imagine 06

REIMAGINING THE ENVELOPE

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imagine 06 –
REIMAGINING THE ENVELOPE

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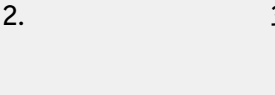

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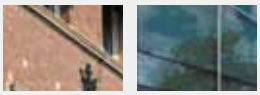

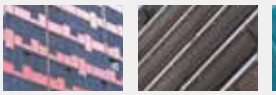

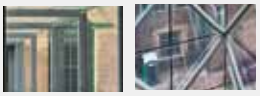

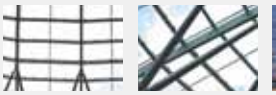

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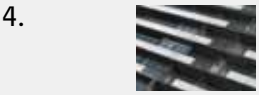

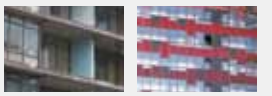

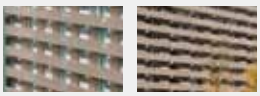

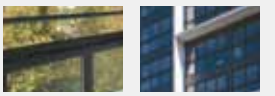

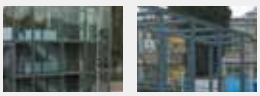

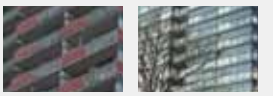

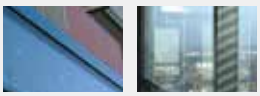

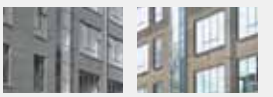

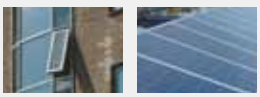

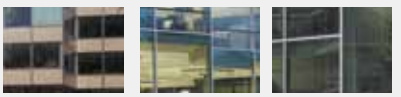

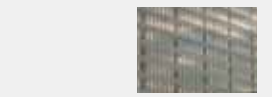

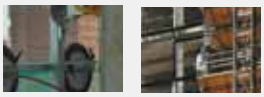

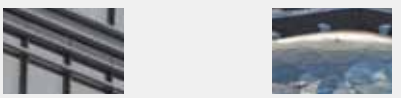

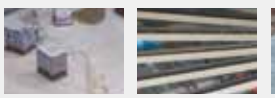

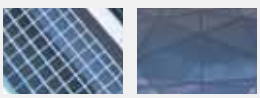

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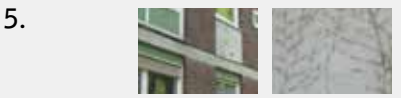

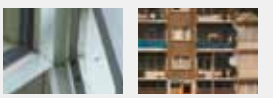

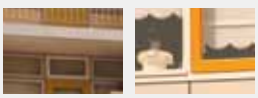

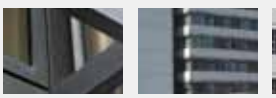

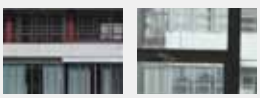

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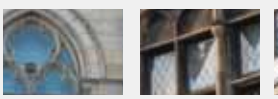

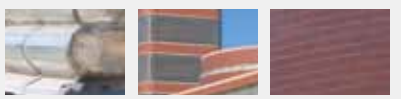

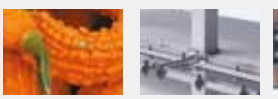

CONTENTS

1. INTRODUCTION

An architect's nightmare: The building has existed for ages, the interior has just been remodeled, an incredible amount of money has been spent to complete it on a – well – acceptable quality level; and now the client asks: "What about the façade? Can we renew that as well? But please don't change too much and do not touch… and please, please do not make any noise while working… and of course, do not spend a lot of money…" And the fact is that the building never looked very good in the first place; it is actually one of the lesser examples of its time and was not treated well over the past years. To summarize: There are many similar stories of unloved real estate and little to no budget to work some magic. How can we design something good under such conditions; how can we create a well rounded story when reinventing a building in its current location and function?

This volume of the imagine book series focuses on the building envelope, specifically the reuse of buildings and their envelope: There are many buildings that have an aesthetic, societal and built environmental value which needs to be recognized and transferred into up-to-date conditions. There are two main reasons to tackle such challenges; on the one hand the pure fact that someone asks us to (if we will not do the job, who will and how?), and on the other hand the potential of existing buildings for future functionalities, uses and users. And this is where the concept of the imagine book series and this volume in particular come into play: To inspire, to identify potential and opportunities, and to not hesitate to strive for unusual, maybe strange and unexpected solutions.

Of course, this has to be placed into a scientific context and backed by experience from architectural and construction practice: The scientific link is the TU Delft / Faculty of Architecture, in which the chair Design of Construction runs the Façade Research Group. As part of the Group's activities, various research activities in the field of the building envelope are conducted – with some of the main topics being the reuse of the building envelope in the field of utility buildings (PhD Thiemo Ebbert), the building envelope of multi-unit housing (PhD Thaleia Konstantinou), and the embodied energy of building envelopes (PhD Linda Hildebrand). In addition, the Dutch façade builder association VMRG (Vereniging Metalen Ramen en Gevelbranche) links companies from the façade industry with the research grant "Innovatie Prestatie Contracten 2009 – 2012 / Refurbishment" to these topics and organized an interest group with the companies De Groot & Visser, BRS, Hermeta Gevelbouw, Solarlux NL

and Kremers Aluminium. The program itself was called “Living Façades for New Construction: R&D for green, sustainable building façades and façade systems in the field of refurbishment”. After intense interaction of science and practice it supplied a collection of principal requests, strategies (replace, add on, wrap it, cover it) and best practice exsamples by the companies. Besides documenting the environmental and constructional background and the results of this interaction, the ‘imagine’ potentials and ideas complete the storyline of this book.

If refurbishment is understood as an acknowledged issue amongst stake-holders and the building industry on a national and international level and that we need to consider upgrading the aging building stock due to the huge potentials for energy savings and its economic and social relevancy, we need to face all technical problems, operational costs and internal conditions to result in the most favorable living and working conditions possible, as well as increased property value. This requires a sense of excitement for the process itself and the result! The purpose of this book is to demonstrate that refurbishment measures are not only necessary actions to deal with the problems of aging buildings, but that they can also be attractive solutions for owners, users and architects. The goal is to stimulate and inspire all the parties involved by presenting successful solutions and innovative ideas.

Be inspired!

One of the many workshop and discussion rounds

2. BACKGROUND AND CONTEXT

REFURBISHMENT IS SUSTAINABLE

Our Common Future reported on many global realities and recommended urgent action on eight key issues to ensure that development was sustainable. One of those key issues addressed by the World Commission on Environment and Development (WCED) is energy[1]. The importance of the use of energy is largely connected to the depletion of fossil fuels and climate change.

Fossil fuels energy, meaning the energy produced by oil, gas or coal, is dominating the energy supply worldwide and is expected to retain its importance over the next 20 years. As the economies power ahead on fossil fuels, the specter of diminishing reserves heightens anxieties. Moreover, the demand for fossil fuels is above the underlying growth of the rate of supply. Nevertheless, problems with fossil based energy supply and use are related to environmental issues such as air pollution, acid precipitation, ozone depletion, and, of course, climate change.

'Climate change' encompasses the wide variety of accompanying impacts on temperature, weather patterns and other natural systems. The list of evidence that the climate is changing is long; from an increase in average surface temperatures, the sea level rising, melting of glacier ice etc. The fundamentals of climate change involve the same basic physics that keeps the earth habitable. It is related to the 'greenhouse gases' in the atmosphere, the two most important of which are water vapor and CO_2. The production of energy through the burning of fossil fuels and long-term deforestation has been increasing the concentration of CO_2 and other greenhouse gases in the atmosphere since the industrial revolution began; thickening the greenhouse blanket and inducing an enhanced greenhouse effect. Most scientists agree that there is a cause-effect relationship between the observed emissions of greenhouse gases and global warming[2]. In June 1990, the journal "Nature" supported this strong relation between the energy used and the climate change conclusion. It demonstrated a remarkably close correlation between temperature and concentrations of CO_2 in the atmosphere from 160,000 years ago until 1989. It also revealed that present concentrations of CO_2 are higher than at any time over that period.

The issue of climate change has been addressed since the 1980's. Following scientific consensus, governments established the Intergovernmental Panel on Climate Change (IPCC) to help them understand and build some international awareness on the nature of the problem. The fourth assessment report from the IPCC confirmed that climate change exists and is predicted to continue; the emission of greenhouse gases from human activities, such as the burning of coal, oil and gas is causing an overall warming of the earth's atmosphere, and climate change is the most likely result with potentially major economic and social consequences. The IPCC also defined the context and principles upon which governments subsequently negotiated the 1997 Kyoto Protocol. The Kyoto Protocol to the UN Framework Convention on Climate Change (UN FCCC) represents a top trend towards globalization in economic and environmental policy and sets the underpinning elements of global efforts to tackle climate change in the twenty-first century. Six man-made (anthropogenic) greenhouse gases have been defined: carbon dioxide (CO_2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbon

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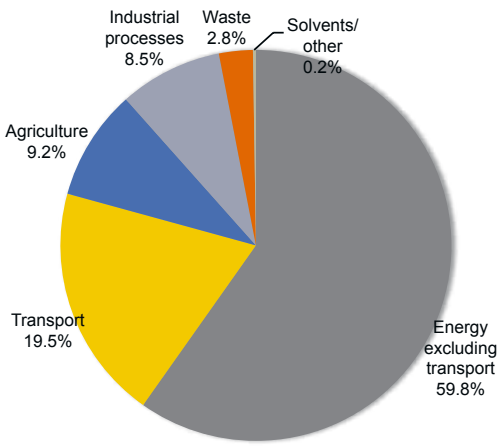

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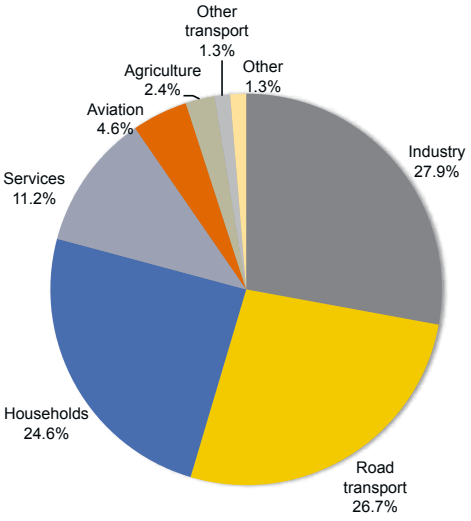

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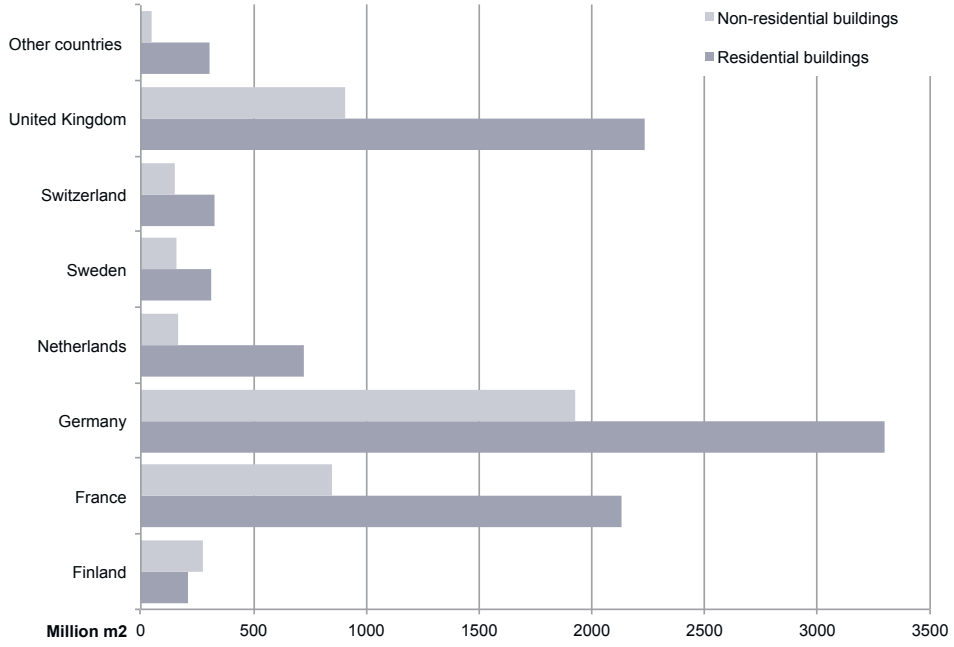

1 Greenhouse gas emissions by sector, EU-27, 2007
2 Final energy consumption, EU-27, 2006
3 Residential and non-residential floor areas per country

(HFC), perfluorocarbon (PFC) and sulphur hexafluoride (SF6); together, these six greenhouse gases form what is known as the Kyoto basket of greenhouse gases. In order to allow the global warming potential of each of the gases to be compared, the information presented has been converted to CO_2 equivalents[3]. In practice the protocol imposes a 5% global cut in CO_2 emissions based on the 1990 levels, to come into action in 2008/2012. Yet, the UN IPCC scientists stated that a 60% cut world-wide would be necessary to halt global warming.

THE NEED TO REDUCE ENERGY DEMAND AND THE BUILDING SECTOR

Statistics confirm that energy use is the main factor responsible for greenhouse gases (GHG)[8] and hence climate change. Energy use produces 59.8% of GHG, followed by transport (19.5%), agriculture (9.2%), industrial processes (8.5%) and waste (2.8%). Consequently, reducing the use of energy can make a considerable contribution to the alleviation of the climate change and compliance with the Kyoto Protocol and EU targets.

Under the Kyoto Protocol, the European Community has agreed to an 8% reduction in its greenhouse gas emissions by 2008 – 2012, compared to a base year which is generally defined as the year 1990. In addition to the Kyoto Protocol, in January 2007 the European Commission adopted a proposal for an energy policy for Europe, with the goal to combat climate change and boost the EU's energy security and competitiveness. Based on the European Commission's proposal, in March 2007 the Council endorsed targets such as reducing greenhouse gas emissions by at least 20% (compared to 1990 levels) rising to 30%, increasing the share of renewable energy to 20% and making a 20% improvement in energy efficiency. The European Parliament has continuously supported these goals. The European Council has also made a long term commitment to decarbonization with a target for the EU and other industrialized countries of 80 to 95% cuts in emissions by 2050.

In March 2011, the European Commission issued a roadmap to a 2050 target. In the roadmap, the building sector (residential and services) is explicitly mentioned as a key sector. The expected reduction will reach 53% by 2030 and 88 – 91% by 2050. This reduction is larger than that in other sectors such as transport, agriculture, and industry; indicating the importance of the building sector and the urgency of the measures to be taken. In order to achieve this significant reduction, new buildings should be low or zero-energy buildings [Directive 2010/31/EU12]. The refurbishment of the existing building stock, however, poses an even greater challenge. The analysis predicts that investments in energy-saving building components and equipment will need to be increased by up to € 200 billion over the next decade.

The reason why the importance of the building sector has been recognized and addressed by legislative parties is that the building sector (residential and service buildings) is the biggest energy user. It accounts for 35.8% of final energy consumption in the EU; more than the industry (27.9%) and road transport (26.7%). Thus, there is an urgent need to reduce the energy demand of the building sector. The issue has also been addressed by national and international legislative parties and institutions. The International Energy Agency (IEA) has identified the building sector as one of the most cost-effective sectors for reducing energy consumption, with estimated potential energy savings of 1,509 million tons of oil

equivalent (Mtoe) by 2050. Moreover, by reducing overall energy demand, improving energy efficiency in buildings can significantly reduce carbon dioxide (CO_2) emissions from the building sector, translating to possible mitigation of 12.6 giga tons (Gt) of CO_2 emissions by 2050[4].

The recognition of the building sector's importance has led to mandatory and/or voluntary energy performance certificates. In Europe, the European Directive on the Energy Performance of Buildings (EPBD) was adopted in 2002 and required to be implemented into members' national laws by January 2006. The EPBD requires that an energy performance certificate is made available when buildings are constructed, sold or rented out. The certificate has to express the energy performance (EP) of the building. In general, the objective of the EPBD is to 'promote the improvement of the energy performance of buildings within the community taking into account outdoor climatic and local conditions, as well as indoor climate requirements and cost-effectiveness'. As far as the renovation policies are concerned, apart from the EPBD, there is a major EU influence on housing policy through the EU Construction Products Directive and indirectly through the Air Quality Directive and the Energy End-Use Efficiency and Energy Services Directive.

The real challenge for an effective implementation of the Energy Performance Building Directive (EPBD) is to properly refurbish existing buildings in a manner that will use minimum amounts of non-renewable energy, produce minimum air pollution as a result of the building operating systems, and minimize construction waste; all within acceptable investment and operating costs, while improving the indoor environment in terms of comfort, health and safety. An increase of building energy performance can constitute an important instrument in the efforts to alleviate the EU energy import dependency (currently at about 48%), comply with the Kyoto Protocol to reduce carbon dioxide emissions, and reach national and international targets.

REFURBISHMENT

The existing building stock has drawn some attention to change policies over the last few decades. Nonetheless, it is safe to say that the issues arising from existing buildings have not received the attention they deserve. The existing building stock exceeds the number of newly built dwellings by far. While new buildings add a maximum of 1% per year to the existing stock, the other 99% of buildings are already built and produce about 26% of all carbon emissions[5].

Therefore, our attention should focus intensely on existing buildings. It is obvious that far more energy conservation and other sustainable benefits can be achieved in the existing building stock than in new developments. Over the last five to ten years this awareness has widely spread under many stakeholders involved.

The issue of refurbishment is complex, encompassing a number of parameters such as the architectural design and construction, energy efficiency along with political support and incentives, socio-financial effects, and user behavior amongst others. In the discussion about what makes refurbishment sustainable, social, ecologic and economical aspects play an important role. These are the three major perspectives encompassed by the sustainable development triangle, a concept adopted by the 1992 Earth Summit in Rio de Janeiro. All three aspects influence each other.

4

Building immanent factors	Urban design	Desired improvement of the urban quality
		Preventing vacancy as cause of social problems in a neighbourhood
	Architectural design	Outdated appearance
		Exterior impression bad for the reputation of the user/owner
		Decay of a valuable architectural heritage
	Function	Transformation of the building
		Change / Optimisation of the office concept
	User comfort	Unpleasant indoor condition
		Hygienic problems
		Sick building syndrome (SBS)
		Building related illness (BRI)
	Technical installations	High operational energy demand
	Hazardous material	Asbestos
		PCB (Polychlorinated biphenyls)
		PAK
		MMMF (machine-made mineral fibres)
	Building physics	Lack of insulation
		Water leak
		Wind leaks / draft
		Planning for climate change
		Fire protection deficiencies
	Building owner / user	Tenant considers relocation
		Owner user initiates renovation
Legal	Fire regulation	Compulsory fire safety improvements
	Safety	Danger of damage to third party
	Energy consumption	Compulsory energy consumption certificate
Economy	Operational costs	High energy demand
		High maintenance cost
	Renting	Bring an empty building back to the market
		Tenant considers relocation
	Marketing	Users' representation need
	Financial market	Institutional investors are bound to invest

4 Motivations for reconsidering an existing building[7]

ECONOMIC ipv
ECOLOGICAL
???

ECOLOGICAL RELEVANCE

Since the connection between sustainability, energy use and the building sector has been established, it is understandable that an upgraded, energy efficient building stock is important from an ecological point of view. Studies have identified the potential for refurbishment to upgrade the energy efficiency of the building stock. They have also concluded that, from an ecological and economic point of view, thorough renovation is typically to be preferred over superficial renovations that carry the risk of missing the climate targets and leaving potentially huge absolute savings untapped.

The importance of addressing the existing stock is mainly due to the fact that the renewal rate of the building stock is very slow. It is estimated that only 1% building stock is added each year, which means that over a period of 10 years only 10% of the stock will meet at least the current level of building regulations for newly built dwellings. On the other hand, the condition of the existing stock is problematic, as it was built under far lower energy and sustainability standards (and with the use of poorer materials) at the time of construction. However, regarding materials and waste, studies show that the environmental impact of life cycle extension of a building is definitely less than demolition and new construction. The energy consumed during the production and transport of materials, the so-called embodied energy, is stored in the construction itself and demolition means throwing this energy away. Consequently, refurbishment is the answer to upgrade the condition and efficiency of the aging building stock and, hence, reduce the energy demand of the building sector, resulting in the relevant environmental benefits.

ECOLOGICAL RELEVANCE

Along with embodied energy, buildings are also stored capital; money bound in raw materials. While façades and technical installations may reach the end of their technical life span at the age of 30 years, the load-bearing structure can last for a century or more. Thus, demolition would not only be a waste of energy but also a waste of invested capital.

The operational cost of a building is strongly related to its energy consumption. Energy prices have risen by more than 40% over the past 10 years, which directly leads to higher operational costs. As a result, increased energy bills are a current issue. Research has shown that tenants would accept higher rental rates, if the operational costs were lower. Real estate developers express the economic refurbishment target: Total rent including utilities has to remain at the same level, but the share of the base rent must be higher. Therefore, refurbishment has a direct economic effect, by improving the energy efficiency and reducing the energy consumption of a building.

SOCIAL RELEVANCE

When buildings today are in need of refurbishment, the task is to keep history alive and preserve its value for society. In practice this means that each project has to be evaluated according to its unique qualities and potentials. Refurbishment can then fulfill two important tasks. On the one hand, it preserves the design qualities and socio-cultural values of a building, a street atmosphere, or a neighborhood. On the other hand, based on experiences with architectural ideals and urban concepts, today's planners are able to revise older concepts and repair 'mistakes' made by previous generations. For example, poorly designed urban neighborhoods with vacancies that often occur when buildings do not fulfill current

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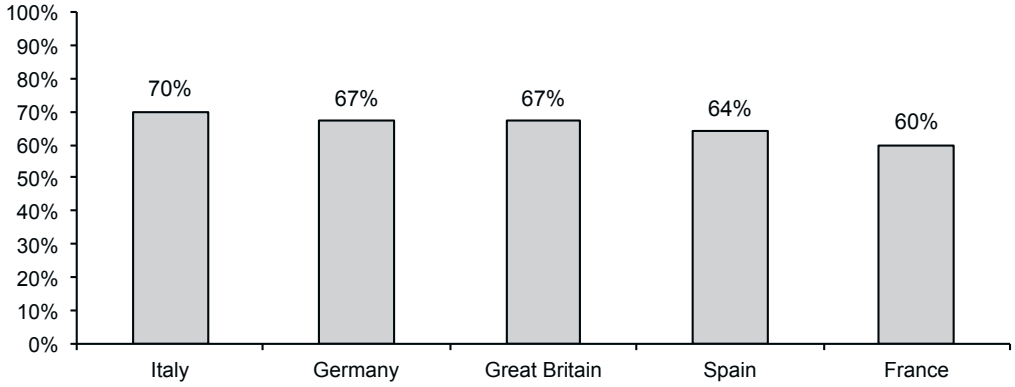

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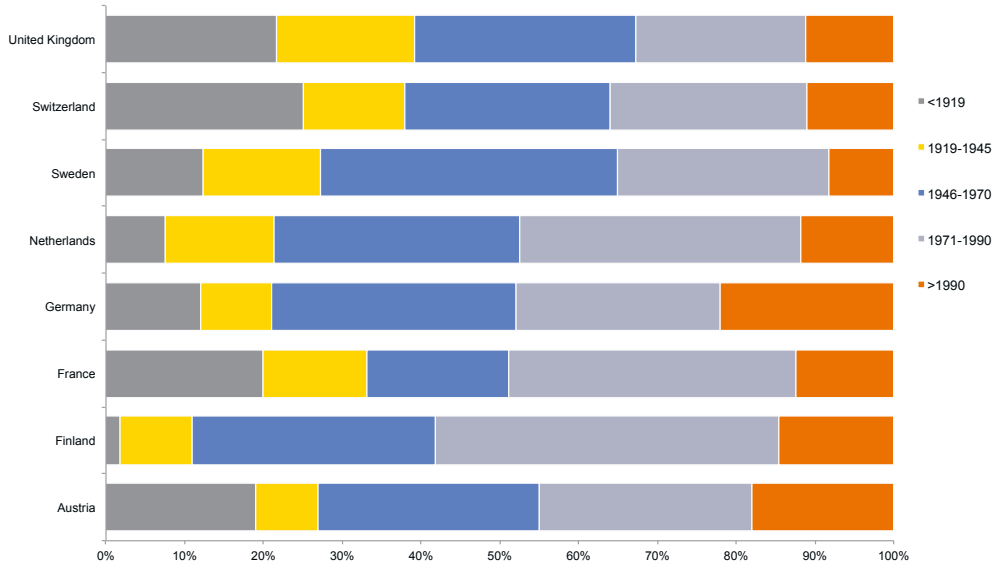

5 Percentage of non-residential buildings built before 1978
6 Age distribution of the residential building stock

demands and misuse of properties lead to vandalism, social problems and therefore lack of acceptance by neighbors. Furthermore, technical decay is connected to social decay[6]. Groups of users with socio-economic strength leave the buildings or even neighborhoods and are replaced by weaker groups. This mechanism often results in high turnover, vacancies, lack of control and generally "unfavorable" living or working conditions. Refurbishment can reverse such problematic social environments, as buildings meet today's demands and provide a functional and attractive contribution to society.

