

Christine Naumann (*1982) studied Interior Architecture and Architecture at OWL, University of Applied Sciences (HS OWL) in Detmold and finished in 2008. After her studies she was coordinating the DAAD-Project „Climate Related Energy Efficient Design (CREED)" as a Research Assistant in 2009. From 2010-2011 she worked as architect in South Africa and from 2012-2015 again as research assistant for the EFRE-project „Kitchen Miles and More" at the department "Produktion und Wirtschaft" at HS OWL. Since 2015 she has been supporting the chair "Baukonstruktion und Baustoffe" and since 2016 she is coordinator of the research focus „ConstructionLab". In 2017 she obtained her professional master in the field of „Multiprofessionelle Versorgung von Menschen mit Demenz und chronischen Einschränkungen (M.A.)" at the University Witten-Herdecke at the department "Pflegewissenschaft".

Theresa Kellner (*1984) is scientific and teaching assistant at the Detmold School of Architecture and Interior Architecture, a department of OWL University of Applied Sciences (UAS OWL) since 2014. She is an Interior Architect and Social Pedagogic, who studied at the UAS OWL, Germany, at the University of Florida, USA and at the Otto-Friedrich-University in Bamberg, Germany. She holds a Master Degree in Interior Architecture and a Diploma in Social Pedagogy. Since 2014 she is working as a research assistant at the International Office and the Department 1 of UAS OWL and is managing several international third-party funds projects together with various partner universities.
Her interests are on topics such as perception and space, the phenomenology of architecture, participative architecture, modern movement and heritage.