THE BUILDING STOCK

In every refurbishment project, the first step always is to examine and analyze the existing building. In order to be able to propose successful solutions and respond appropriately to the refurbishment needs, we must be familiar with or at least understand the typical forms of construction of the past years. The objective is not to document the complete history of each building, but to gather relevant information about its original construction, current condition and future prospects. Hence, we should look at the building stock at three levels: past, present, future. For this purpose of our discussion on refurbishment, we will try to give an overview of the building stock and identify the decisive factors.

The building stock consists of a variety of building types such as offices, commercial buildings, schools, hospitals, apartment buildings, terraced or detached houses etc. The different building types share certain similarities in the parameters that affect the refurbishment strategies. However, groups with considerable differences in terms of size, constructional features, function, decision making and market processes etc. can be identified and, thus, they need to be addressed separately. There are two general categories that the building stock can be divided into; residential (houses and apartments) and non-residential.

According to the 'Europarc-Survey', which estimates the building stock in the five largest Western European Countries – Germany, France, Italy, Spain and Great Britain – the total stock excluding agricultural constructions in the five countries mentioned above adds up to 16 to 17 billion m^2 net occupiable floor area. The general relation between residential/ non-residential is 70/30[7].

To investigate the possibilities of refurbishment, it is essential to understand the parameters that formulate the refurbishment scenario. The construction period and the market are regarded as the most important parameters. Data on the age of the building stock give a good indication of the physical characteristics of buildings. Depending on the different construction date, each building exhibits typical characteristics and shortcomings according to the material used, the requirements and regulations, the design and the construction techniques applied during that specific period. The market, on the other hand, in terms of ownership and tenure status, is particularly significant with regards to renovation, as it determines the decision making and the profit of the investment.

THE NON-RESIDENTIAL BUILDING STOCK

Research has shown that reliable data on the non-residential building stock in Europe, both on construction period and on construction type, is very scarce. The treatment of statistical data differs from country to country. Some countries, like Switzerland and Sweden, keep up-to-date statistics. Other countries (Italy, Spain)

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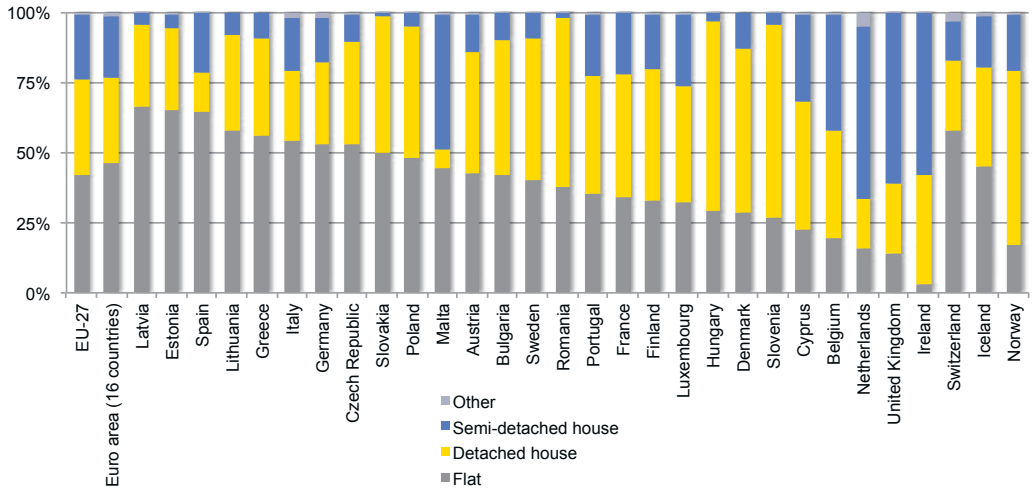

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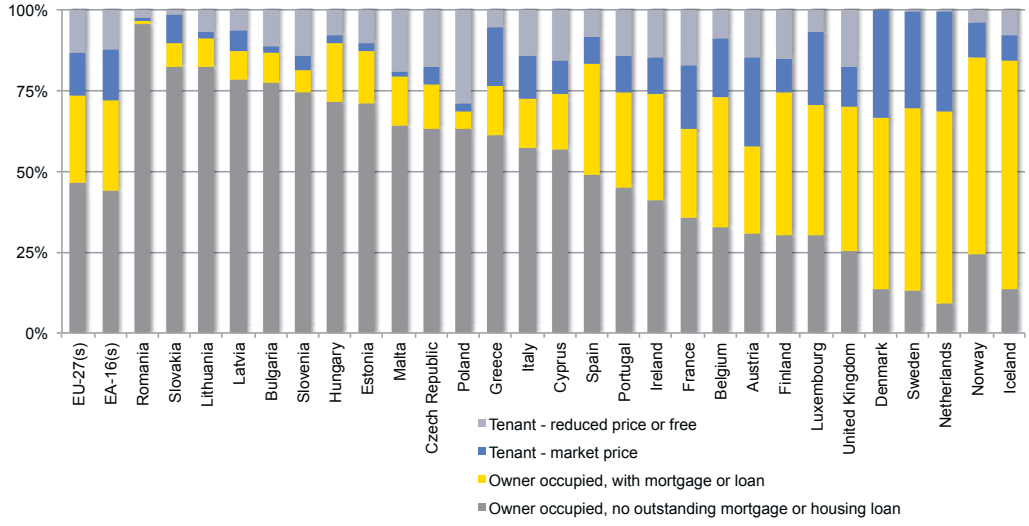

7 Households broken down by type of dwelling in the EU 2009
8 Households broken down by type of tenure in the EU 2009

supply old statistics that have been discontinued. Yet others (Germany) have only recently started to keep track of the building process in the field of non-residential buildings. The most important source of data can be found in the 'Europarc-Survey'. Results of this study were published by the IFO institute[8]. According to this publication, the term 'non-residential building' covers all buildings of non-residential use and excludes agricultural buildings. Therefore it includes buildings for education, health-care, trade and production. The Europarc-Survey further divides the European building stock into two age groups: 'Built before 01.01.1978', and 'Built between 01.01.1978 and 01.01.1998'. In 1998, two thirds of the office stock was older than 20 years. Italy, Germany, and the UK hold a larger share of old buildings than France and Spain, where the building boom started later than in the other countries.

TENURE AND VACANCY

The non-residential building stock consists of diverse building types and, thus, different ownership statuses can be found. With regards to office buildings, renting became the most common form of ownership, to allow flexibility and easy relocation[7]. Governmental and educational building and special market sections are mostly owner-occupied.

The European office market experienced significant growth from 2005 to 2007. In 2008, an economic crisis hit the real estate market. There was the steep increase in office take up in Europe until mid-2007 and the drop in demand during the past year. Real-estate companies expect a revision of rental rates in the coming months. Rents are expected to fall in the future. The drop in demand is owed to collapses of companies and a decrease in employment. Companies wanting to rent offices can demand lower rental rates for their desired quality of space. This will lead to higher vacancies in less popular locations and a redirection towards the best locations. This fluctuation creates a bigger demand for high-quality and easily adaptable office space. A term often used in relation to high quality office space is 'grade A'. For the Netherlands, for example, it is expected that unless an office building is rated 'grade A", it will not be lettable.

Vacancy is one of the major issues in the non-residential market. According to the Dutch ministry of 'Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer' (VROM), 6.7 million square meters of office space was vacant in May 2010 in the Netherlands[9], which exceeds 14% of the total available office floor space. In a healthy financial market this amount should be around 5%. In Germany, the total stock of vacant office space decreased in 2006 and 2007, the vacant stock of un-refurbished space increased in 2006 by 11% and in 2007 by another 10%. This shows that only up-to-date space is lettable, while un-refurbished space threatens to become structurally vacant[23]. The job of the investors is to keep their property on the market by upgrading, renovating or refurbishing it.

THE RESIDENTIAL BUILDING STOCK

The residential building stock represents almost 70% of the building floor area. Moreover, the residential building stock energy demand accounts for 1/4 of the energy demand in Europe. Therefore, the condition it is in and the impact it has are extremely important. The following figure shows the breakdown of the residential building stock into the different construction periods in different European countries.

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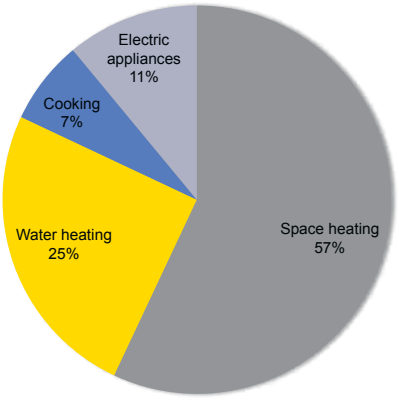

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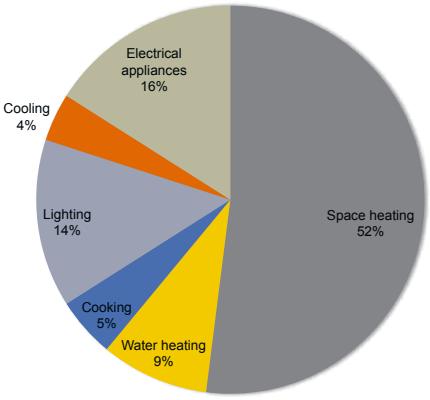

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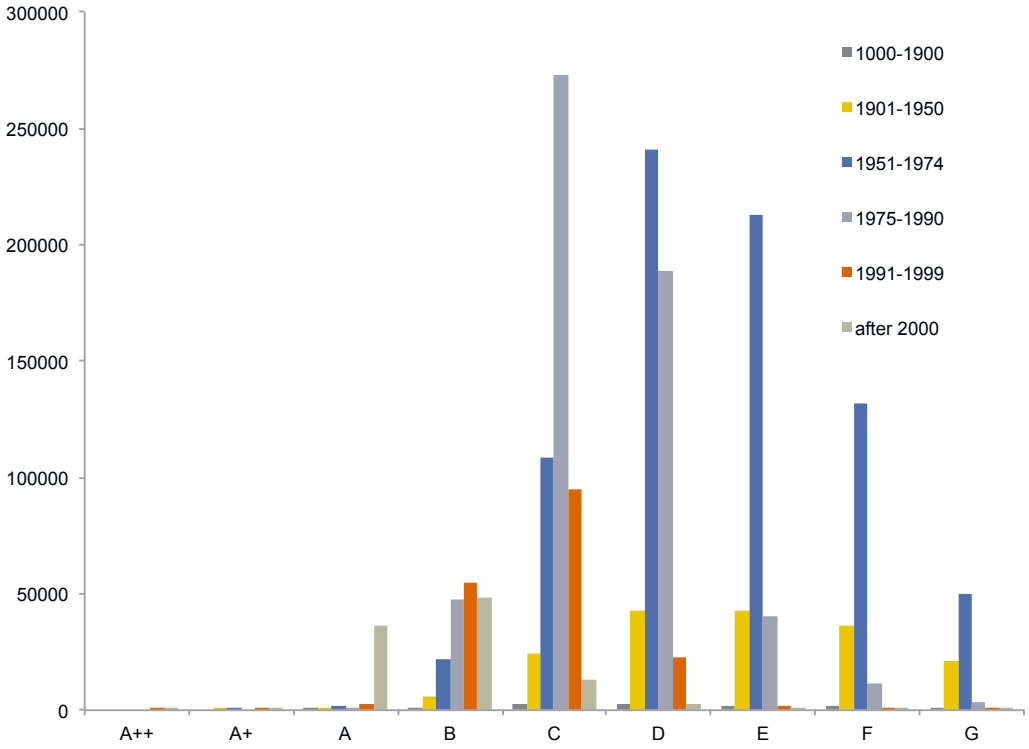

9 Final energy consumption in residential buildings in EU countries: breakdown in end-use
10 Final energy consumption in non-residential buildings in EU countries: breakdown in end-use
11 Energy labels for housing in the Netherlands in 2010

The pre-war residential building stock accounts for 20% to 39% of the total residential building stock in general; the pre-war building stock is reasonably homogenous in terms of construction characteristics. Dwellings built after World War II and before the oil crisis account on average for 29%. This particular part of the stock, which represents almost one third of the total stock, is not very homogenous. A varied mix of construction types exists, from traditional to modern, from low-rise to high-rise. A common characteristic, however, is that the buildings were generally poorly insulated at the time of construction and that there is a need for renovation. In most countries, the dwellings built between 1970 and 1990 account for 21% to 27% of the total stock. In general, the dwellings built during this period are reasonably well insulated, but already need some degree of renovation, particularly the older ones. The percentage of newly built dwellings (since 1990) appears to be almost 14% on average, varying between 8% and 22%.

In 2009, 41.8% of the EU population lived in apartments, 34.4% in detached houses and 23.0% in semi-detached houses. The share of persons living in apartments was highest in Latvia (66.2%), Estonia (65.1%) and Spain (64.6%). The share of people living in detached houses was largest in Slovenia (68.7%), Hungary (67.6%), Romania (60.7%) and Denmark (58.4%). Norway also reported a high share (62.4%) of those living in detached houses. The highest propensity to live in semi-detached houses was reported in the Netherlands (61.4%), the United Kingdom (60.9%) and Ireland (57.6%).

In terms of ownership status, the residential building stock is divided into three main categories: owner-occupied, social rented (reduced price), and private rented (market price). Roughly stated, the owner-occupied and the rented sector share a similar part of the residential market, even though it may vary in the different countries.

At least half of the population lived in owner-occupied dwellings in 2009 across all of the EU member states; the figures ranged from 57.5% in Austria to 96.5% in Romania. The share of persons living in rented dwellings at market price rental rates in 2009 was less than 10% in 12 of the EU member states, as well as in Iceland. In Denmark, the Netherlands, Sweden and Austria more than one quarter of the population lived in rented dwellings at market price rental rates. The share of the population living in a dwelling with a reduced price rent or occupying a dwelling free of charge was less than 20% in all of the member states except for Poland where this share reached 29.1%.

Because the owner-occupied and the rented sector share parts of the market, they are both important in the achievement of sustainable renovation. In the owner-occupied market, the investor is also the one who profits from the investment. However, there is often a lack of financial means to invest. On the other hand, in the rented sector there is a conflict of interests. A major characteristic is that the owner has to invest, whereas the occupant profits from the investment. In the private rented sector, this may be solved by increasing the rent, insofar as it is desirable and possible within the existing regulations. In the social rented sector, this would be more difficult, therefore specific financial solutions and regulations will be necessary.

ENERGY EFFICIENCY

The existing buildings stock in European countries accounts for about 40% of final energy consumption in the European Union member states, of which residential

use represents the two thirds of the total energy consumption in the buildings sector.

More than half of the final energy consumption of residential and non-residential buildings in the EU is used for space heating. In residential buildings, water heating also plays a major role. Final energy consumption in the household sector grows at a rate of 1.1% per year. This increase in consumption is mainly due to the increased use of specific appliances (household appliances, air conditioning, heating, etc.) and higher standards of living in the EU. Improvements in energy efficiency per square meter and per appliance appear to have been offset by larger average sizes of dwellings and an increase in the average number of household appliances.

In non-domestic buildings, the type of use and activity makes a huge impact on the quality and quantity of energy services needed. Across Europe, energy consumption in the commercial sector grows at a higher rate than other sectors, predominantly due to the expansion of HVAC systems in new buildings. Office and retail are the most energy intensive typologies; typically accounting for over 50% of the total energy consumption for non-domestic buildings. Hotels and restaurants, hospitals and schools follow.

About 70% of the existing buildings are over 30 years old, and about 35% are more than 50 years old. This is an important observation given that most national building regulations that mandate thermal insulation of building envelopes were introduced after the 1970s following the energy crisis. The energy efficiency of buildings has improved over the last decade, but there is still a very long way to go. When considering glazing only, a recent study by the independent institute TNO shows that over 85% of glazed areas in Europe's buildings are made of inefficient products while advanced double and triple glazing with six to eight times higher energy efficiency does exist[10]. In 2006, over two-thirds of the UK homes (70%) had an energy performance rating of band D or E according to the Energy Performance Certificate (EPC) bands. Less than 10% of homes achieve a rating of band C or higher, while 20% lie within the most inefficient bands F and G. Similarly in the Netherlands, the vast majority of dwellings built in the post-war period have label D or lower.

With regards to non-residential buildings in the Netherlands, more diverse energy labels are documented. Still, the data confirms that the aging buildings stock is performing badly. Namely, the 44% of Dutch non-residential building built before 1975 have a label G[11].

CONCLUSION

In the context of sustainable development and the need to reduce energy demand, refurbishment of the existing, aging building stock is an acknowledged issue. Climate change due to the emission of greenhouse gases (GHG) from human activities is a major issue that needs to be addressed. The building sector has an important role to play as it is responsible for about 40% of the energy consumed, which is the main producer of GHG, as 60% of the GHG is due to energy use. Since a reduction of energy consumption in the residential building sector is urgent, the efforts must focus on the existing residential buildings, as they exceed the number of newly built dwellings by far. Refurbishment constitutes a necessary action to meet the energy targets for the next decades. Not only does it provide huge potentials for energy savings, but it is also economically and socially relevant. Technical problems, operational costs and internal conditions can be improved,

resulting in more favorable living and working conditions
as well as increased property value.

Over the past five to ten years, the awareness of the importance of existing buildings has widely spread under many stakeholders involved, and the building industry is already busy with upgrading the building stock. The façade is an integral part in most refurbishment strategies. The following chapters will guide us through realized projects, suggested solutions and innovative refurbishment principles. This volume sets off not only to present successful solutions to upgrade the efficiency of buildings but also to provide inspiration and motivation to creatively embrace the refurbishment task that lies ahead of us.

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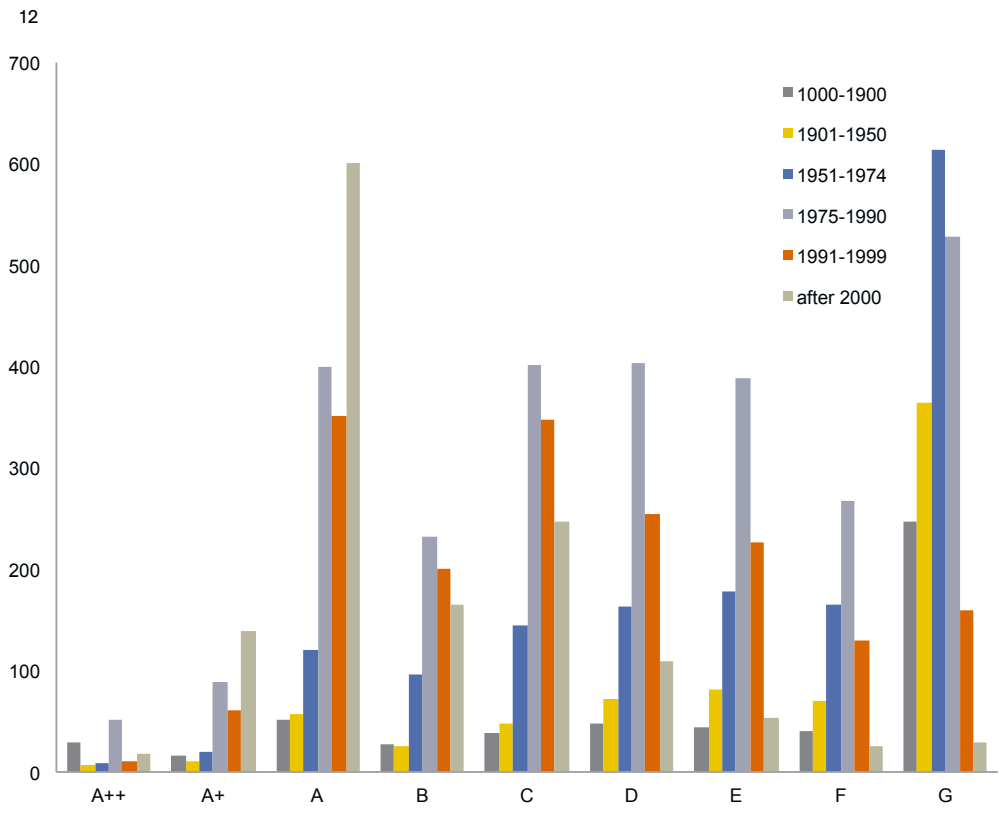
PICTURE SOURCES

- Figure 1: Greenhouse gas emissions by sector, EU-27, 2007 (source: Eurostat 2010, fig. 11.6 © European Union, 1995 – 2011).
- Figure 2: Final energy consumption, EU-27, 2006 (source: Eurostat 2010, fig. 11.20 © European Union, 1995 – 2011).
- Figure 3: Residential and non-residential floor areas per country (source: Itard and Meijer 2008).
- Figure 4: Motivations for reconsidering an existing building (source: Ebbert 2010).
- Figure 5: Percentage of non-residential buildings built before 1978 (source: Ebbert, 2010).
- Figure 6: Age distribution of the residential building stock (source: Itard and Meijer, 2009, p. 35).
- Figure 7: Households broken down by type of dwelling in the EU 2009 (source: Eurostat 2011© European Union, 1995 – 2011).
- Figure 8: Households broken down by type of tenure in the EU 2009 (source: Eurostat 2011© European Union, 1995 – 2011).
- Figure 9: Final energy consumption in residential buildings in EU countries: breakdown in end-use (source: Itard and Meijer 2008, fig 2.8).
- Figure 10: Final energy consumption in non-residential buildings in EU countries: breakdown in end-use (source: Itard and Meijer 2008, fig 2.9).
- Figure 11: Energy labels for housing in the Netherlands in 2010 (source: AgentschapNL.
- Figure 12: Energy labels for non-residential buildings in the Netherlands in 2010 (source: AgentschapNL).



12 Energy labels for non-residential buildings in the Netherlands in 2010

3. REFURBISHMENT STRATEGIES

FAÇADE REFURBISHMENT STRATEGIES IN CURRENT PRACTICE

When considering updating the aging building stock, the façade and/or the entire building envelope are the building components that are typically of the biggest concern. Most refurbishment projects include retrofitting at least parts of the building envelope. However, when it comes to integrated refurbishment, which can be the preferred solution both from an environmental and an economic point of view, all of the key aspects of the building envelope need to be considered and included in the refurbishment measures. The key components of the building envelope are the exterior wall, basement ceiling, roof, balcony, and windows. However, the building services should not be neglected, as they can be connected to the envelope as well, for example in the case of distribution systems or solar panels. The following chapter explains why the façade is such an important component in the refurbishment discussion. It also identifies categories of façade intervention in current refurbishment practice.

THE IMPORTANCE OF THE FAÇADE

The façade of a building is the main element of its architectural expression and the key feature of its existence, as it characterizes the building and makes it conceivable both from the inside and the outside. An old, degraded façade suggests a neglected building, with all relevant environmental, economic and social consequences. On the other hand, an upgraded, renewed, and well maintained façade improves the appearance even of an old building, increasing its appeal for current and prospective users.

What is more, the façade plays a key role not only in the form and appearance of the building, but also in its performance; in terms of optimized energy use and the indoor climate. If we compare a building to the human body, then the façade represent the skin, which performs an important function of the body's reaction to weather variations and regulates the heat emission. Moreover, the façade can be perceived as the body's clothing, serving to protect from weather and other external influences and can respond accordingly. Regarding the overall energy consumption of buildings, with the energy demand for heating being the predominant factor, the façade undeniably constitutes an integral part of the building's environmental impact. The energy consumption for heating buildings is directly related to the heat loss through building components and to losses through ventilation and air infiltration. And it is inversely related to the heat gains in buildings through sun radiation; all of which are parameters that depend on the quality and functionality of the external building envelope.

In spite of the importance of the façade for a sustainable, comfortable and desirable living and working environment, the façades of existing and aging building stock often fail to successfully fulfill their purpose. This can be due to technical deficiencies either created at the time of construction or, more often, emerging as building components approach the end of their usable life-time. Buildings suffer from a variety of physical problems. A lot of these are connected to the external envelope. Considering that the expectation for the structural life time

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	Problem	Effect
Energy efficiency	Poor thermal performance of the envelope (roof, walls and windows)	Energy losses, high energy demand
	Poor airtightness of the openings	Energy losses, high energy demand, user discomfort
	Thermal bridges	Energy losses, high energy demand, internal condensation
	Out-dated installations	High energy demand, risk of technical problems, user discomfort
Façade and cladding	Corrosion of ties and fixings	Façade parts destruction, accident risk
	Inadequate movement between cladding and structure	Façade parts destruction, accident risk, Degraded appearance
	Misalignment of panels	Accident risk, degraded appearance
	Loose or falling render	Degraded appearance
	Poor acoustic insulation	User discomfort
	Poor damp-proofing	Accident risk, water penetration, user discomfort
	Inadequate details of the junction with floor slabs and internal walls	Degraded appearance
	Mould growth	Health risk, degraded appearance
	Deterioration of parts of the façade	Accident risk, degraded appearance
Spatial deficiencies	No use of the external spaces	Degraded appearance, risk of social problems, insufficient function
	The need for extra spaces	insufficient function
	No handicap access to the apartment (no lift, ramps etc)	Accident risk, insufficient function

1 Typical problems

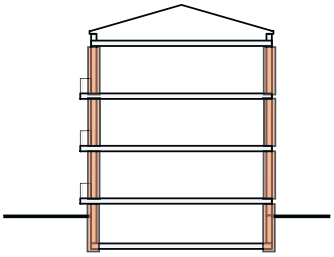
of a building is at least 60 years while the envelope may show signs of obsolescence after only 20 to 30 years, it is understandable that older façades are in need of refurbishment. The following table presents some of the typical problems that are either directly related to the façade or that façade refurbishment could address. In practice, each façade poses its own unique set of problems, since they are connected not only with the respective construction techniques and materials, but also with unique parameters, such as the location, climate, pollution, function, user-related factors, constructional errors etc.

REFURBISHMENT STRATEGIES IN CURRENT PRACTICE

The above mentioned problems are considered typical for the building stock, and the building industry is busy trying to deal with these issues. There is a wide variety of refurbishment projects using strategies to address the shortcomings and the specifications of each project. If we take a closer look at state-of-the-art refurbishment strategies and examples from the industry, we can identify certain categories of intervention. Given the diversity of options, those categories represent a systematized approach to an overview of refurbishment strategies. They can be executed on different levels, but similar characteristics generally underlie the principal concept. It is also possible to encounter a combination of intervention categories.

The categories of intervention are as follows:

REPLACE



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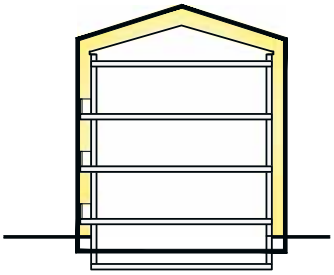

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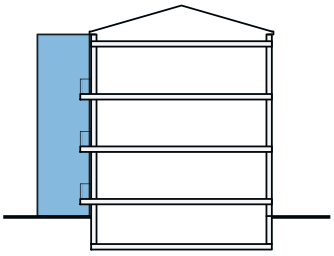

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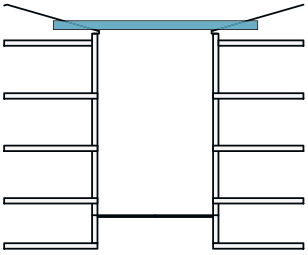


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2 Replace: Shell, The Hague, De Groot en Visser, architect Braaksma & Roos
3 Replace: Headquarters DVH, Amersfoort, Hermeta
4 Replace: Boeverhavenlaan, Zoetermeer, de Groot en Visser, architect zzdp
5 – 6 Wrap it: Meidoornlaan, Weesp, De Groot en Visser, architect Hans van Heeswijk
7 Wrap it: Torenflat, Zeist, Kremers Aluminium, Frowijn de Roos architecten
8 Wrap it: Torenflat, facade assembly

REPLACE

The replacement of a façade is the most common approach to refurbishing a building. In this case, the old façade elements will be removed and replaced with new ones. The façade elements to be replaced can range from the entire façade to parts of it, especially in those cases where the exterior impression should not be changed. If a building is listed under monument protection, for instance, we need to consider improving the interior façade surface rather than the exterior. Adding interior insulation is usually combined with replacement of windows and applied to load-bearing walls.

If the entire original façade is removed, new products can be used for the new façade elements. All opportunities are open for a new building skin that complies with current building physical, technical, and design requirements. Also, the inner layout and the building services can be entirely renewed and redesigned to meet the new demands.

The strategy can be applied to several types of buildings, various types of perforated façades or façade panels to curtain walls. Especially curtain wall structures are interesting for replacement, as new façade units can be prefabricated and installed relatively easily. The costs for a particular solution depend on the level of intervention and the materials chosen. Generally, the costs for a complete renewal are higher than for simply improving parts of the façade; but it constitutes a more integrated solution with a possibly longer life span.

The impact on the users will be significant, because the existing elements have to be removed and the new elements need to be attached to the structure. Hence, the building needs to be unoccupied. It is preferably applied when a building is already empty, either because of a long-term vacancy or during a change of tenant. Otherwise, the occupants need to be relocated during the building period. Optimal logistics can help to minimize this problem as the construction and, thus, the relocation time can be reduced.

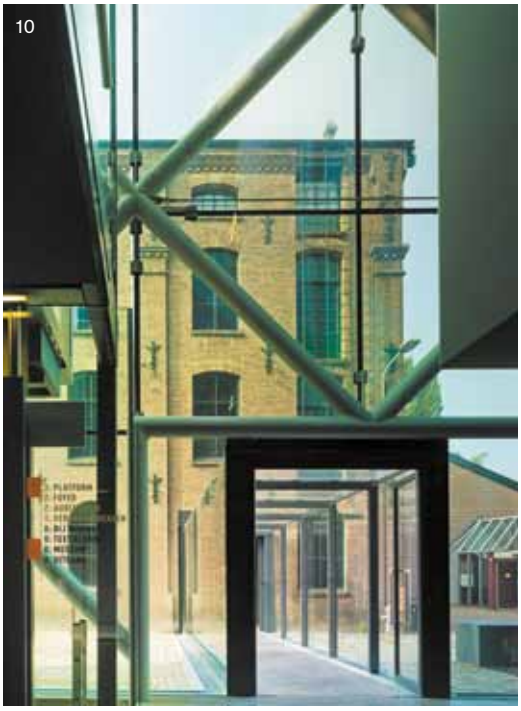
WRAP IT

This strategy will 'wrap' the building in a second layer. This second layer could consist of external insulation, cladding of the balconies or even a second skin façade.

If there are no restrictions for the building design, and the original façade provides sufficient structural integrity, the building envelope can be upgraded from the outside. This concept includes replacing windows and adding insulation and a new cladding. This solves the issues of thermal bridging and increases the thermal resistance of the envelope.

Moreover, there is the possibility of different cladding materials, which can be used to renew the building's appearance. In the case of a second skin façade, the dimension can range from a few centimeters to several meters. It can cover the entire existing façade, a portion of it with different forms of divisions, or it may create a tent-like structure over several buildings. The thermal barrier of the building will be shifted from the existing structure to the new façade. This will give the inside an entirely different climate, and a 'buffer' zone will be created between the existing façade and the second skin façade. The influence on the people, architecture, climate and the building itself will be very high. A lot of new possibilities occur within this strategy. This solution can solve critical connections and even add extra floor space.

A complete replacement often causes a lot of interference with the interior, long construction time, and thus high costs. On the other hand, the second layer can



9 – 11 Add on: Textielmuseum, Tilburg, Architectenbureau cepezed
12 Add on: MCH Westeinde, The Hague, de Groot en Visser, architect De Jong Gortemaker Algra architecten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13 Cover it: Kerk Wassenaar, Wassenaar, Architect G. Lankhorst, BRS
14 Essent, Den Bosch, O III architecten, BRS
14 – 16 Cover it: Het Sieraad, Multifunctional centre, Amsterdam, Architect: O III, BRS
17 Scheepvaartmuseum, more info on page 66

be added to the outside of an existing structure with little interference and disturbance of the users, who don't need to vacate the building during the time of construction.

ADD ON

In many cases, a new structure is "added on" to the existing building mainly due to functional reasons. The add-on concept can vary from small interventions, such as adding new balconies, to a whole new building as an extension to the existing one.

Extension of the building, apart from the additional floor area gained, may add other benefits to the building. Structurally, there are several options to realize this extension, for example by creating a secondary structure in front of the building or suspending the extension in front of the existing structure. With the extension constructed, the old façade is no longer part of the building envelope, while the new façade is built to comply with the requirements for improved environmental performance. The climate can be improved because of the new façade options and the possibility to include extra installations in the extension. The technical bottlenecks, e.g. thermal bridges, will be improved as well because of new and better connection solutions. This strategy should be combined with the previous concepts for those parts of the building envelope that are not connected with the new extension.

This intervention will have a great impact on the residents because parts of the old façade have to be removed and intelligent connections have to be created to connect the extended façade. This makes the execution of this concept quite difficult, but not impossible. One critical limitation can be the additional area of surrounding space needed.

COVER IT

A strategy to upgrade existing buildings is to cover parts of or entire internal and external courtyards and atria. The covered spaces are often referred to as glasshouses. They are mostly covered with transparent elements to allow visual contact with the exterior and to increase heat gains.

This strategy has great impact on the architectural appearance, the surrounding area and the building itself. It can also add functional space, and it changes the relation between inside and outside.

Potential insufficient thermal performance of the old façade and other problematic details no longer pose a problem, when a new interior space is connected to the old façade, as the heat transfer is reduced. The new space may be heated or rely on solar heat gain. In both cases, adequate shading and ventilation are required to avoid overheating. This strategy should be combined with the previous concepts for those parts of the building envelope that are not connected with the new extension.

This solution is not generic because not every building is suitable for this intervention. The shape of the building is an important criterion for this strategy to work as a refurbishment possibility.

4. BEST PRACTICE

4.0. INTRODUCTION

Refurbishment is a very diverse approach, each project is different. Being together for the last three years with five biggest façade building companies offered a very good inside view on different refurbishment projects. This chapter allows us an inside view; each company had chosen a set of properly executed projects within the last years. Beside their short informative project description, they also explain their way of doing it. So be inspired by the very unique projects that are illustrated from the constructor's view.

4.1. 'TORENFLAT ZEIST' FAÇADE

BUILDING TYPE Apartment block
LOCATION Zeist, NL
CLIENT Vestia
ARCHITECT Frowijn De Roos
YEAR (ORIGINAL CONSTRUCTION / REFURBISHMENT) 1973 / 2009
FAÇADE CONSTRUCTION Kremers Aluminium, Tilburg
COMPANY PRODUCT(S) USED Schüco en Kremers Aluminium

INTRODUCTION

Our involvement in this wonderful renovation project began in January 2007, a true metamorphosis!
During the first phase, the architect and our company as a manufacturer of aluminum solutions for the building industry looked at the various requirements that the façade and renovation process had to meet. The goal was to expose the residents to a minimum amount of inconvenience. Therefore, the building was not supposed to be scaffolded, while at the same time the use of man-lifts was hardly possible due to the surrounding apartment blocks. Also included in the architect's design were a number of technical challenges that had to be met.
Aluminum was chosen as a material for this project because of its durability and recyclability. Another advantage of aluminum is to be able to construct slender elements of sufficient rigidity.
Low maintenance requirements and updated thermal properties of the new façade represent a large upgrade for the building. These, along with the durability of aluminum, are qualities that have prepared the building for the next 40 to 50 years.

THE EXECUTION

To minimize the inconvenience to residents during assembly, the existing mounting holes of the removed balcony railings were used to anchor the façade. The number of newly drilled holes (noise pollution) was thus reduced to a minimum. The fully glazed façade elements were prefabricated and finished at the factory, and subsequently mounted horizontally and vertically during assembly on site.
The architect's design includes glass panels that vertically span several stories. This made it impossible for the horizontal junction of the elements to be achieved at floor level, where the anchors were installed. The horizontal attachment of the elements was therefore performed at parapet height (floor height + 1.200 mm).

The message was: “No standards: Renovation requires a tailored solution, looking for the simplest solutions using existing building parts.”

LOGISTICS

Vestia chose PHB – Paul Hardonk Bouw (formerly Hardonk & Ebenau Deventer) as contractor during the selection procedure. Together with PHB, initial planning of the logistics and the renovation project began.
The application of an element façade made it easy for the individual trades to conduct their work much faster: the contractor started the interior finishing immediately after the first elements were mounted.
Obviously, the resulting shorter construction time is an important benefit for the residents.
The entire sequence of production, packaging and transport was fine tuned to the assembly schedule. Therefore the required stock of elements on site was minimal; a mandatory requirement due to the limited space surrounding the building.

MOUNTING

Mounting the façade elements was fully self-supported by placing two small self-propelled cranes on the roof of the apartment building. In order to minimize the dependence of the lifting operations on current wind conditions, two steel cables were installed from roof to ground. During lifting, the elements were safely guided upward along the steel cables, minimizing the wind’s ability to catch the elements.
Construction speed: between 150 and 200 m^2 of elements mounted per day.

The building before refurbishment

The building after refurbishment

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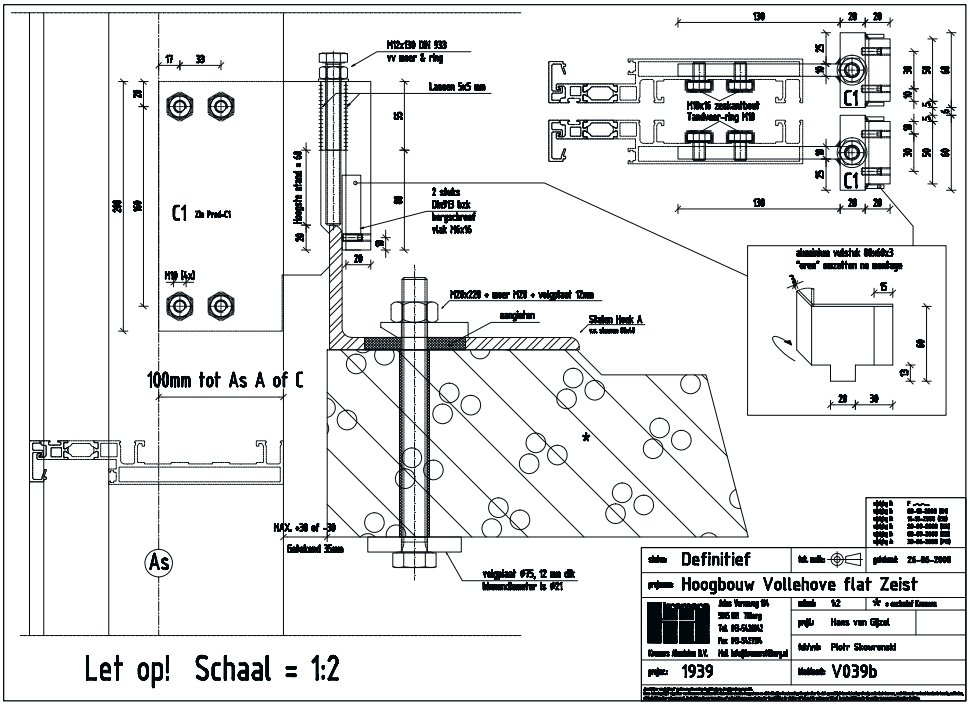

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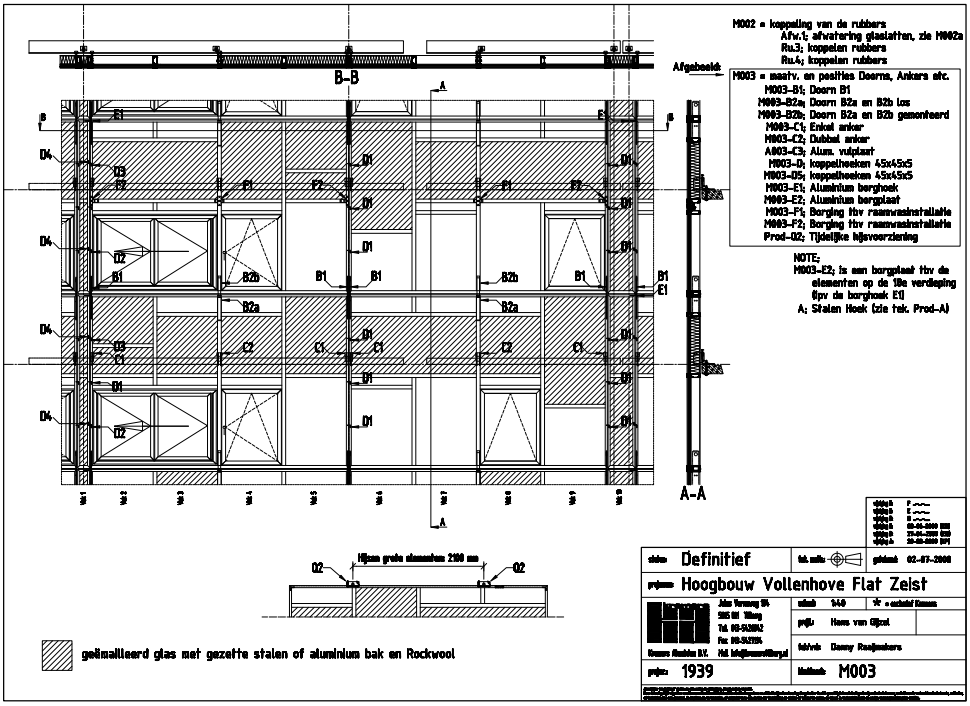

1 Construction detail
2 Elevation and section of the planning


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3 Mounting the prefabricated elements onto the stripped building
4 The finished façade
5 Progress of the assembling phase
6 – 7 The finished tower (foto's Bart van Vlijmen Fotografie)

4.2. 'DE VALK' FAÇADE

BUILDING TYPE Apartment block
LOCATION Apeldoorn, NL
CLIENT WBV Ons Huis Apeldoorn
ARCHITECT Groosman Partners BV
CONTRACTOR Aannemingsbedrijf Draisma BV
YEAR (ORIGINAL CONSTRUCTION / REFURBISHMENT) 1960 / 2008
FAÇADE CONSTRUCTION Solarlux Nederland BV
COMPANY PRODUCT(S) USED SL-60e folding-sliding windows

The "Valk" is the last of six identical apartment buildings in the neighborhood of Zevenhuizen in Appeldoorn. The building is owned by the residential cooperation "Ons Huis" and was built in the 60s. While all the other five buildings of this type were demolished and new buildings planned; the purpose of this one is to remain as an exsample of the time as well as the new spirit that can be created with well thought out refurbishment. To fulfill all new demands in terms of sustainability, comfort and current design standards of modern architecture, the building was completely stripped down to its load-bearing structures.

The architectural firm of Groosman Partners designed the refurbishment for maximum contact with the exterior and the environment; light flooded living spaces, a new transparent look and low energy consumption were high on the list of demands. The products of Solarlux Nederland were well suited to meet these requirements. The architect designed folding and sliding window frames for the living rooms as well as the bedrooms to allow maximum contact with the outside environment. The fact that all window elements are openable allows for easy cleaning of the glass elements and efficient maintenance from the inside; with the added benefit of reducing the running costs. The easy use of these folding and sliding elements also supports the user's comfort level, because he/she can control the climate of the apartment individually.

In order to change the overall architectural impression of the building to a new design, a suspended prefab concrete grid is placed in front of the existing load-bearing structure. Its pattern divides the façade in different compartments, which will be filled in entirely with the prefab façade elements. A special mounting bracket was developed to securely mount the up to 3 x 8 m large façade elements. This results in a fast assembly process and a high amount of security and precision within the tolerances of the building.

To improve the logistics of handling and assembling the prefab façade elements, a special transport rig was developed that allows for the elements to be mounted to the building directly from the rig with a lift. Therefore, no extra space to store the elements nor additional scaffolding is necessary. The assembly process was properly tested in advance, security checked and fine tuned to guarantee a smooth operation. Thus, a tight time schedule was made possible in cooperation with the general contractor that even allowed additional time for unpredictable weather conditions. All of these measures made it possible to finish two stories per week.

The entire assembly process of the elements was done before the planned timeframe, and all partners agreed that advance planning of the proper teamwork and cooperation of the involved parties helped to fulfill the high demands in terms of quality, time and costs. Anything is easier to be accomplished in a team. Solarlux especially received compliments for their role as team players within the building team. Ultimately, this building represents the company's products at its best with satisfied users and clients, and therefore illustrates a very well executed refurbishment project.

The building before refurbishment

The building after refurbishment

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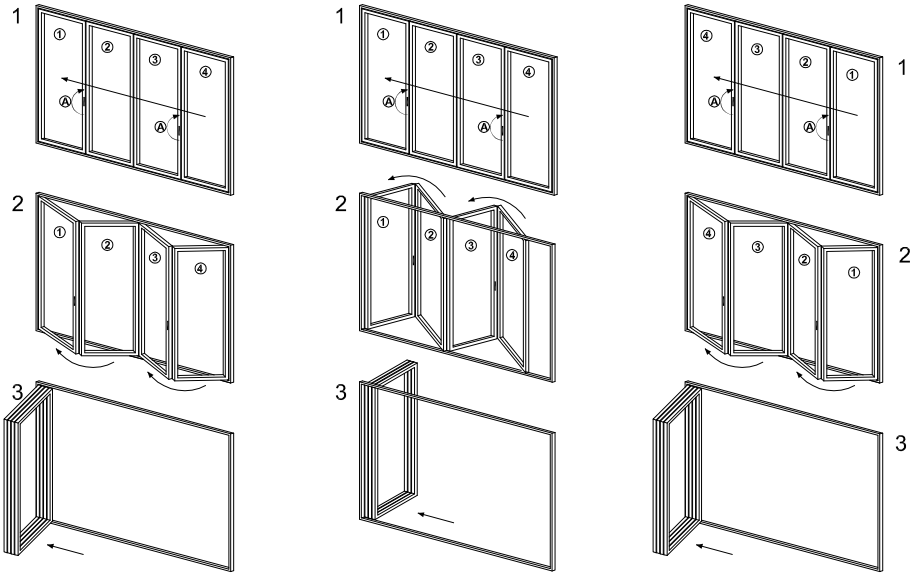

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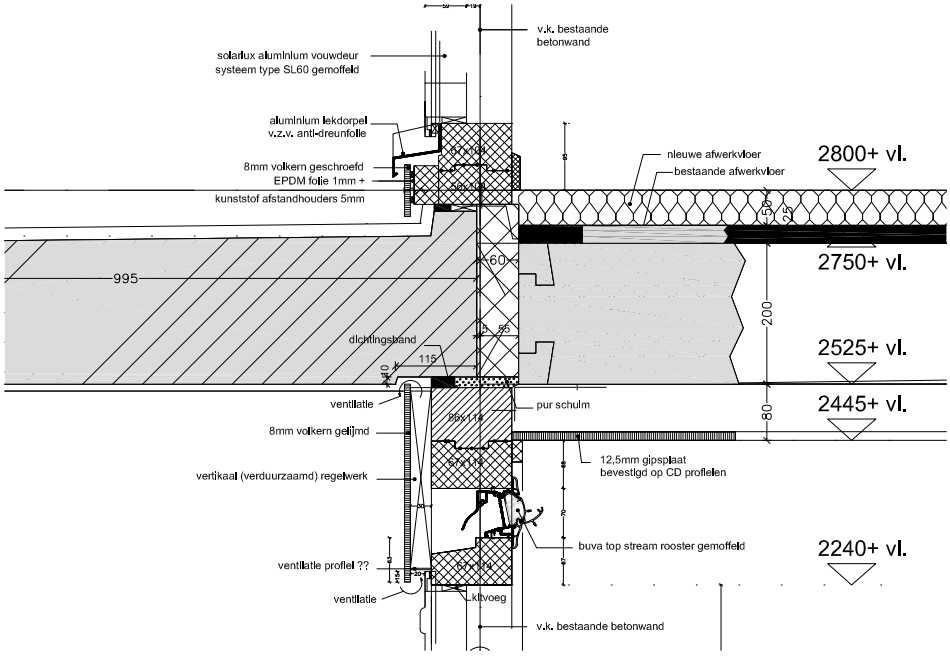

1 Different folding principles
2 Detail Solarlux.pdf: A section of the typical detail


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3 Concrete structure – entirely stripped
4 Lifting the prefab façade elements
5 Façade elements after assembly
6 View from the inside of the balconies with open folded windows
7 Finished project

4.3. 'PIAZZAFLAT' FAÇADE

BUILDING TYPE Apartment block
LOCATION Gorinchem, NL
CLIENT Poort 6
ARCHITECT A3 Architecten
CONTRACTOR Breijer Bouw B.V
YEAR (ORIGINAL CONSTRUCTION / REFURBISHMENT) 1970 / 2010
FAÇADE CONSTRUCTION Solarlux Nederland BV
COMPANY PRODUCT(S) USED SL-25 modular balcony glazing

The Piazzaflat in Gorinchem is a typical residential tower that houses many people. Its former appearance was determined by side-by-side balconies, a very typical building type of the 70s.
A3 Architecten took on the project from the owner Poort 6 to transform the apartment block into a new future-oriented residential building with focus on sustainable, modern functionality. Because the building is one of the highest in the region, the refurbishment project also became a showcase for refurbishment of this type of building.

In addition to updating the building facilities and the entire technical installation of the individual apartments, the building also received a new fire staircase on one side to ensure the safety of the residents. The upper level was transformed into a panorama apartment that provides a wonderful view of the surrounding landscape.

The new architectural design transformed all balconies into sun rooms that act as buffer zones and increase the usable living space of the individual apartments. To have the best of two worlds – a sun room and a balcony – the architect chose folding and sliding windows from Solarlux, which offer year-round comfort, user friendliness and low cleaning and maintenance requirements. The glass elements also increase the acoustic insulation properties and offer improved living quality.

To execute the assembly and mounting of the façade elements under the eyes of the 144 occupants, the contractor, owner and Solarlux worked out an intelligent logistic plan to minimize noise, dust and other disturbances for the occupants. Before and during all building activity, informative meetings about all the ongoing and future refurbishment activities were held for the occupants to make the process as smooth as possible and address potential problems in advance.

The entire construction process was specified down to the last detail and conveyed to the residents of the building. Solarlux analyzed the building's details and developed a mounting bracket that uses the old holes of the balcony plates that originally held the parapet construction of the balconies. This enabled very efficient and quiet assembly. Solarlux, working under the lead of the general contractor Breijer was able to show its team player skills to deliver good quality and a seamless installation process.

The renewed building exemplifies what intelligent refurbishment can achieve: the balconies, rarely used in the past, are now enjoyed by the residents as sun rooms and additional space all year round.

Up to now, the current energy measurements already showed an reduction of 23% energy demand, the project now receives a final adjustment and a even higher energy saving is awaited.

The building before refurbishment

The building after refurbishment

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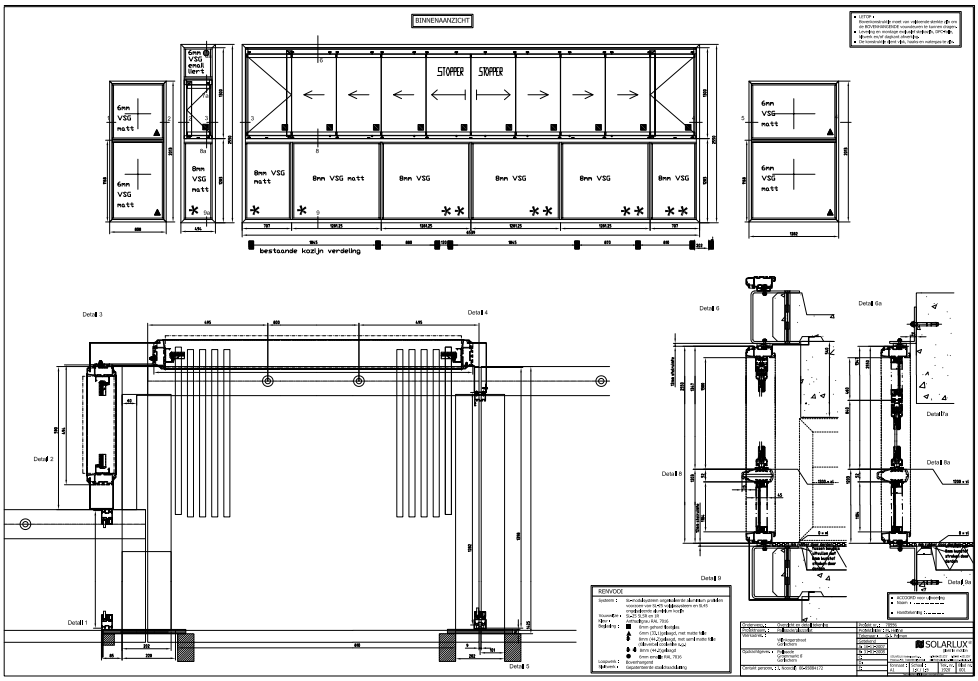


1 Production details of the prefab façade elements

2 Removing the old parapets
3 Detail view of the test mockup
4 Inside view from the new balconies
5 Detail view of the finished balconies, closed
6 The Piazzaflat after refurbishment

4.4 EUCALYPTUSHOF

BUILDING TYPE Apartment block
LOCATION Rotterdam, NL
CLIENT "Onze Woning" Housing Association
ARCHITECT The Room Industry, Rotterdam
YEAR 2007
FAÇADE CONSTRUCTION BRS
COMPANY PRODUCT(S) USED used: glass, steel, Artdeck®

This apartment complex, built in the early 1980s, looked dated and neglected. The dense concrete entrances of the two apartment blocks were socially unpleasant and not user-friendly. The balconies and galleries showed serious signs of weathering. The question of the client was whether the existing building could be 'revitalized', with the requirement that the refurbished building had to be safer and more accessible.

The new entrances consist of steel and glass. Elevators are incorporated in the doorways. The elevators, made entirely of glass and steel, reinforce the transparency of the entrance and improve user convenience. For the staircases, a very simple but efficient glazing system was designed, which to this day is used for low-budget solutions. The principle is a 60 mm wide EPDM glazing rubber that is mounted on the steel and serves as secondary waterproofing. On the inside, the glass is clamped with a flat aluminum cornice.

The floors of the galleries are elevated and door sills have been omitted; making the homes more easie accessible for seniors. Artdeck® gratings have been used for the floor spaces of the gallery. These gratings, filled with EPDM, are sound-absorbing, light-weight and water-permeable. Through its color, the surface conveys a warm feeling, and it remains non-slippery throughout the seasons. The upper galleries feature a glass canopy.

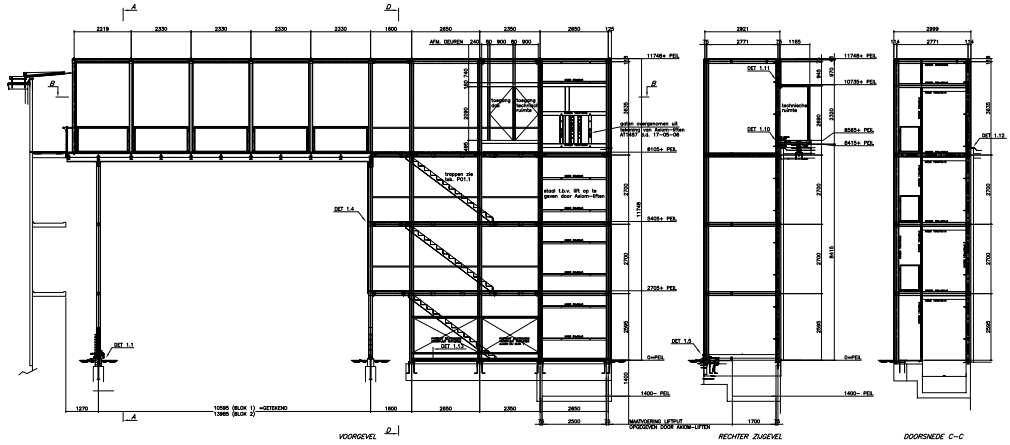
The gallery floors were raised with the light Artdeck® floor elements without any modification of the concrete construction. Steel railings, prefabricated with glass, were assembled in the workshop, which reduced the inconvenience for the residents to a minimum. The floors and stairs of the walkways are also fitted with Artdeck® gratings. One single color, which nicely matches the new environment, was chosen for all façade elements, providing the entire building complex with a completely new, modern look. After the revitalization, the complex has generally attracted a

different type of tenant. This indicates that the modifications have been successful. For this renovation, BRS supplied the floor gratings, steel and glass structures for the stairwells, elevator shafts, walkways, porches, balconies and galleries. Several budget cuts were worked out in collaboration with the general contractor to finally achieve a customized solution within the very competitive budget of the client.

The building before refurbishment

The building after refurbishment (foto: architect)

1



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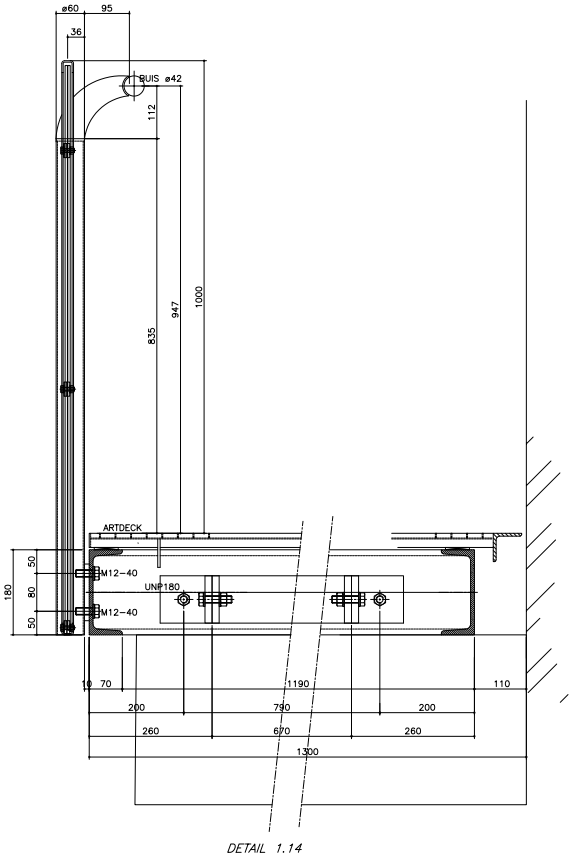

DETAIL 1.14

1 Overview of the steel structure
2 Detail

3 Assembling of the prefabricated steel structure
4 Lifting the elements
5 The finished walkways
6 Detail from the staircases
7 The finshed project

4.5. KONINGSVROUWEN VAN LANDLUST

BUILDING TYPE Apartment block
LOCATION Amsterdam, NL
CLIENT Eigen Haard, Housing Association
ARCHITECT Archivolt Architecten BNA
YEAR (ORIGINAL CONSTRUCTION / REFURBISHMENT) 1930 / 2011
FAÇADE CONSTRUCTION De Groot & Visser
COMPANY PRODUCT(S) USED Own development windows, sun shading, PV panels

The dwelling 'Koningsvrouwen van Landlust' was built in the thirties. During those times, closed block allotments were very common.
The architects of the project, Versteegh architects, wanted to introduce more light into residential units. They created the first strip blocks in Amsterdam.
The porch homes were built with a brick structure with steel framed single glazed windows. The steel frames were flat and slim. Small noticeable details are the water drains and the outward opening windows. In the eighties, the windows were replaced by aluminum framed double glazed windows. Back then, aluminum did not exhibit the possibilities it has today. The white aluminum does not look elegant and does not prevent heat loss.

Together with the owner Eigen Haard, the architectural firm Archivolt Architects and the supplier of aluminum window frames Schüco, De Groot & Visser developed a new system with a view line of only 5 cm. The system is highly insulated with a Uf = 1.93 W/m^2K. The windows are structurally glazed to be able to use a single view line. A special coating was applied that has a slight glimmer to resemble the look of steel. Furthermore, modern water drains were attached that resemble the authentic version. Combined, these measures maintain the look of the thirties, but meet today's functionality and requirements!

The building before refurbishment

The building after refurbishment (foto's Sander Baks)

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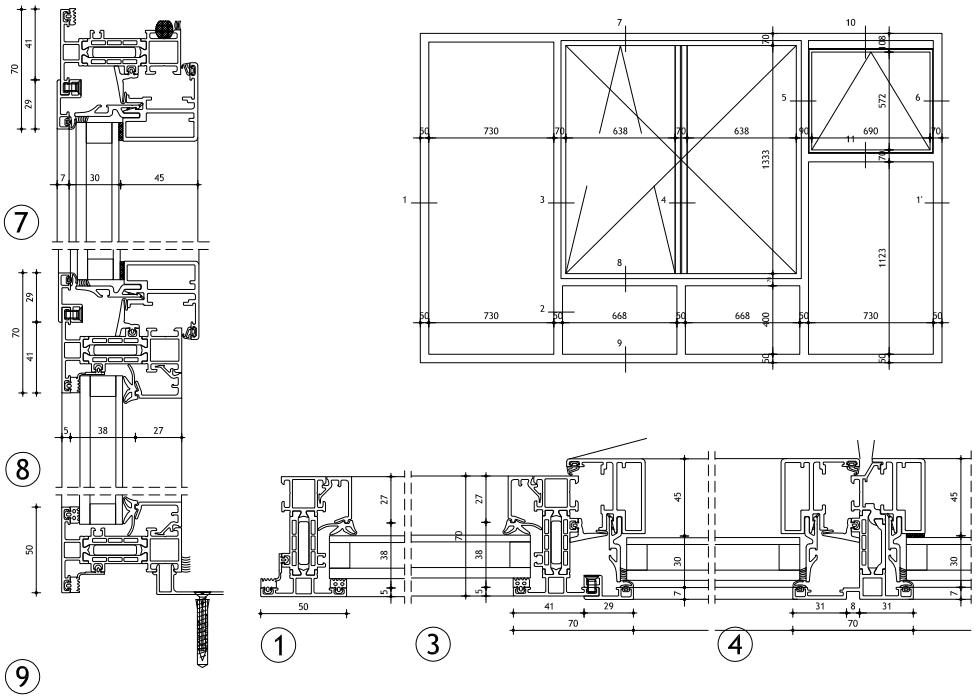

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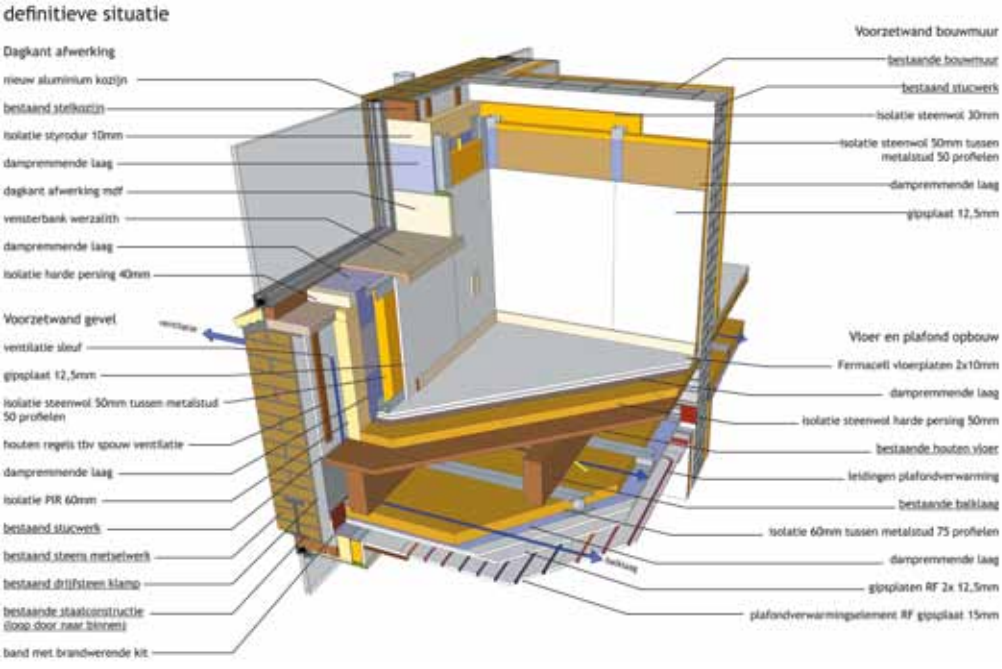

1 Details of the windows
2 The different layers of the building construction


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3 The old situation
4 Mounting the window elements
5 Comparison: old right side, new left side
6 Partial view of the finished facade
7 PV cells mounted on the roof
8 The finshed project

4.6. HEADQUARTERS DHV

BUILDING TYPE Office building
LOCATION Amersfoort, NL
CLIENT DHV Group, global engineering consultancy
ARCHITECT Façade designed by DHV
YEAR (ORIGINAL CONSTRUCTION / REFURBISHMENT) 1970 / 2010
FAÇADE CONSTRUCTION Hermeta
COMPANY PRODUCT(S) USED Schüco

DHV renovated its head office based on sustainability principles and the objective to significantly reduce energy consumption. The renovation is in line with DHV's policy of achieving climate neutrality. The company itself is responsible for the integrated design and project management of the renovation project.

With the renovation of its head office in Amersfoort, the energy label was improved from G to A. That is a remarkable achievement for a 40-year-old building. Buildings with an A energy label perform according to high requirements for new constructions. To achieve this level of performance in a large office building constructed in the 1970s, innovative solutions were needed. New installations ensure that cooling and heating make more efficient use of energy. The building has a new look by applying an entirely transparent glass façade that combines better daylight conditions with sun control.

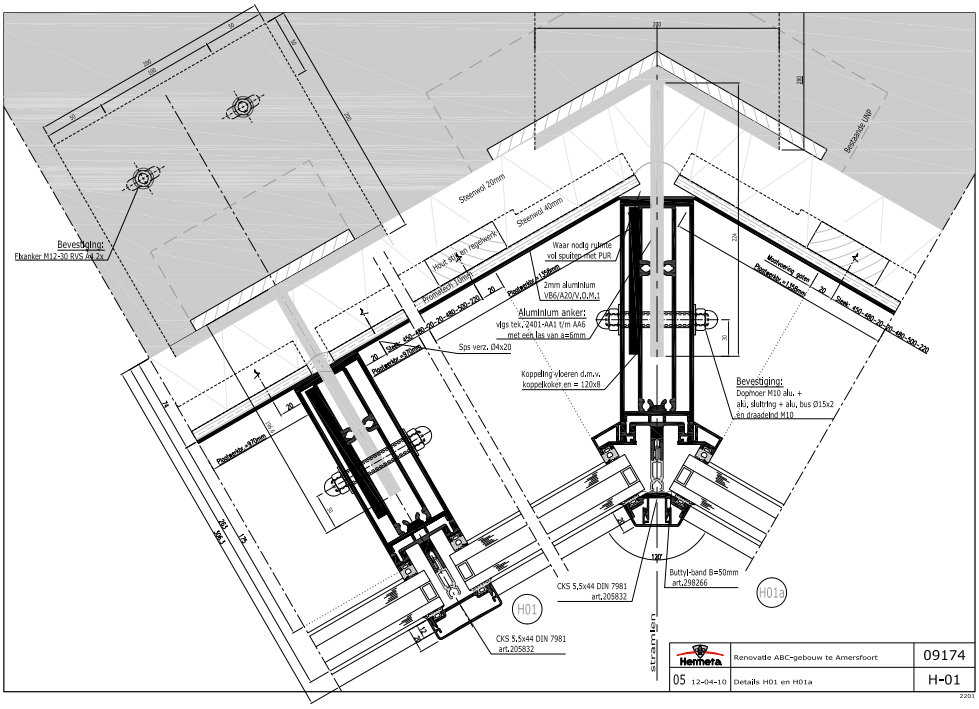
A sustainable renovation does not necessarily cost more than a regular renovation. The integrated approach of this project resulted in a more efficient design. The line between design and tender phase disappeared; for example, façades, roof and installations were directly associated with each other. This meant that more operational energy could be saved. The additional man-hours for the design phase were quickly balanced out with the resulting lower operating costs. DHV achieved annual energy savings of € 100,000.

During renovation, high comfort levels were maintained in a sustainable manner. DHV employees can enjoy the working environment. A good indoor climate leads to healthy and happy workers, which is an important economic consideration. Renovation of an older building can, thus, simultaneously increase comfort and reduce energy demand.

The building before refurbishment

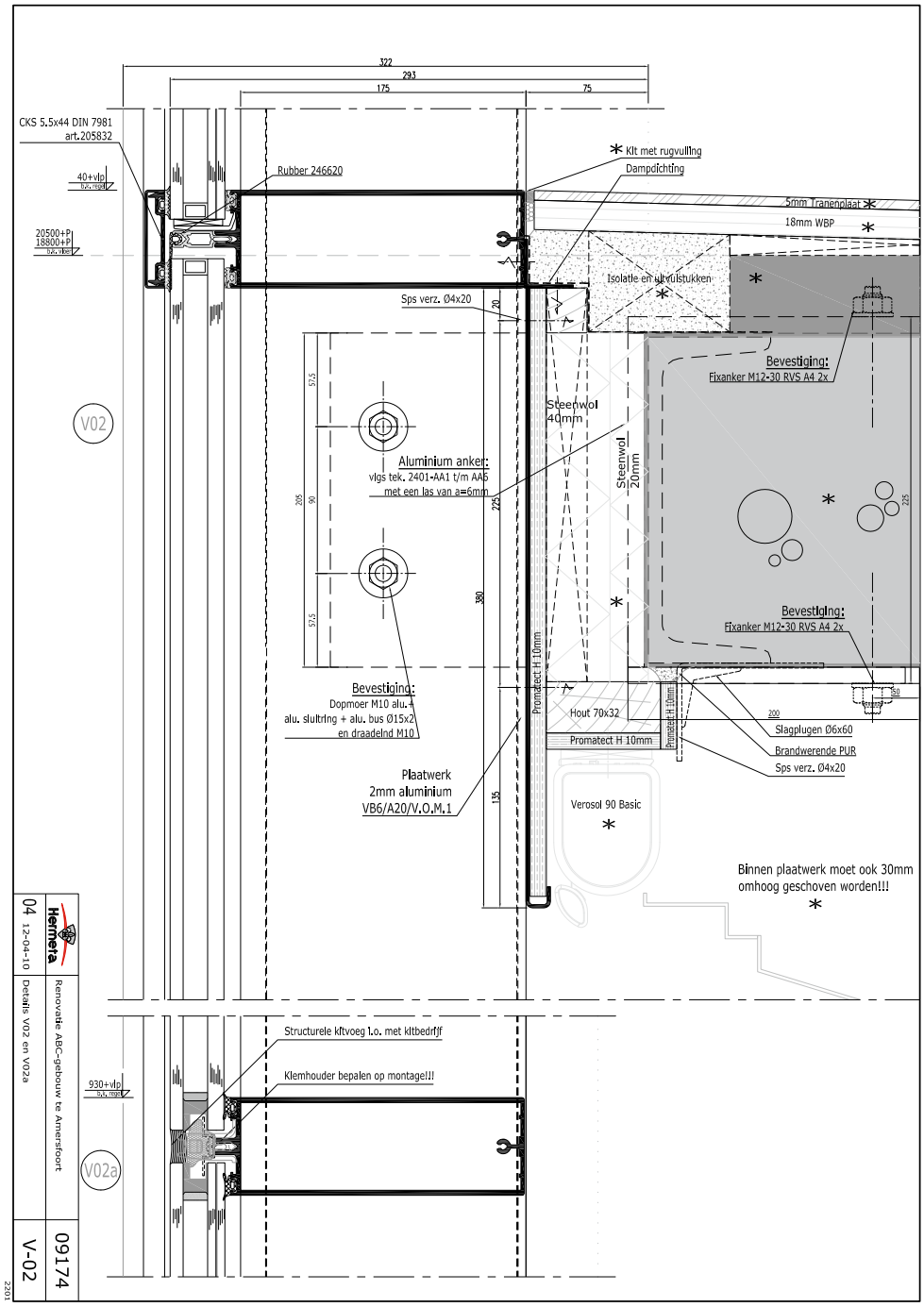
The building after refurbishment

1



1 Detail of the inner corner of the facade

2


322
293
175
75
CKS 5.5x44 DIN 7981
art.205832
40+vlp
b.t. regel
20500+P
18800+P
b.t. regel
Rubber 246620
Klt met rugvulling
Dampdichting
5mm Traenenplaat
18mm WBP
Isolatie en uitvulstukken
Sps verz. Ø4x20
20
V02
Bevestiging:
Fixanker M12-30 RVS A4 2x
Steenwol
40mm
Steenwol
20mm
Aluminium anker:
vlgs tek. 2401-AA1 t/m AA5
met een las van a=6mm
57,5
205
90
57,5
225
380
225
Bevestiging:
Fixanker M12-30 RVS A4 2x
Promatect H 10mm
Bevestiging:
Dopmoer M10 alu.+
alu. sluitring + alu. bus Ø15x2
en draadelnd M10
Hout 70x32
Promatect H 10mm
Promatect H 10mm
200
Slagplugen Ø6x60
Brandwerende PUR
Sps verz. Ø4x20
Plaatwerk
2mm aluminium
VB6/A20/V.O.M.1
135
Verosol 90 Basic
Binnen plaatwerk moet ook 30mm
omhoog geschoven worden!!!
Structurele kitvoeg t.o. met kitbedrijf
Klemhouder bepalen op montage!!!
930+vlp
b.t. regel
V02a
Hemeta
04
12-04-10
Details V02 en V02a
Renovatie ABC-gebouw te Amersfoort
09174
V-02
2201

1 Detail

3 – 5 Different impressions of the finished facade refurbishment (foto's: Joost Brouwers)

4.7. MONARCH I

BUILDING TYPE Office building
LOCATION The Hague, NL
CLIENT Provast & ASR Vastgoedontwikkeling
ARCHITECT KCAP Architects & Planners
YEAR (ORIGINAL CONSTRUCTION / REFURBISHMENT) 1960s / 2011
FAÇADE CONSTRUCTION De Groot & Visser
COMPANY PRODUCT(S) USED Curtain wall – All-in-One Façade by De Groot & Visser

The CAK office (Central Administration Office) is a redevelopment in a new business district, The Monarch in the Beatrixkwartier in The Hague. The Spanish architect Joan Busquets designed the master plan for this area, with all new buildings being oriented perpendicular to the highway. Since the CAK office is a redevelopment, the existing building from the 1960s with its footprint paralleling the highway does not conform to the new urban layout. The building no longer fulfilled the needs and requirements of today. Provast Development decided to strip the building down to its bare structure in order to create a completely new façade. This new façade gives the building a new look, provides a healthy working environment and offers an energy saving solution.

KCAP designed the redevelopment of the 55 m high building, which accommodates around 17,500 m^2 of modern office floor space, and includes an underground parking garage for 200 parking spaces and public space. The new façade with its horizontal orientation and increased transparency interprets its predecessor and the surrounding modernist buildings in a contemporary way and reintegrates the building in the modern business area.

De Groot & Visser developed a new façade system; The All-in-One Façade. The AOF is a combination of the best of the three main existing façade systems: window, curtain wall and element façade. It uses the frame of a curtain wall, includes the flexibility and functionality of windows and offers the building speed of an element façade. The architect maintains his or her freedom of design, the contractor benefits from reduced building times, and the developer gets a building with a functional façade that also competes for the different ‘green’ labels. Sun shading systems could easily be adapted into the design as well. The All-in-One Façade was applied to the CAK office building.

The new façade does not only fulfill the latest sustainable standards (Breeam-NL certificate 'Excellent', June 2011), but also integrates nearly all installations, such as ventilation, electricity and sun shading systems. Special anchors, developed by De Groot & Visser, create the space needed to accommodate ventilation and electricity in between the floor and the façade. This enlarges the total floor area.

A unique extruded profile was created to cover the sun shading screens. When rolled up, the screens are completely out of sight, nicely hidden inside these pocket profiles. Special openings on the rear side make maintenance easy. De Groot & Visser is a specialist in façades as well as sun shading systems. This combination is particularly beneficial for a project such as the CAK Office. The costs for engineering, production and assembly as well as the risks and guarantees are substantially lower than if the work had been divided between two or more parties.

The building before refurbishment

The building after refurbishment

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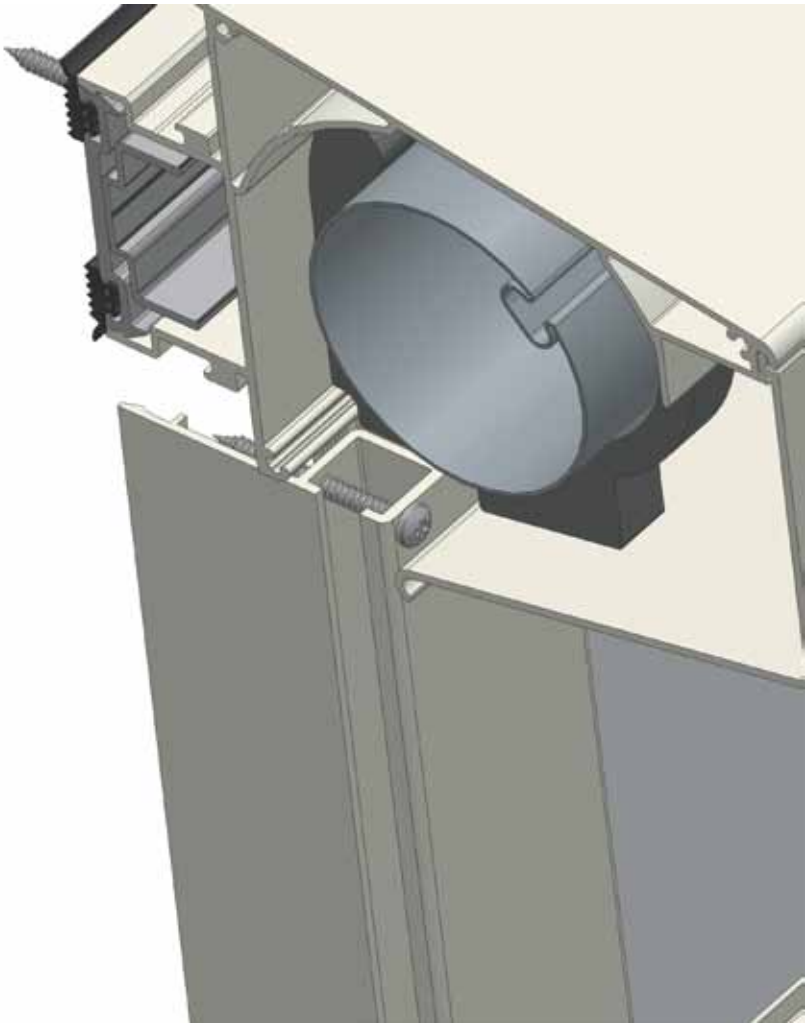


1 Detail of the integrated sunshading elements within the façade profiles

2 Project under construction
3 Inserting the elements
4 Façade assembling in process
5 Finished façade
6 Corner detail of the finished façade
7 Visualization of the design (rendering: architect)

4.8. SCHEEPVAARTMUSEUM, GLASS COVER OF THE MARITIME MUSEUM

BUILDING TYPE Museum
LOCATION Amsterdam, NL
CLIENT Rijksgebouwendienst
ARCHITECT Laurent Ney, Brussels
YEAR (ORIGINAL CONSTRUCTION / REFURBISHMENT) 1700 / 2011
FAÇADE CONSTRUCTION BRS
COMPANY PRODUCT(S) USED Glass, tiltable section, rosettes

The nation's Maritime Warehouse – a warehouse in classical Dutch style – has been the striking location of the Maritime Museum Amsterdam since 1973. However, the building was never entirely adapted to this new function. Necessary improvements of the climatic conditions and changing demands of the public have led to the Maritime Museum closing for large-scale renovation and refurbishment.

The 17th century building was covered with a glass roof. In keeping with the theme of a maritime museum, architect Laurent Ney based his design on the compass card and the compass lines of old sea charts. This form was rationalized and divided into 3, 4, 5 and 6 angles. Approximately 75 % of them are triangular as the triangle is the simplest form from which to build a facetted, arched roof. All window panes have unique shapes. The overall shape lets each part of the roof contribute to the load transfer. The maximum height of the aesthetic glass dome was determined by the ridge height of the adjacent roofs (approximately 5 meters from the existing roof gutter).

The glass has to follow the shape of the steel sections exactly. The architect, steel builder and BRS Building Systems have developed a special section with a newly created "bowl joint". The sections are freely tiltable. Rubber gaskets, including a second water stopper, are usually installed onto these sections. The rubber is sufficiently flexible to follow the segmentation between two adjacent windows. The glass is then installed and fixed. This is done with butterfly clamps, spaced at 300 mm, in the groove of the insulating glass for which the spacing lug between the two windows is slightly recessed. The windows are then completely sealed on the outside.

Cover sections were not applicable. The great variety of different angles made it nearly impossible to achieve waterproofing using sections that would prevent rainwater from freely running down. The glazing used

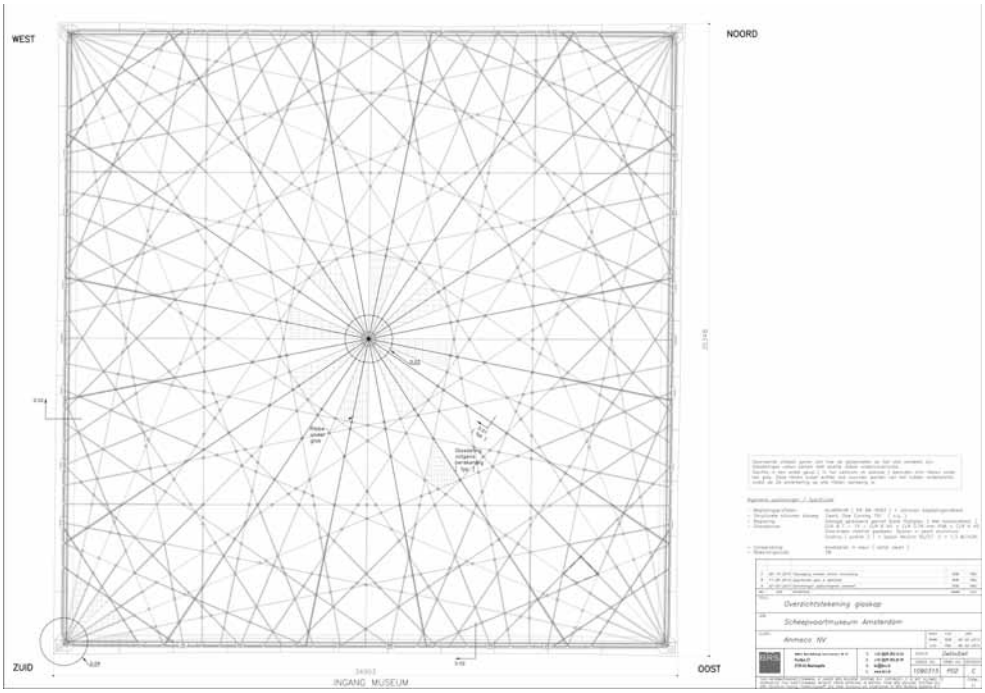
consists of sun-blocking, insulating and, in some cases, walkable glass. The glazing in the ridge and corners of the glass cover converges at a very sharp angle, which made the hardening process challenging. All windows undergo a heat soak test to limit breakage due to nickel sulphide inclusion.

At the nodes, BRS made use of specially produced silicon rosettes as secondary water proofing. These have been customized in order to properly align the various rubber gaskets at each nodal point and to minimize errors. The same applies to the sections. They were also customized. Their placement was very exacting because the tapped holes were already made in the steel sections, which had to correspond with the holes in the glazing tee.

By covering the courtyard, an area of 30 by 30 meters was created, which can be used throughout the year. Complete integration of illumination, cabling, mounting of glass panes, wind and waterproofing is solved in one single detail. The museum has therefore been updated to a museum of the 21st century.

The building after refurbishment

1



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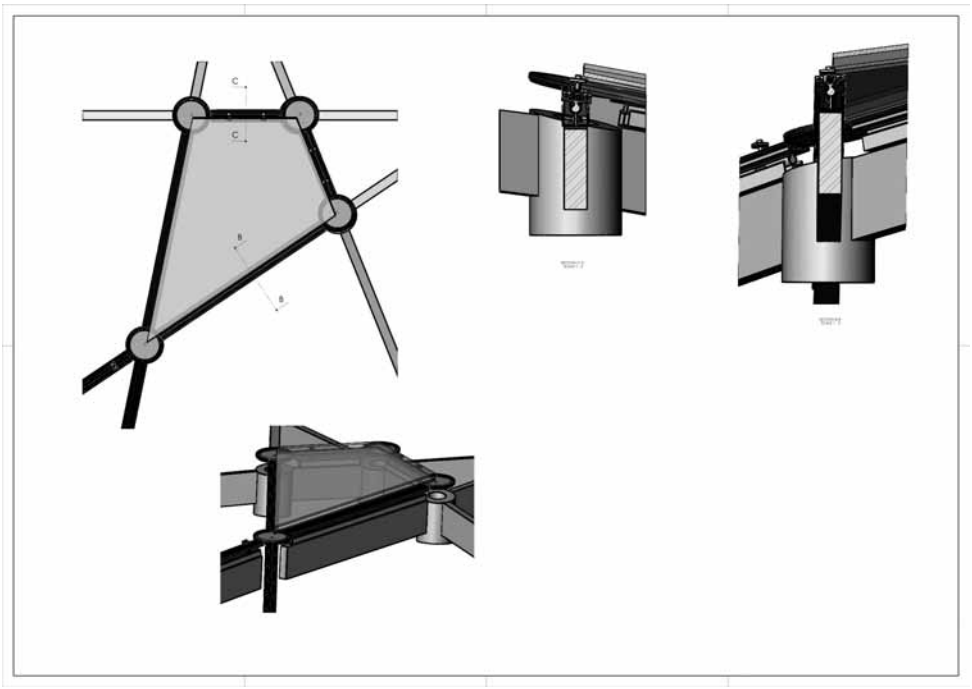
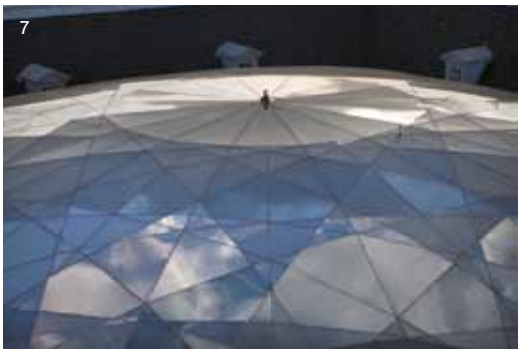
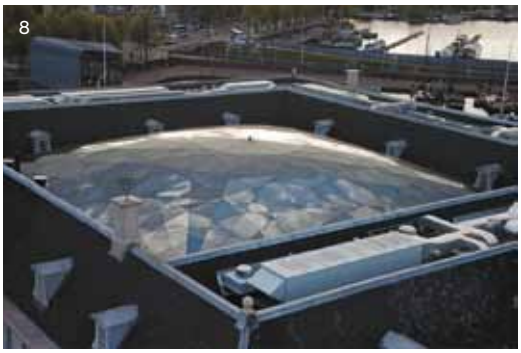


1 Overview of the roof pattern
2 Detail of the glass roof structure





3 View into the courtyard during the building phase
4 Inserting the glass elements
5 Building site overview, half covered
6 Corner detail of the glass elements
7 The finished roof pattern
8 The completed roof structure

5. CASE STUDIES

5.0. INTRODUCTION

Normally the facade building company is one of the last members to join in the design process of a facade refurbishment. First comes the architect, who starts thinking about the whole refurbishment and the demands according the demands of the clients. He is the one who determines the look, function and the design of the new building. Within this chapter we asked the companies who are involved in the IPC research, to play the architect. How would you do the refurbishment, if no one else had thought about it before? A set of different building exsamples were given to cover a wide range of building types, out of which the different companies chose a building to refurbish. Some are chosen because they will be perfectly suited for their own product range, some of them because their way of building and executing will fit perfectly, and some are chosen as a challenge to illustrate what the company is able to do.

So get inspired by the concepts that also illustrate the different niches and specialities each company is able to fill and perform in.

5.1. CASE STUDY 1

TYPE Multi-residential building
LOCATION Breslauer Str., Krefeld, Germany

The refurbishment project is a four-story residential building, located in the Gartenstadt area at the outskirts of the city of Krefeld in Germany. It was originally constructed in the late 60s.
It is part of three identical complexes, consisting of two buildings, one three-story and one four-story apartment block, laid out in an L-shaped arrangement around an internal yard.

The structure of the building consists of load-bearing masonry brick walls and concrete slab, both in situ. The façade is constructed with lightweight concrete blocks and brick cladding. The balconies are formed as loggias on the continuous concrete slabs. No insulation has been used on the façade or the floors. The original windows have already been replaced with double glazed PVC frame ones.
The following U-values can be adopted for the current building envelope: external walls $U = 2.05\ W/m^2K$, basement ceiling $U = 3.01\ W/m^2K$, roof slab $U = 3.01\ W/m^2K$, window $Uw = 3.00\ W/m^2K$.

The main problems identified are the lack of insulation of the external walls and roof, thermal bridges at the balconies, deterioration of parts of the façade and prefab elements and mould growth. Additional issues are spatial problems such as the need for extra spaces for the apartments and handicap exits. These types of problems are considered typical for the buildings of the relevant period, not only in Germany, but all over Europe.
The refurbishment proposal should address these problems, along with providing a general modernization of the architectural appearance of the building. An additional requirement is to propose a solution for noise protection due to the proximity of the building to a highway on the north side.

Current situation of the building block

CASE STUDY 1

SOLUTION DE GROOT & VISSER

This type of housing is typical for many areas in Germany and the Netherlands. The floor area of the individual apartments is too small and parts of the building are very poorly insulated. These dwellings are often labeled as social housing; therefore the potential investment volume is limited.

De Groot & Visser applies a solution to increase the floor area and insulate the apartments in one single operation. Even though the balconies are small, they can be used as an extension of the apartment. De Groot & Visser insulates the balconies and creates a new glass fence for maximum light incidence.

The upper half of the newly created veranda is now open. This means added value for the apartments. The verandas can be fully closed with a movable glass panel. When open, the glass panel is parallel to the ceiling of the veranda. If closed, the panel is in line with the fence.

Since a motor supports the system, the glass panel is easy to move. Opening the panels to just a small gap already provides fresh air ventilation.

CASE STUDY 1

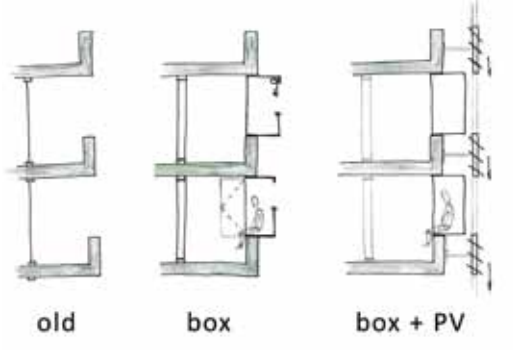
SOLUTION HERMETA

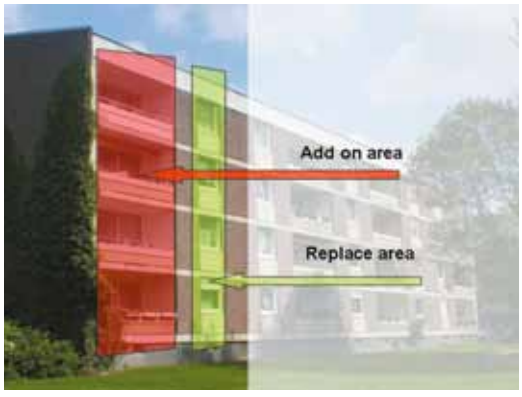
The current façade of this project consists of bricks and single pane glass.
As part of this solution, we only deal with the component glass. The concept for the renovation is called the “Look Out”. This concept will provide both additional space and comfort for the occupants.

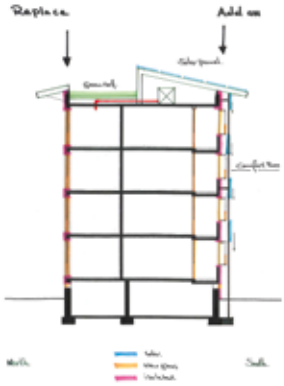
Since the building consists of repetitive units, the dimensions of the window frames are all of equal size. However, the “Look Out” concept may vary per home, providing maximum flexibility in appearance, performance and price.

The main materials used for this concept are glass and aluminum. Depending on the actual forces to be determined, the use of steel may be necessary.
The space created can be used either as a balcony or a bay window. Obviously the chosen variation will need to be decided upon in advance. The various options can be seen in the sketches.

One of the advantages of the “Look Out” concept is that the elements can be prefabricated in a variety of colors, glass types and sizes, resulting in a short construction time on site. Additional options can be integrated into the element, such as sun blinds and/or ventilation devices. Solar panels for energy generation are also conceivable.







5.2. CASE STUDY 2

TYPE Multi-residential building
LOCATION Kanaleneiland, Utrecht, The Netherlands

Kanaleneiland is an early post-war neighborhood built between 1956 and 1964. It is situated in the southwest of Utrecht and has 14,946 residents (2002). The neighborhood consists of a very high proportion of social rented housing, mainly in the form of apartments. The population of Kanaleneiland is made up mainly of families with children. The majority of the Kanaleneiland residents are dissatisfied with their residential environment (Graaf L. de).

The neighborhood consists of identical housing units. Each unit consists of two apartment blocks and two L-shaped, single-family low-rise houses, creating a nearly enclosed block. The subject of the study is one of the apartment blocks, as indicated in Figure 1.

The buildings were built according to the "VAM" construction method (Priemus, 1970, p. 12.4). The façade consists of wooden-framed, single-glazed doors and windows between the load-bearing structural elements. The frames are in poor condition and the parapets have little or no insulation.

The current condition of the blocks is considered to be problematic, not only socially but also technically. One of the main problems identified is the low thermal resistance of the façade panels, resulting in extreme heat loss. Moreover, there is moderate or no insulation in the inner cavity leaf, roof and floors. The drainage is in poor condition, resulting in leaking and sagging ceiling storage. Finally, there is no sound insulation in the floor/ceiling/walls.

The refurbishment should try to address these problems. Proposals for the modification of the floor plans along with the façade to create diversity in the residential buildings would also be beneficial.

REFERENCE

Graaf, L. de, Kanaleneiland: The place to be! An analysis on Social Partners Collaboration in the city of Utrecht, INTERACT project, Utrecht School of Governance
Priemus, H. and Elk, R.S.F.J. van, Niet-traditionele woningbouwmethoden in Nederland, Stichting Bouwresearch, Rotterdam






Current situation of the residential apartments

CASE STUDY 2

SOLUTION KREMERS

The building chosen is a good example of a typical Dutch building. Built in nice neighborhoods and well connected to public transportation, these buildings are definitely worth considering for refurbishment.

To solve all of the problems that the aged envelopes pose, the best solution is to create an entirely new envelope, following the Wrap It principle. The goal is to cover the building with a unitized façade similar to the project in Zeist. First, the unitized prefab elements will be mounted on brackets onto the existing building. After the whole façade is mounted, the old existing window elements will be removed. By doning it in this order, the disturbance for the occupants will be minimized.

To conserve the design of the building, the existing balconies will be covered with a new closed insulated façade. This will ensure that all building physical issues can be dealt with underneath the cover. This would include potentially existing cold bridges.

The overall glass ratio will be reduced to improve energy consumption rates; the amount of natural incident daylight is still at its maximum by mounting the windows as high as possible to direct natural light into the depths of the room. By adding different colors to the insulated panels of each of the different building parts, they can receive unique identities.

CASE STUDY 2

SOLUTION SOLARLUX

The given building is a very typical residential building that can be found in the entire country of the Netherlands. The assumption is that the problems with this building are nearly as typical for all those built during the same time period: bad insulation quality, leaking seals and, of course, high energy consumption and uncomfortable living conditions.

Our preferred method to refurbish this building would be to wrap it entirely with our façade products. The overall envelope cover with state-of-the-art products would address all current and future demands in terms of insulation values, ease of use and high living comfort.

A new layer of balconies would be added on the front of the old façade to enlarge the usable living space. The existing balconies would be covered with sliding and tilting windows that would transform these balconies into sun rooms that can be used all year round.

An efficient way of mounting the new façade elements would be developed to reduce noise and dust during the refurbishment, so that the building could remain occupied during refurbishment.

5.3. CASE STUDY 3

NAME Sparkasse Vorderpfalz
TYPE Office building
LOCATION Ludwigshafen, Germany

Sparkasse Vorderpfalz is a regional bank in Ludwigshafen, Germany. The head office building is located in the city center. The building presented an interesting case for a case study, because the façade structure of the 'tower' with cantilevering service platforms was relatively common in Germany during the 1960s and 1970s.
The supporting structure of the office tower is formed by steel columns and beams. The floors are made of in-situ concrete. Only four structural columns carry all vertical loads. The horizontal stiffening is achieved by the stair-case and elevator shaft.

The building features three different façade structures. The façade structure of the tower appears to be a combination of a curtain wall and ventilated cladding in one structure. It is supported by a framework of steel profiles, placed as a curtain wall in front of the floor edge and concrete parapet. This framework is filled by using pressure plates known as stick systems. The window units are equipped with insulated glass and provide the thermal layer. In front of the massive parapets, the façade is clad only with a non-insulated aluminum panel, which is ventilated in order to let air into the ventilation unit. The concrete parapets show 40mm of insulation on the inside.

All office spaces are fully air-conditioned by means of decentralized units. Fresh air is drawn in directly through the façade. It is heated or cooled by a HVAC unit in the parapet cladding and then introduced into the room. Exhaust air is then let out through the same unit without recovering heat energy. The system is controlled centrally and is not adjustable by the user.

Major constructional problems of the façade lie in rainwater entering the construction along the consoles, as well as in lacking insulation and wind tightness. Currently, the building consumes over 315 kWh/m^{2}^{2}a of energy, of which approximately 80% is used for heating and cooling. All building physical aspects have to be brought up to current standards. This shall reduce the operational costs and energy consumption significantly.
The users must be given more control over their personal indoor climate.

Today the building is used by the owner and their staff but the future intent is to rent out office spaces in small units. Keeping this in mind, the owner wishes to reduce running costs and give the building a new and modern appearance. Special consideration is needed for the fact that the interior has recently been refurbished and the building is in use. Therefore it is neither affordable nor desirable to disturb interior finishes and the working staff.

The building situation

CASE STUDY 3

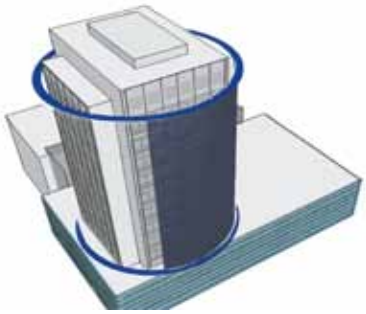
SOLUTION BRS

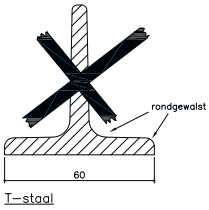
The purpose of this concept is to improve both the appearance and the comfort of the building. These goals can be accomplished by placing a modern, durable façade construction in front of the existing façade. The choice of materials and the design determine the appearance. The materials used are a combination of structural glass and sleek recyclable steel profiles. The curved shapes give the originally angular building a friendlier look.

The comfort level inside the building can be improved by integrated awnings with tiltable slats. This way, the users can adjust them to their individual preferences. The application of PV solar panels and triple glazing generates energy as well as saves energy. A special feature of this solution is that the sun screen can rotate and follows the position of the sun. This ensures an ideal indoor climate. Integrating photovoltaic cells in the glass slats of the sun screens that move with the sun maximizes the energy yield of the PV cells.

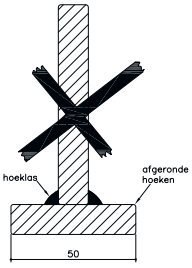
Sleek, sharp-angled and laser-welded steel T-beams with minimum beam widths of 40 x 100 mm provide sufficient clamping surface to realize a sleek, story-level span. The windows are mechanically secured from the inside and structurally glazed on the outside. The structural façade glazing can be fireproofed where needed. Maximum transparency is achieved with the story-level spans and minimal construction.

The glazing of the parking garage, located at the base of the tower, will be covered with a digital screen with 30% transparency for public safety purposes. Using digital screens, each window pane can be given a different print pattern. The different function of the parking garage is therefore distinctive relative to the office building, but fits in with the overall look of the building due to the common use of the material glass.

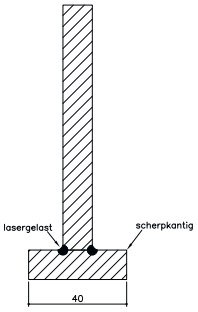




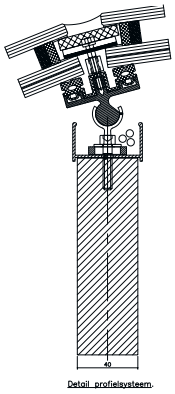
T–staal

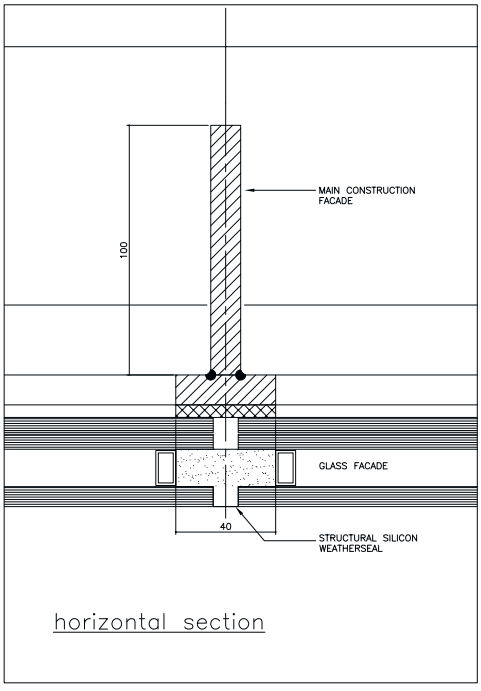


Samengesteld T–profiel

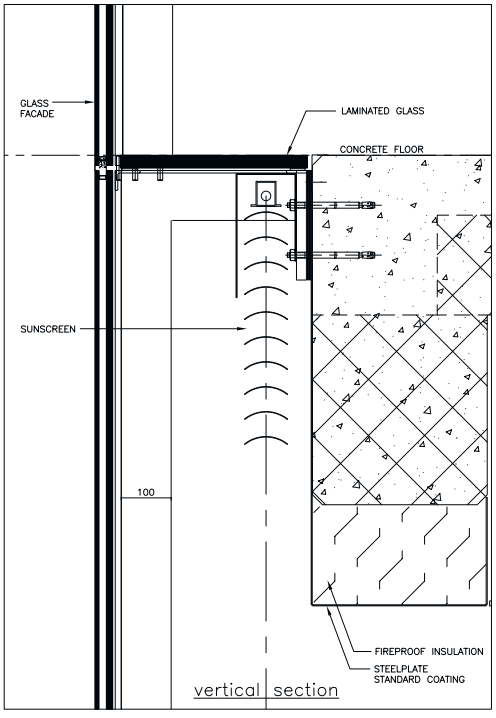


Lasergelast scherpkantig T–profiel

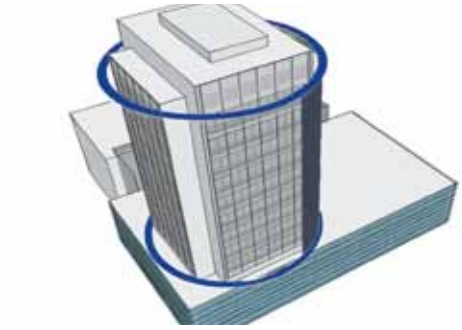

Detail profielsysteem.



horizontal section



vertical section



5.4. CASE STUDY 4

TYPE University
LOCATION Bielefeld, Germany

The concept for the university building resulted from a design competition that was won by a group of young architects in 1969. The architectural design aimed at providing a 'university campus under one roof'. It wanted to tackle the tasks of an industrialized society and take maximum advantage of the possibilities of industrial building. The university building is located on a wide lawn. All other buildings are situated at quite a distance. This is due to the original plan to provide space for expansion. Although the university desires to attract visitors, the huge building volume and the rather hidden entrance situation do not attract people that are not affiliated with the university.

The main building of the university in Bielefeld, Germany features a façade structure that was common in the early 1970s; not only in Germany but also in other Central and North European countries.
The main structure consists of a steel skeleton with concrete floors.
Both the architectural and functional concept, as well as the size of the building and the tight construction schedule resulted in an industrialized manner of production that used pre-fabricated elements.

The façade is constructed of pre-fabricated parapets of light-weight concrete. The parapets carry the window units. These are realized as a series of window frames. The main planning guideline was to achieve optimal variability of the available room sizes. Hence, the façade grid is set off the structural grid by 60 cm to allow variability of possible dividing walls. The windows are composed of 30 cm wide vertically fixed glazing that can also serve to connect dividing walls, and 90 cm wide elements with operable windows.

The façade does not supply sufficient thermal insulation. The window profiles were designed specifically for this project and are not equipped with thermal separation. The insulated glass dates from the 1970s.
The façade is not wind tight and provides a very low insulation level.
Special zones, such as the library, show a curtain wall of steel profiles that is equipped with insulated and – in some places – single glass panes. These façades do not fulfill any of the current standards and are characterized by cold bridges and condensation.

The following U-values can be estimated:

Concrete parapet	2.13
Window	3.15
Roof (partly refurbished)	0.13 – 0.43

The refurbishment plan wants to deliver innovative solutions that generate an added value for the campus. It has to create a building with up-to-date building physical properties and technical installations. The limited structural capacities as well as the need to remove toxic materials are special tasks in this project.

The current status of the building complex

CASE STUDY 4

SOLUTION BRS

The purpose of this building project is to create conditioned indoor spaces by covering outdoor spaces with steel and glass constructions. These indoor spaces can be given various (new) functions.

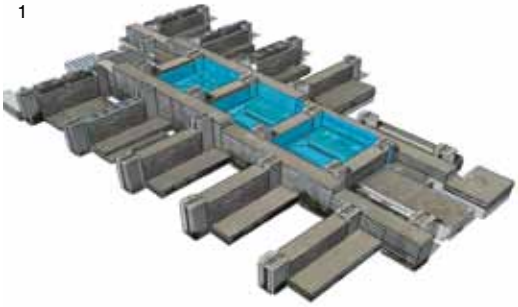
A glass entrance will be created which will be clearly recognizable for visitors. It will also serve as a meeting place. The other outdoor spaces within the building complex can be covered in order to be used for various functions such as sun lounges, a tennis court, swimming pools or a restaurant. Leisure facilities in a well-lit area will have a positive effect on the comfort of the students. Moreover, the roofing protects the existing buildings against the weather, resulting in reduced maintenance costs. The existing building shell will lose less energy due to the glass cover.

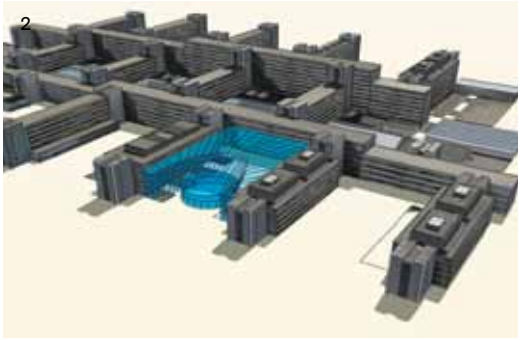
The heat generated underneath the glass construction can be utilized for heating the building. During summer, the heat can be used for heating water and the remainder can be stored underground and retrieved in the winter with heat pumps for air, floor, and wall heating of the building.

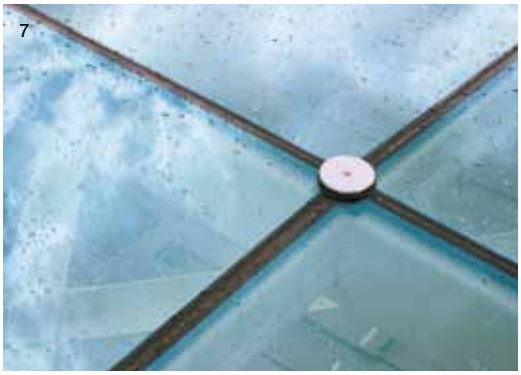
Factors such as energy, health and design have played an important role in determining the choice of the construction. Large spans are realized with a construction of steel beams and columns. They carry the slightly curved glass roof made of cold bent insulation glass. The cold bending process is done on site on a round rolling support construction.

The curved roof provides good drainage and can be easily implemented with the cold bent glass chosen for the construction. It creates a nicer appearance than buckled roofs. The transparency is greater than with traditional glass roofs because the glass is mounted directly on the steel with EPDM rubber. No extra rods are needed. Moulding is not required either and there is no overheating of the glass during the bending. Warm bent glass for glass roofs is not a viable option due to the high cost involved; about twice the cost of a cold bent glass roof. Additionally, cold bent glass has better optical qualities than warm bent glass.
A sliding roof ensures natural ventilation and can be adjusted on demand. The spaces created can be utilized during day and night time due to the integration of LED illumination in the steel construction.

Overall, the new design provides the building with a special look, whereby the entrance and the interior spaces can be utilized by the users.







1 – 2 Different concepts to cover the building wings
3 – 7 Images of possible solutions

CASE STUDY 4

SOLUTION DE GROOT & VISSER

This building is ready for metamorphosis. De Groot & Visser developed their own façade system, which can be applied to concrete structures. The entire building is stripped down to the bare structure, and a new façade is applied to the floors using brackets.

The façade system used is called All-in-One Façade and has the unique properties of three existing façade systems: It's as slim as a curtain wall, as easily constructed as a traditional window system and assembled as quickly as an element façade.

The university was built in the 1970s. Because the insulation is poor throughout the entire existing façade, an integrated upgrade is needed. In this case stripping down the building to its bare structure is the most efficient way to deal with the refurbishment. Partly renovating the building would be either more expensive or simply not effective enough.

The All-in-One Façade is a highly insulated façade that is applied in cases where the goal is to achieve a highly rated energy label. Without the need of other parties, De Groot & Visser can enclose an entire building with this façade in a fast, aesthetic, economical and 'green' manner.

6. PRINCIPLES

6.0. INTRODUCTION

Refurbishment is a challenge, all the current demands have to be addressed. Building physics, improved insulation, energy saving, load bearing properties and new functionalities …just to name a few aspects, have to be taken into account. The principles and concepts in these chapter will of course address these aspects but we asked the participating companies to open their minds and think out of the box. So the following concepts include small ideas to improve the refurbishment or will even turn the whole process upside down. Just a few exsamples: Why not extend your own old office with an extra space that comes strsight from the factory with a specialized employee in it? Can we use materials that will change its properties over the day or season to improve its performance, or why don't we cover our whole neighborhood to improve all of the buildings in one attempt….

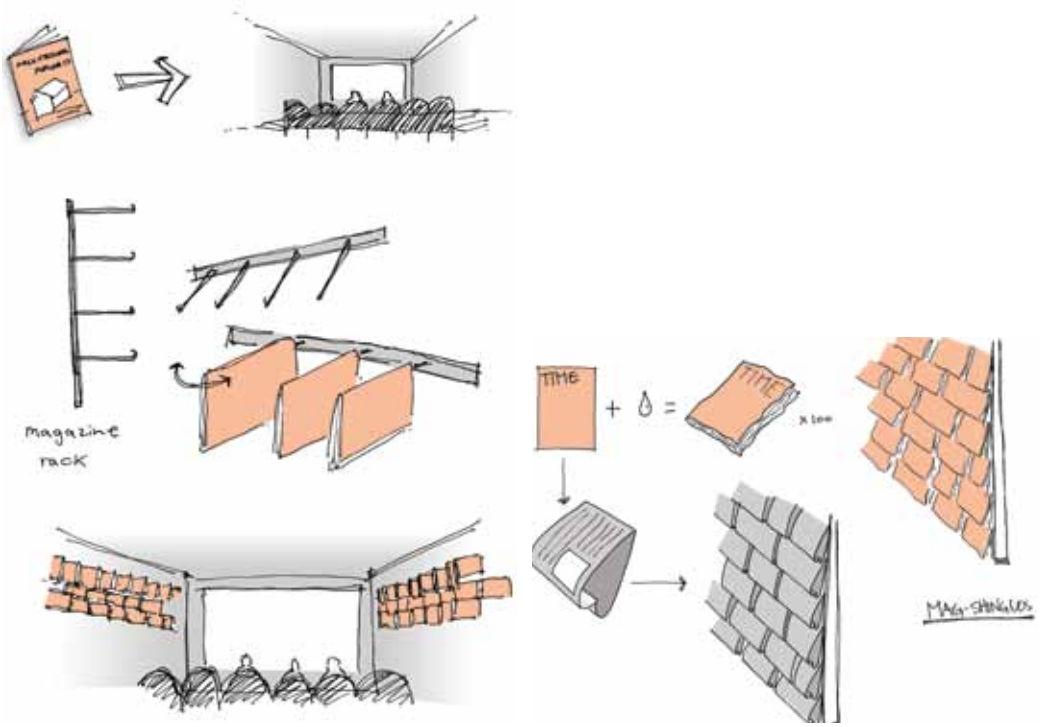
Beside these topics, all of the ideas illustrate that there is still more to discover within this field…and of course refurbishment can be sexy!

ACOUSTICAL MAGAZINE RACK

12-04-2011

IMAGINED BY Washington University St. Louis and TU Delft Workshop “Re-Imagine the Envelope”
KEYWORDS add-on, acoustics, waste material, magazines

Typically, acoustical panels are applied in auditoriums for better sound perception and to soundproof the exterior spaces. However, this is not the case in multi-functional spaces that are only occasionally used as an auditorium. To improve the acoustics in such spaces, old magazines can act as acoustic panels. Stacking the magazines on movable racks increases flexibility and optimizes the use according to the given requirements. During acoustic performances, the racks can be tilted to an optimum acoustical angle. When the performance is over, they can be folded back to occupy less space. And the magazines provide reading materials for the audience before performances start or during intermissions.

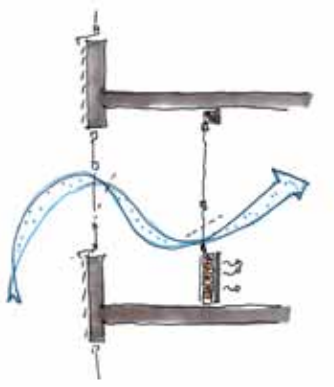


ADD IN 1

14-10-2011

IMAGINED BY IPC Workshop session “Re-Imagine the Envelope”
KEYWORDS wrap it, inverse, internal refurbishment, additional layering

This principle suggests adding additional surfaces to the inside of an exterior wall to provide the required insulation level and technical performance for the construction. This is done to keep the outer surface untouched but, at the same time, provide the building with up-to-date functionality. The construction should be installed as a fixed additional layer; providing all necessary technical functions and services.

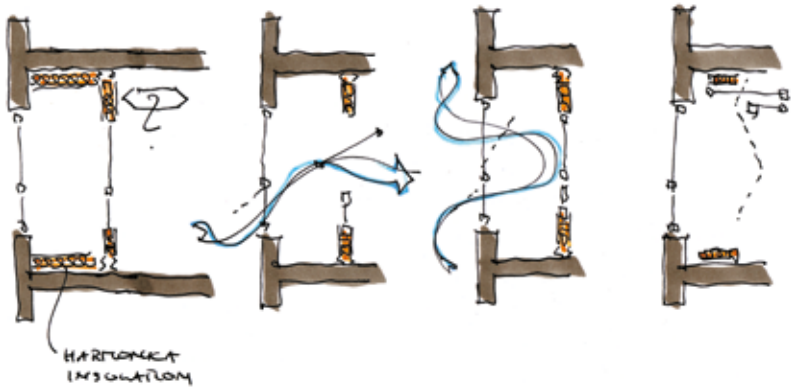


ADD IN 2

14-10-2011

IMAGINED BY IPC Workshop session “Re-Imagine the Envelope”
KEYWORDS wrap it, inverse, internal refurbishment, additional layering

Principle Add in 2 is an extension of principle Add in 1 in that the added inner surface takes on more functional and climatic uses: Changing functions such as ventilation, transparency, humidity control and acoustical performance, this inner surface would be an improvement of the overall building skin. Occupants can adapt the inner surface to their individual needs. In parallel, the existing outer building envelope maintains its constructional and technical performance and – even more importantly – its aesthetic appearance.

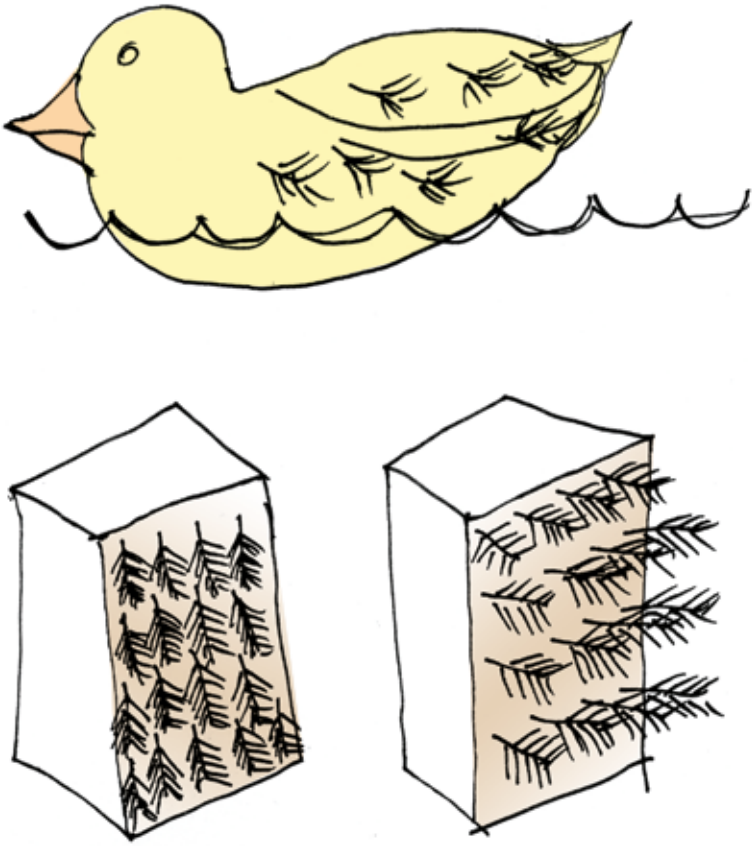


(ADJUSTABLE) FEATHER ENVELOPE

13-10-2011

IMAGINED BY IPC Workshop session “Re-Imagine the Envelope”
KEYWORDS add on, cover it, adaptive envelope

Nature is an indispensable source of inspiration; not only for how the envelope can adapt to external conditions but also how it can be retrofitted. Bird feathers are such an example. Feathers provide birds with waterproofing and insulation and block harmful UV rays from reaching the animal’s skin. In addition, they allow the skin to cool down when required. Just like the building envelope, over time feathers suffer from physical wear, which compromises their insulating qualities. To address this issue, birds shed and replace their feathers periodically in a process called molting.

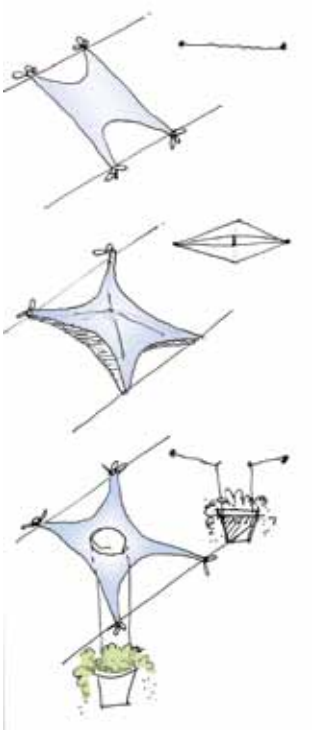


BAG CANOPY

12-04-2011

IMAGINED BY Washington University St. Louis and TU Delft workshop “Re-Imagine the Envelope”
KEYWORDS cover it, grocery bag, recycling, low budget construction

This principle conceives grocery bags combined into a canopy structure over a parking lot. By cutting the bags along their sides and unfolding them, a larger surface can be obtained, for example for shading. Cables could be strung between existing light fixtures in a parking lot, with the bags stretched out between them. As a further exploration, three different bag modules were developed: One just for shading, one for shading and insulation, and one for plantings. By arranging these modules in different patterns, based on the needs of each section of the parking lot, the canopy can take on a unique and dynamic form.

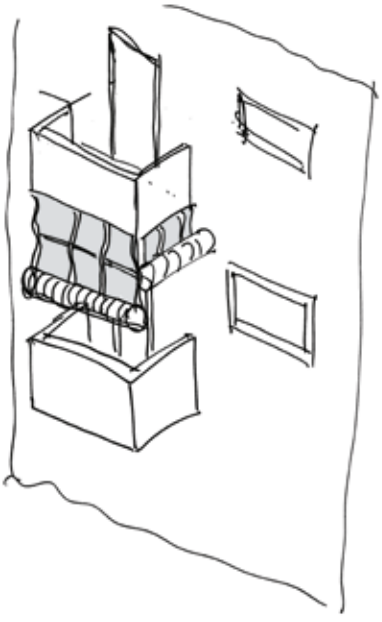


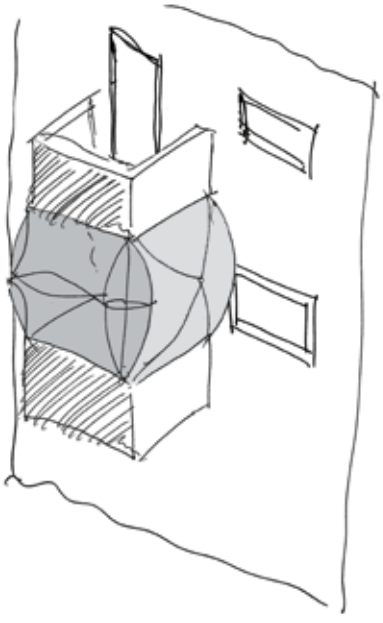
BALCONY WRAP

28-05-2010

IMAGINED BY Solarlux, Ulrich Knaack, Thaleia Kontantinou, Marcel Bilow
KEYWORDS thermal envelope, balcony, textiles, membrane, temporary solution, wrap it

Besides the more common solution of covering an existing balcony with glass elements, a more temporary solution such as a wrap made of foil or translucent textiles could be applied. This could be a DIY project with the materials being readily available at the local hardware store. Alternatively, companies could develop such wraps with more sophisticated materials to provide better performance, and use these low-cost solutions to attract customers for more permanent solutions made of glass at a later stage.



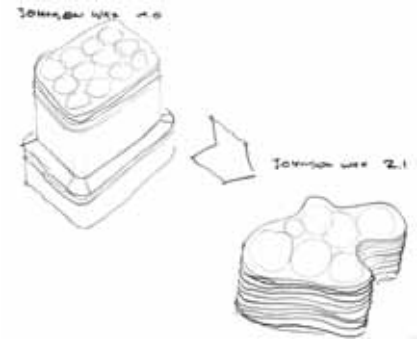


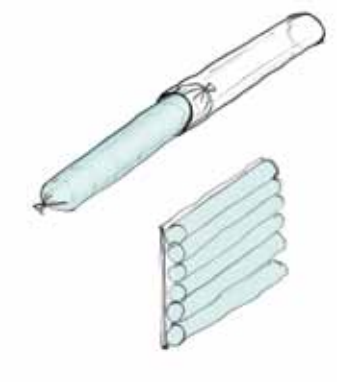
BOCKWURST FAÇADE

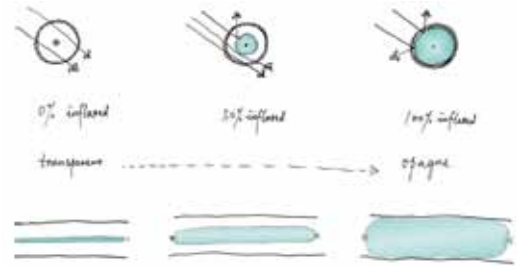
12-04-2011

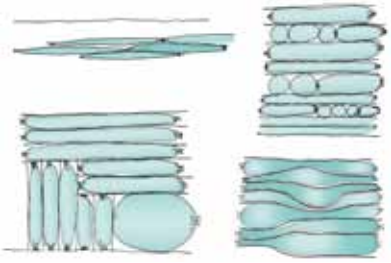
IMAGINED BY Washington University St. Louis and TU Delft workshop “Re-Imagine the Envelope”
KEYWORDS glass tubes, shading, replace

Think about the famous project Johnson Wax Headquarters by Frank Lloyd Wright in Racine, Wisconsin: use glass tubes as a façade construction principle and use them to create free-form architecture; then provide shading within the tubes – and we have a new typology of building envelopes: free-form, translucent and adaptable. Obviously the detailing needs to be worked out to achieve tightness and control of the ‘Bockwurst’ within the glass tubes – more room for further exploitation!







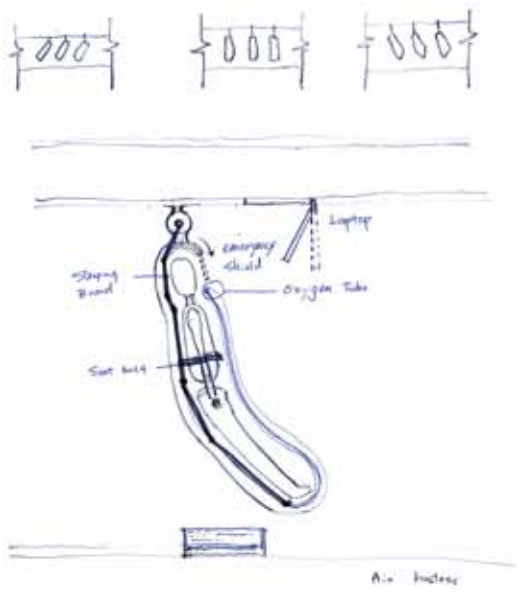


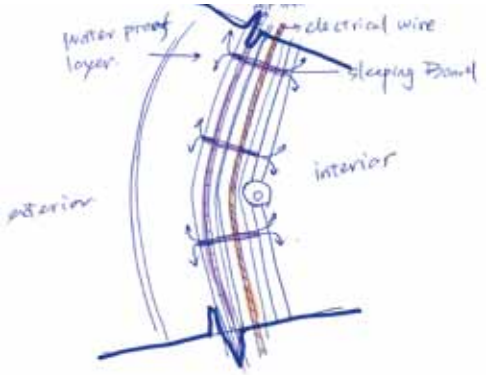
COCOON COMFORT

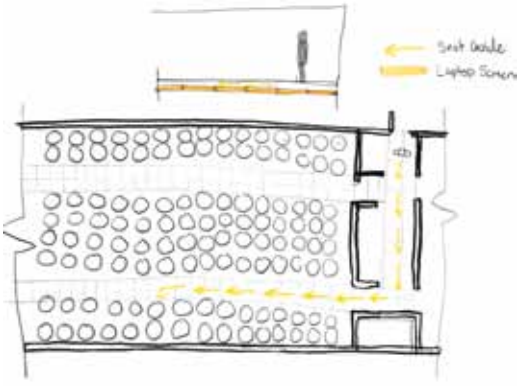
12-04-2011

IMAGINED BY Washington University St. Louis and TU Delft workshop “Re-Imagine the Envelope”
KEYWORDS cocooning, individual environment, personalizing architecture, cover it

An alternative principle to refurbishing our aging buildings would be an individual cocoon for the human being in his or her environment. Thus, the idea is to cover our bodies with a cocoon to provide comfort (oxygen, temperature, etc), and to then place our cocooned selves in the existing buildings which would be outfitted with suspended rail systems. The rather important issue of human interaction still needs to be solved….





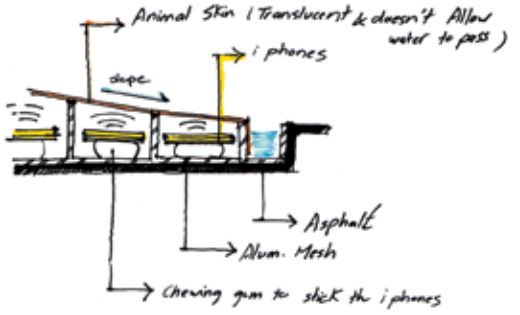


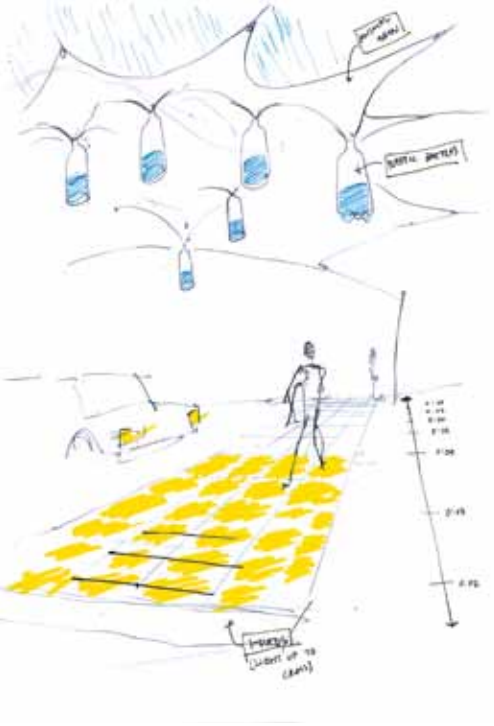
CROSSWALK

12-04-2011

IMAGINED BY Washington University St. Louis and TU Delft workshop “Re-Imagine the Envelope”
KEYWORDS cocooning, individual environment, personalized architecture, cover it

This principle investigates the potentials of interacting surfaces: Floors that respond to the user’s actions, made out of users’ covered iPhones, ceilings made with PET bottles that would improve the thermal mass of the surface or even provide the ability to control the temperature.
The goal is to employ recycled objects for the refurbishment of an existing construction and thereby develop a new environment.



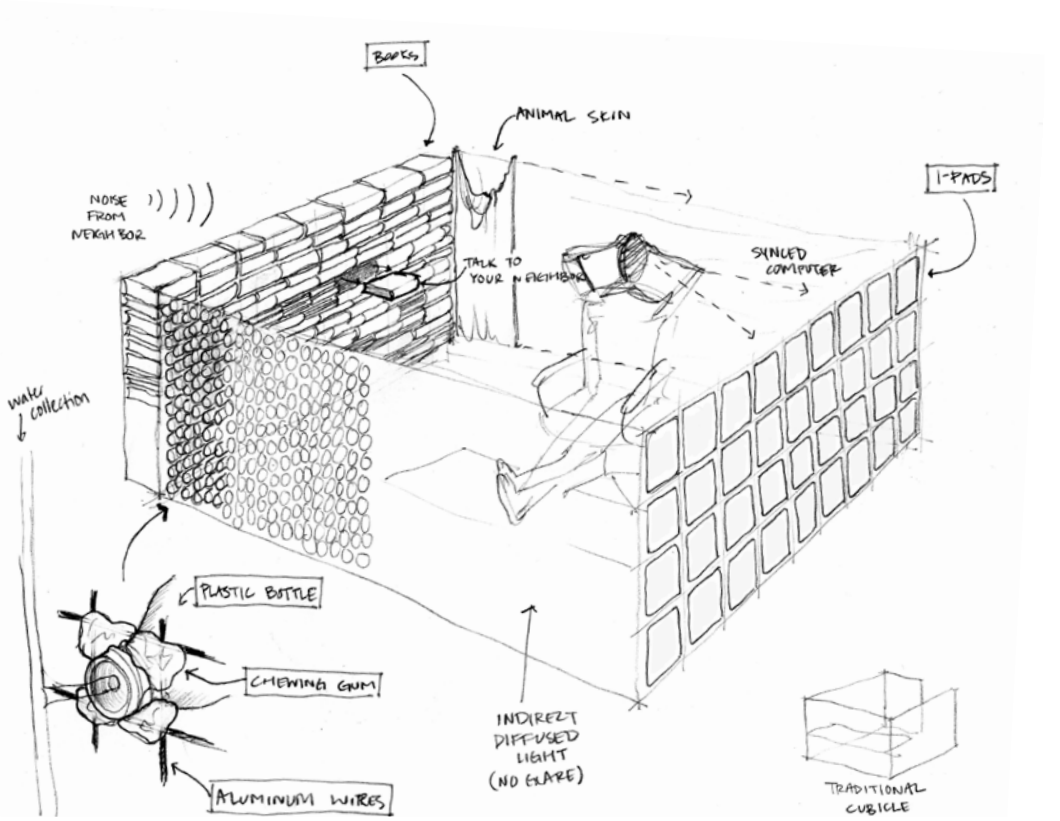


CUBICLE

12-04-2011

IMAGINED BY Washington University St. Louis and TU Delft workshop “Re-Imagine the Envelope”
KEYWORDS façade, office, structure, recycling

This principle involves the idea to rethink everyday items as material to construct space. Think of a traditional office cubicle: it consists of partitions, a desk and a chair, but there are also books, notebooks, computers, iPad’s, water bottles etc. All of these elements can replace the construction elements that define the space. For example, walls made from books with the added benefit of soundproofing from the neighboring cubicles. A partition made of plastic bottles could serve as a light diffuser, while the computer could be replaced by an iPad wall.

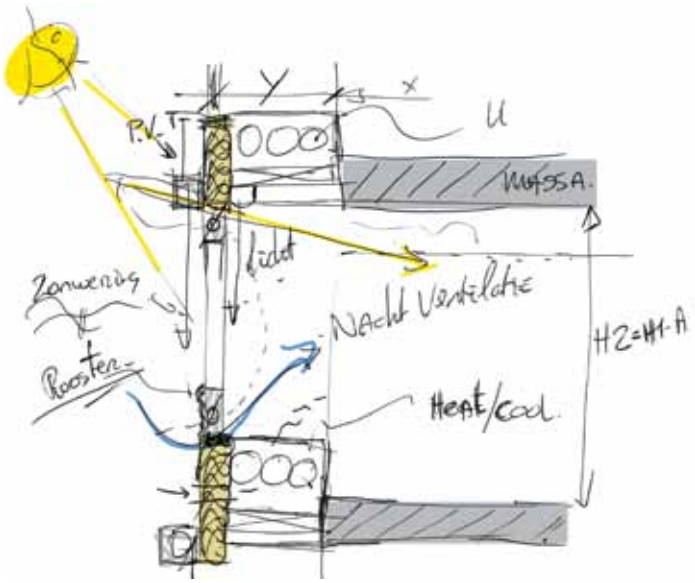


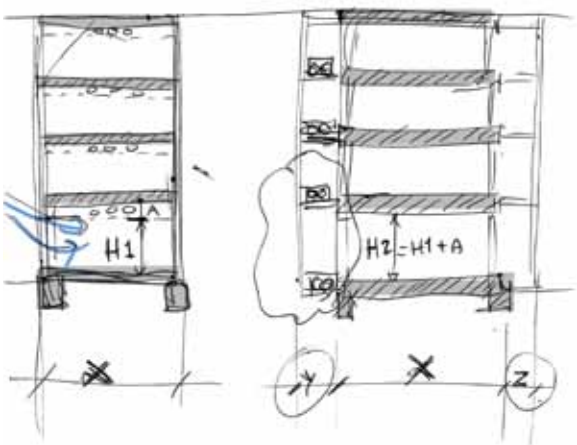
DAYTIME INSULATION

13-10-2011

IMAGINED BY IPC Workshop session “Re-Imagine the Envelope”
KEYWORDS wrap it, night cooling

Thermal bridges in concrete structures are a major source of heat loss in old buildings that need to be addressed with external insulation. However, one way to reduce cooling loads during summer is night time ventilation, which cools down the thermal mass of the building during the night so that the mass can restore heat during the following day.
In this sense, thermal bridges could actually help to cool down the structure and enhance the night ventilation effect. One idea is to use adjustable insulation that can be removed if so required. This way, the thermal mass of the structure could be re-activated during night ventilation.



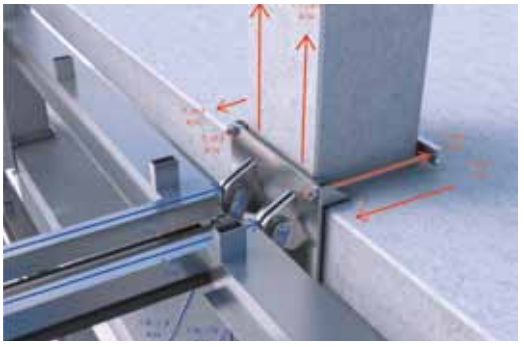


DEMOUNTABLE CONSOLE AND FRAME

15.01.2012

IMAGINED BY Peter van Luijn, Willem Kok
KEYWORDS refurbishment, structure, flexibility, add on, facade

For refurbishment purposes, the most common way to attach new façade elements onto an existing structure is to use chemical glue anchors. However, since this is a very permanent mounting method, the architect can design the building for “here and now”; but the “then and there” is a hypothetical scenario.
This highlights an important issue of any refurbishment project: The degree to which the projectcan be changed or updated again, either if the owner desires this for repurposing reasons or if the life time of the new, refurbished façade has been reached after 20 to 30 years.
This principle addresses this issue by proposing a solution that will have minimal impact on or interference with the main structure of the building by keeping the level of decoupling as large as possible.
The concept uses a console to attach a new façade onto the existing structure. The console is clamped around the columns and floor edges and is thus attached to the building without permanent fixtures based on the principle of square lashing. Hinges and a cable system are attached to the console plate to hold the horizontal frame in place. The horizontal frame provides the required extra floor space for a larger floor plan or outdoor space. The most import and intelligent aspect of the console design is the symmetry and combination of tensile and compressive forces that are the same, however in opposite directions. This means that in theory the forces equalize each other.

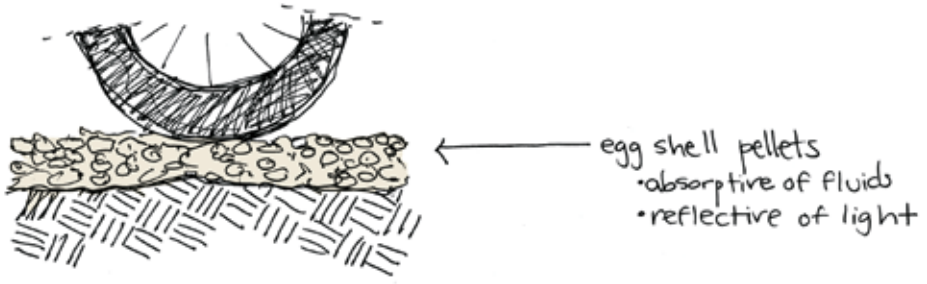


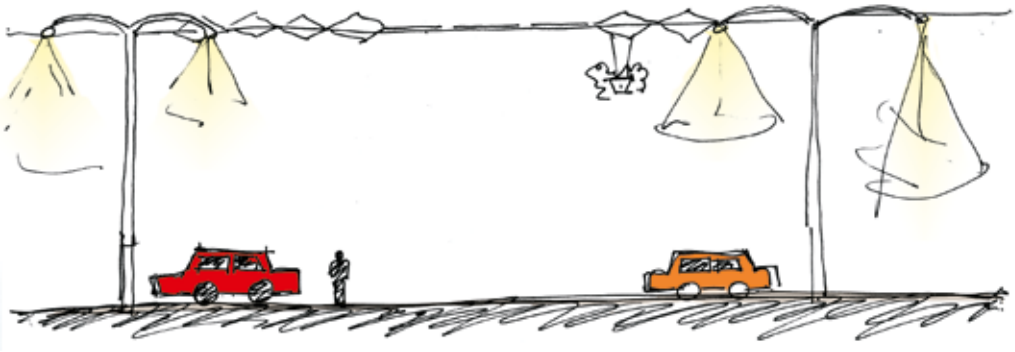
DRIVING ON EGGSHELLS

12-04-2011

IMAGINED BY Washington University St. Louis and TU Delft workshop “Re-Imagine the Envelope”
KEYWORDS cover it, grocery bag, recycling, low budget construction

How do you use eggshells to refurbish a parking lot? That is the question our team tried to answer during a workshop session. While conducting research on the properties of eggshells, we discovered that they are made of calcium carbonate, a very absorbent material. Thus, it would be beneficial to use crushed eggshells as a parking lot surface because the material would absorb any toxic/harmful fluids leaking from cars and prevent them from seeping into the ground. In addition, the light colour of the eggshells would reflect light and thus reduce the heat island effect.



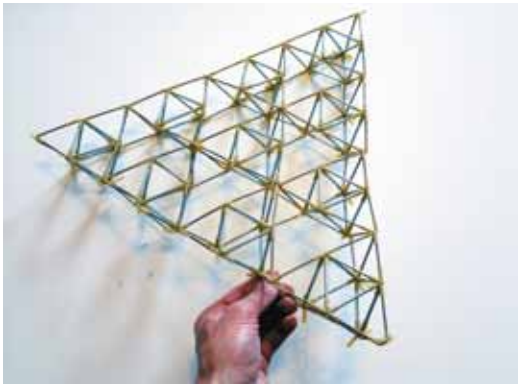


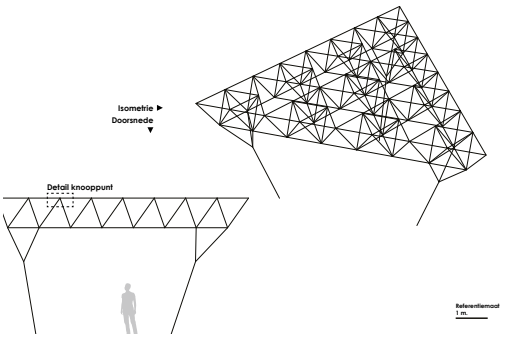
DYNAMIC ENVELOPE

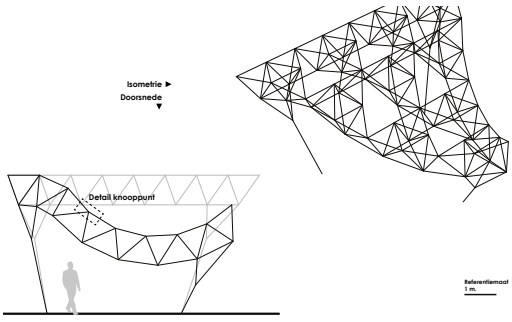
13-10-2011

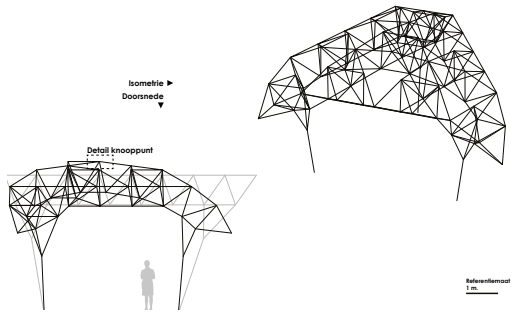
IMAGINED BY IPC Workshop session “Re-Imagine the Envelope”
KEYWORDS add on, cover it, adjustable structures

The more dynamic a building can respond to external conditions, the more efficiently it performs. This principle involves a dynamic structure that can be added to an existing building to create extra dynamic space. The structure could potentially move along with the angle of the sun to provide shading and/or could create openings for ventilation. Moreover, such a dynamic structure could change the space/volume of the building on demand.







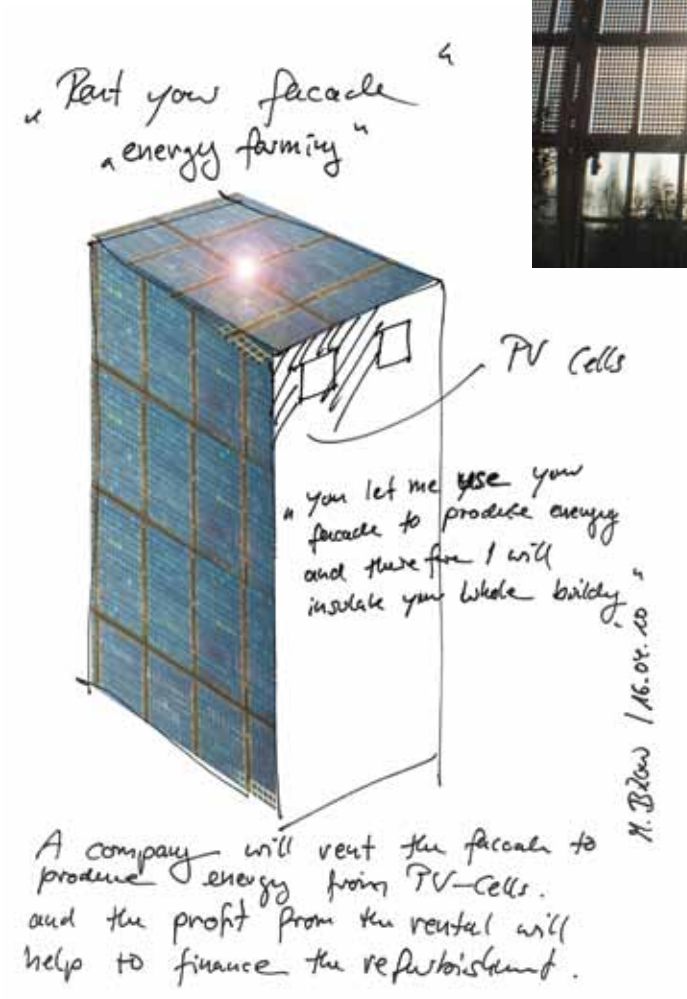


ENERGY FARMING

16-04-2010

IMAGINED BY Ulrich Knaack, Marcel Bilow, Thaleia Konstantinou
KEYWORDS wrap it, PV cells, smart material, cladding, façade, energy production

Of course, this principle is already widely applied on rooftops – all that is needed is permission to erect a photovoltaic system on your roof to produce energy, the equipment is installed and everyone is happy…. However, the next step should be to incorporate this principle into our facades.

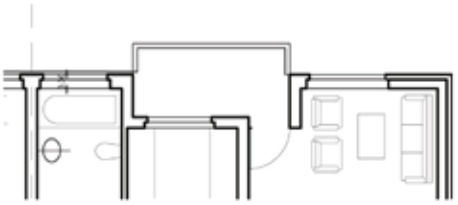


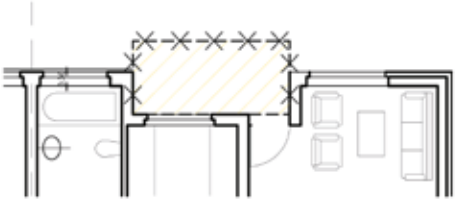
EXTEND THE BALCONY

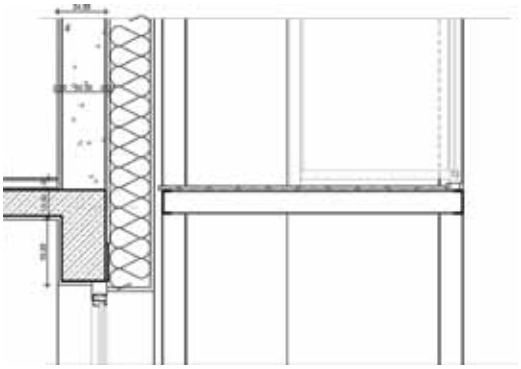
16-04-2010

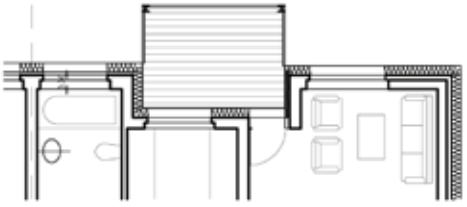
IMAGINED BY Ulrich Knaack, Thaleia Konstantinou
KEYWORDS add-on, balcony, extending living space

A balcony is like the small version of a private garden, so living above the first floor does not have to exclude you from a nice place to enjoy time outside. If there already is a balcony attached to the building, but it causes a thermal bridging problem, tear it down and replace it with a bigger one. This can easily be done by adding a self-supporting structure that will carry the weight of the balcony. In this case, the structure stands next to the building and the problem of thermal bridging is solved.







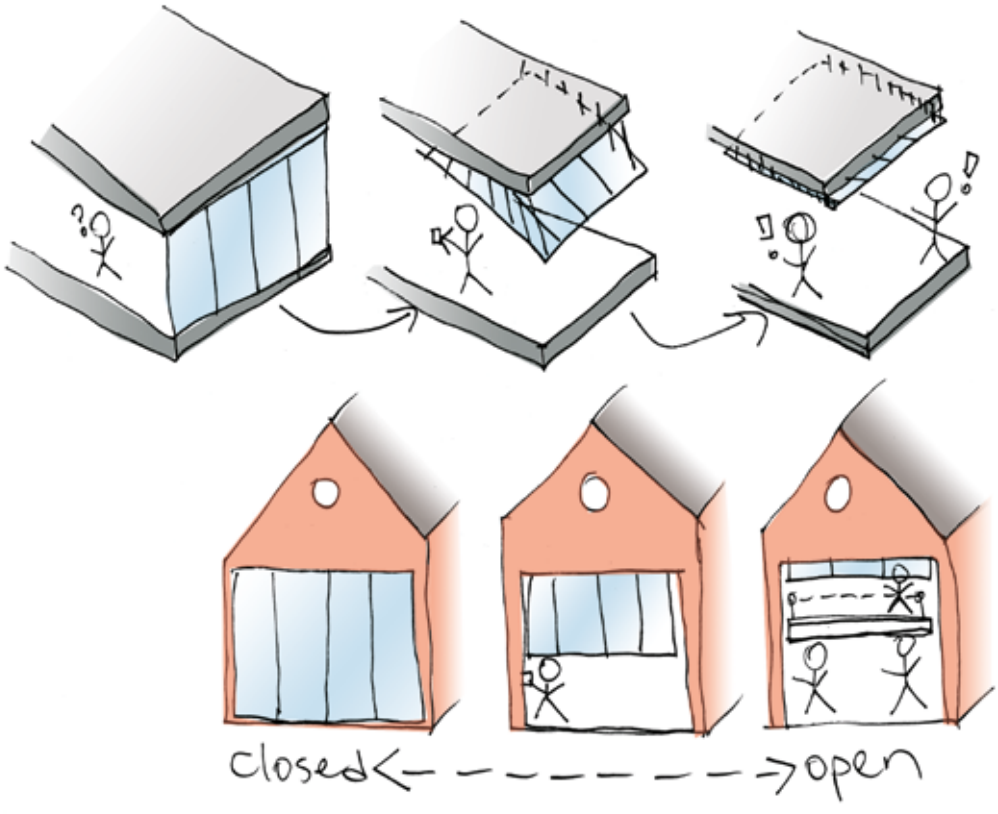


GARAGE CONCEPT

13-10-2011

IMAGINED BY IPC Workshop session “Re-Imagine the Envelope”
KEYWORDS replace, adaptive envelope

Temporary adjustment of the building envelope has always been an important aspect when considering improved façade functionality. Opening windows try to serve this exact purpose. The garage concept is taking this principle one step further. An openable façade panel based on the principle of the garage door provides the opportunity to entirely eliminate the inside-outside barrier. Thus, the living space can be expanded and undisturbed views are made possible. The advantage of this concept over sliding doors is that no extra space is required, as the façade panel moves into the ceiling.

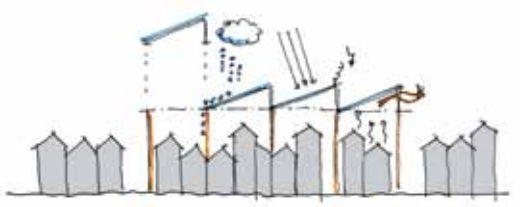


NEIGHBORHOOD HANGAR

13-10-2011

IMAGINED BY IPC Workshop session “Re-Imagine the Envelope”
KEYWORDS cover it, superstructure, glasshouse, light structure

One principal solution to improve the quality of the building envelope would be to cover an entire building block or even neighborhood with a large megastructure: This means that the building envelope itself does not need to be redone, and existing technologies and aesthetics will not change. But at the same time, the technical performance (water, insulation, ventilation, etc.) can be improved and even be pushed to the point of generating energy for self-sustaining use. Besides the technical impact, this concept could change the function and architectural quality of a building or neighborhood.

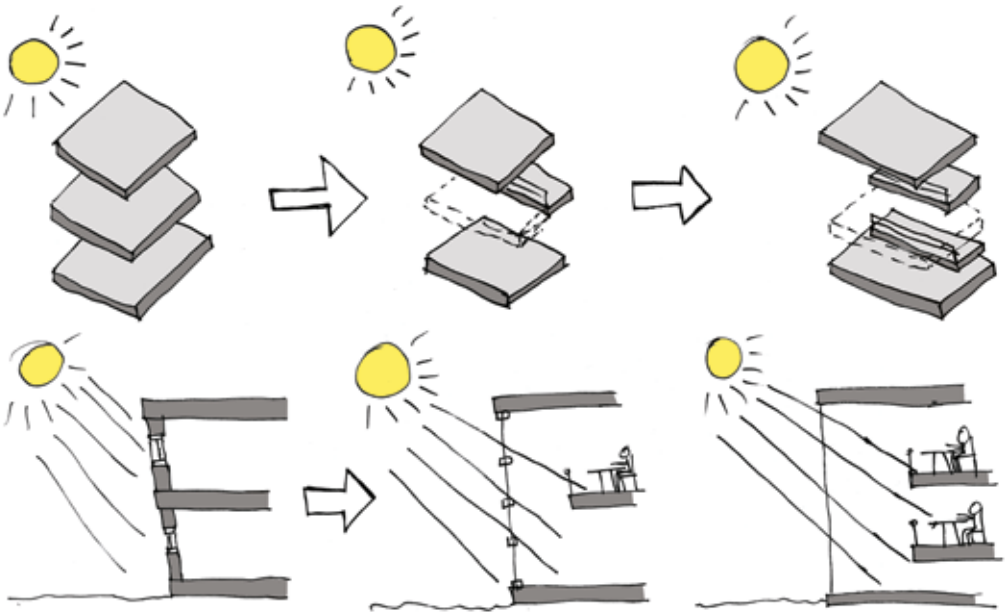


LESS 4 MORE

13-10-2011

IMAGINED BY IPC Workshop session “Re-Imagine the Envelope”
KEYWORDS replace, cut-off slabs

There were times when society required huge amounts of additional square meters to be produced in a very short period of time and on very low budgets. The result are many old buildings that exhibit a lesser standard of quality than we expect today, e.g. low floor-ceiling heights, small openings etc. However, the quality of such buildings can be improved by cutting out parts of the floor slabs to connect spaces vertically. Even though some floor space will be lost in the process, the final result provides higher comfort levels and higher quality homes for the users, because the spaces created are higher, airy and offer better lighting.

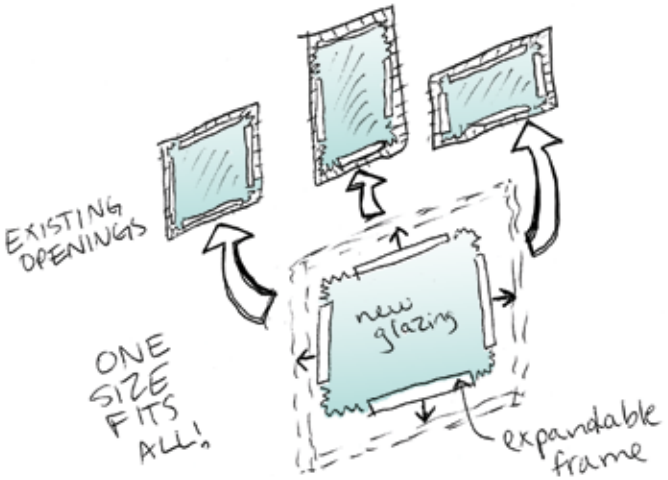


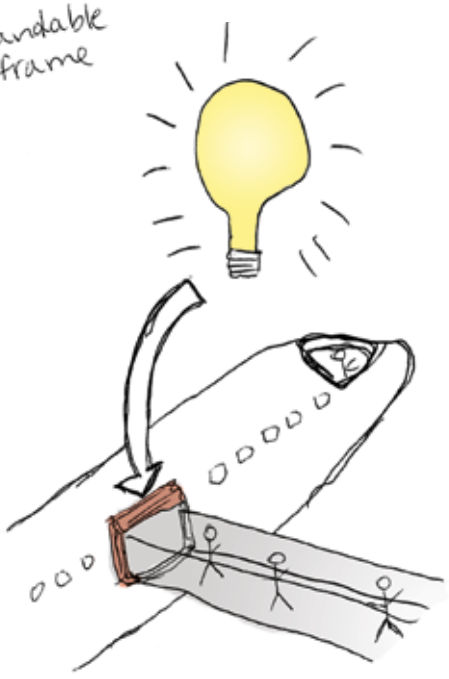
ONE FITS ALL

13-10-2011

IMAGINED BY IPC Workshop session “Re-Imagine the Envelope”
KEYWORDS replace

One of the main problems with refurbishment projects is that they require a high degree of customization, due to excessive tolerances, construction failures of the old building etc. This results in high costs and long construction times. The one-fits-all concept tackles this issue by proposing a replacement window that fits openings of all sizes. The principle is based on the idea of creating an adjustable frame using harmonica joints.



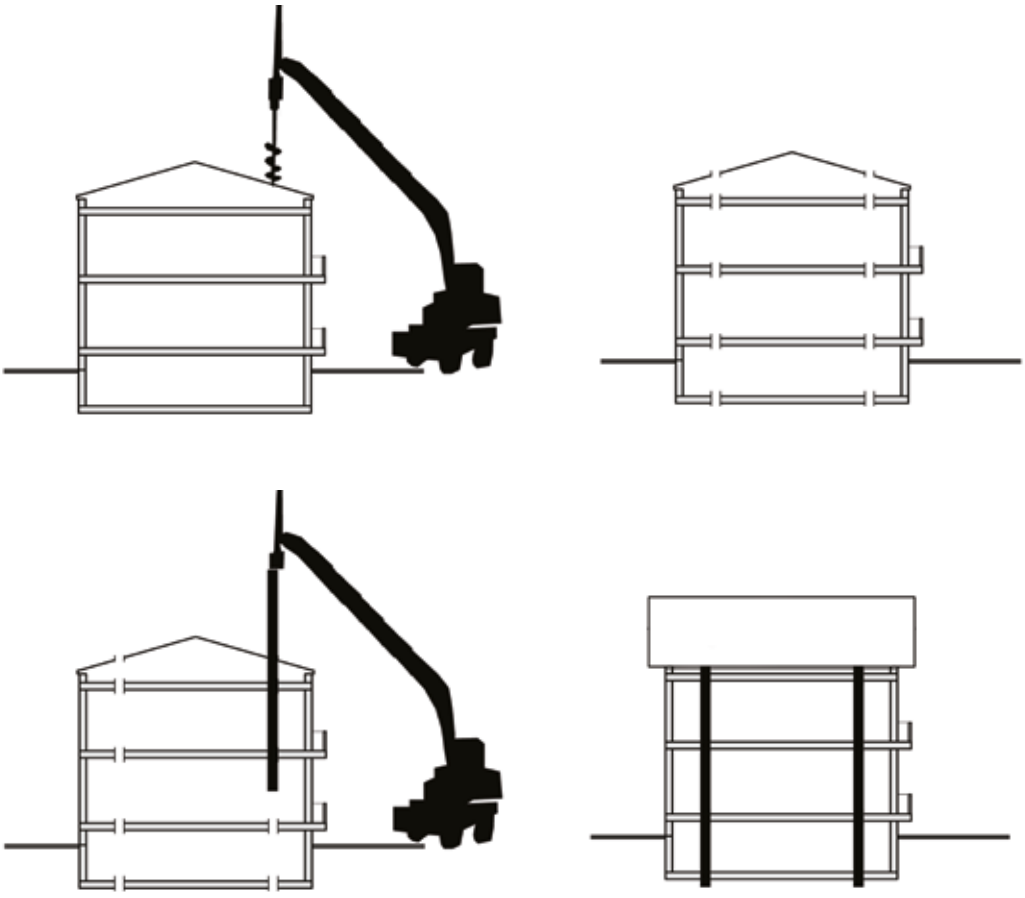


PIERCING

16-04-2010

IMAGINED BY Ulrich Knaack, Thaleia Konstantinou
KEYWORDS add-on floor, load-bearing structure, drilling

When planning a refurbishment project, you often encounter the client's wish to add additional floor space while construction is already underway. The addition of an extra story on top of the existing building is one solution. However, in many cases the existing structures are insufficiently stable to support an extra floor. Therefore, an independent load-bearing structure is required for the additional story. By piercing apertures through the existing floors, the necessary support for a new story could be created while maintaining the footprint of the existing building, and without occupying any of the external spaces.

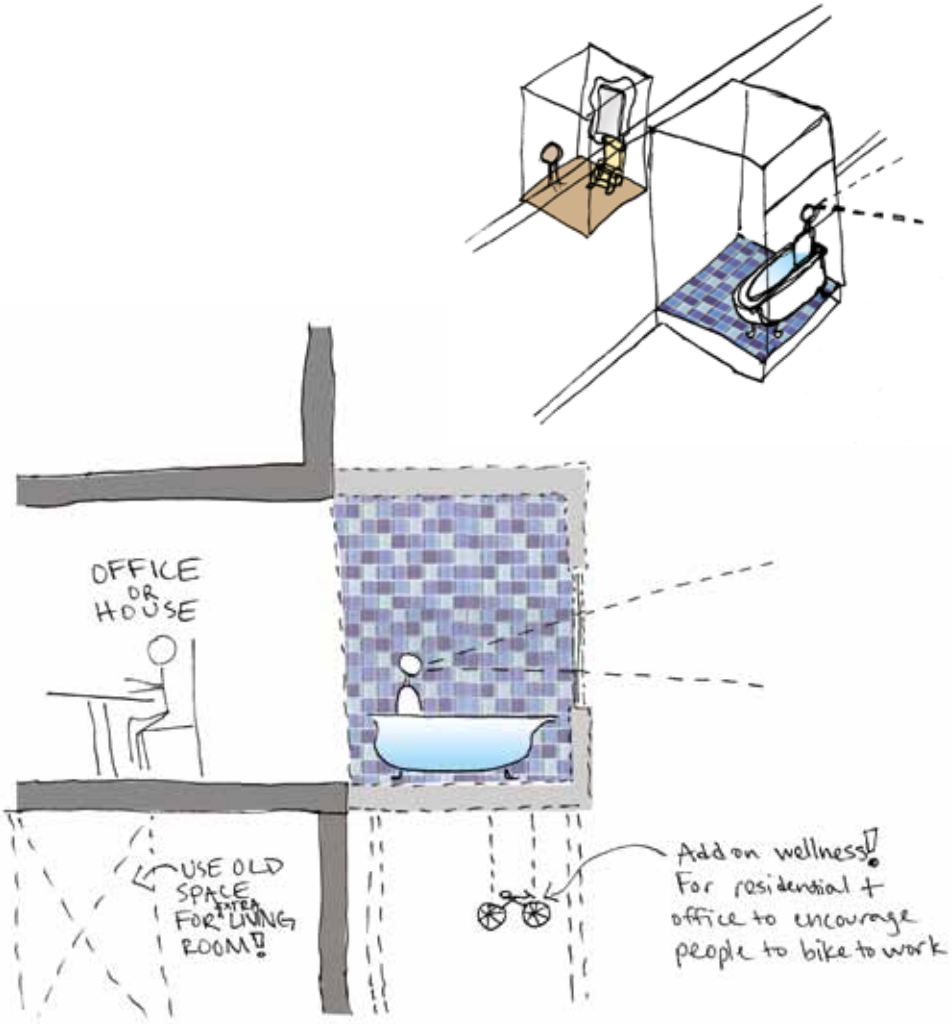


PLUG IN BATH

13-10-2011

IMAGINED BY IPC Workshop session “Re-Imagine the Envelope”
KEYWORDS add-on

Modernization of the bathroom is one of the most frequent requests as part of refurbishment projects. However, this wish typically poses particular additional challenges to the project due to limited space, inadequate technical installations and a high degree of inconvenience for the user during construction time. Installing an additional replacement bathroom on the façade can solve these problems. The new bathroom will be prefabricated with minimum construction time on site. Moreover, the addition will have fewer limitations and more possibilities for upgraded, luxurious sanitary facilities.

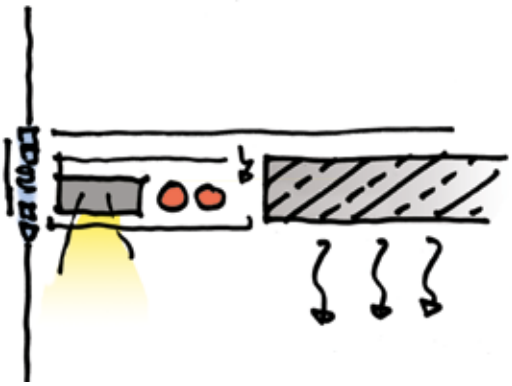


PLUS AND MINUS

13-10-2011

IMAGINED BY IPC Workshop session “Re-Imagine the Envelope”
KEYWORDS add on, service facilities, missing floor-to-floor height, additional floor surface

One of the mostly frequently occurring problems of refurbishment projects is insufficient floor-to-floor height within the existing buildings – particularly in office buildings.
By removing suspended ceilings and adding the service units in front of the floor slab, this concept increases floor height as well as lettable surface area. In addition, the thermal mass of the existing structure is activated, and, in combination with natural ventilation provides better control against overheating.
This concept is mainly driven by the desire to improve technology – but it can also be instrumental in defining and developing the overall architectural appearance of the building through the appearance of the building envelope.

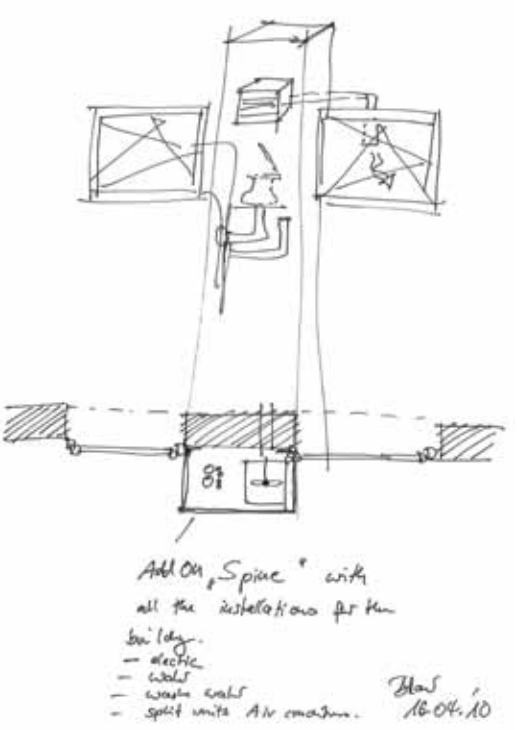


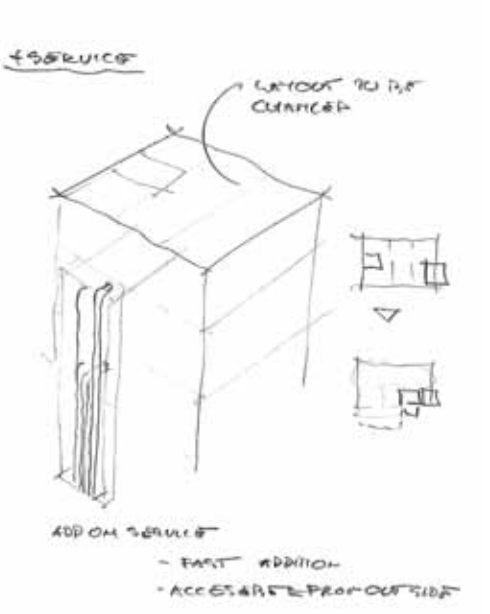
PLUS SERVICE

16-04-2010

IMAGINED BY Ulrich Knaack, Thaleia Konstantinou, Marcel Bilow
KEYWORDS add-on, building services integration, external solutions, easy maintenance

With residential refurbishment projects, the layout of the entire building may change to achieve certain improvements. Drilling vertical shafts through the building to accommodate new technical installations can cause problems.
One concept to address such issues could be an addition of an external installation shaft that functions as a spine, including all necessary pipes and cables. The result would be increased flexibility in rearranging the existing floor plan if so desired, and easier maintenance, because the technical installations could be accessed from the outside without disturbing the occupants. Of course, the shaft needs proper insulation.



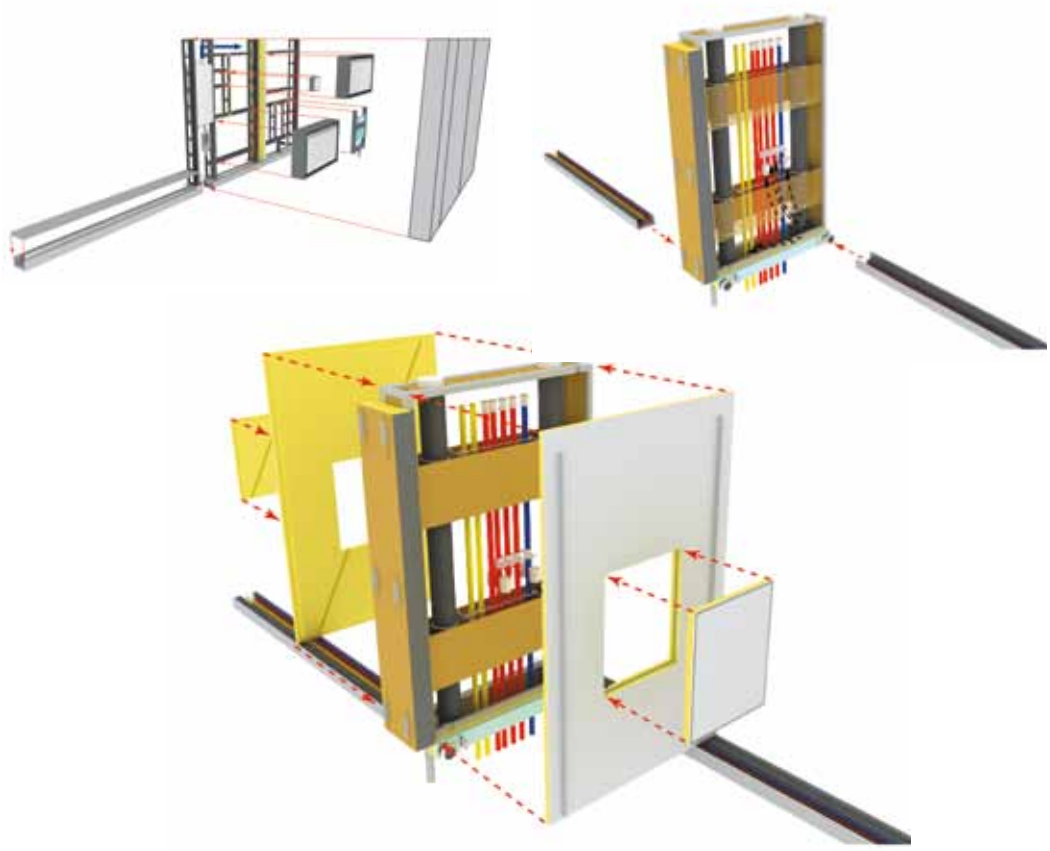


PREFABRICATED DISTRIBUTION SHAFT

15.01.2012

IMAGINED BY Peter van Luijn, Willem Kok
KEYWORDS refurbishment, mechanical service components, distribution, shaft

A common problem when transforming office space into residential dwellings is the difference in necessary distribution shafts. Instead of one central shaft, multiple separated shafts are required to accommodate the new infrastructure. Penetrating or the mere interference with existing structures can result in unpredictable structural behavior, and is sometimes impossible.
To avoid this problem, the necessary shafts can be placed outside the existing floor plan, inside the façade layer. The installation shaft is a prefabricated element that merely requires being placed and connected on the building site. The dimensions of the shaft are adjusted to the individually required space for the particular project and its infrastructure. Risers, pipes and ducts are placed inside the shaft to serve multiple apartments above each other. Horizontal distribution channels can be connected to different sides of the shaft to distribute the infrastructure into the horizontally adjacent apartments. The horizontal channels are easy accessible and offer almost complete freedom in placing and replacing old systems.

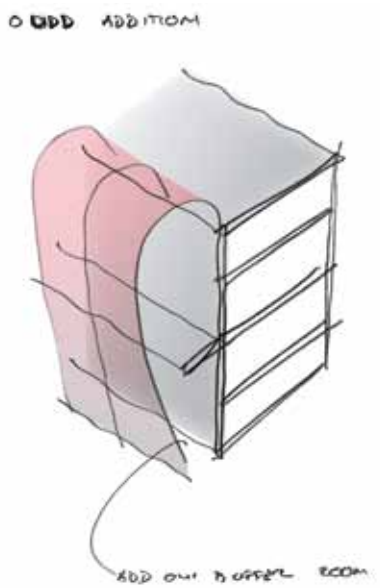


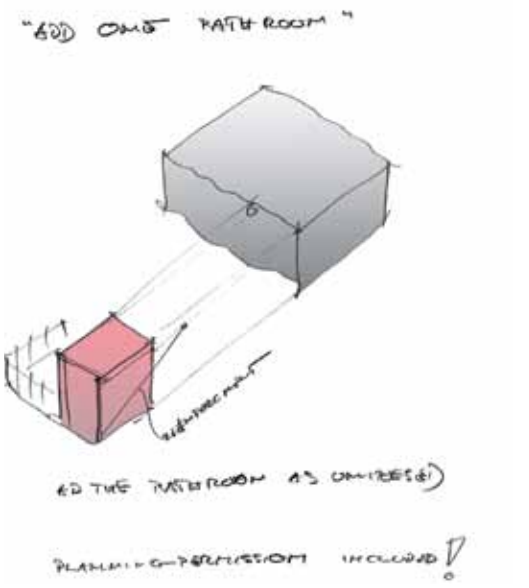
SPATIAL ADDITION

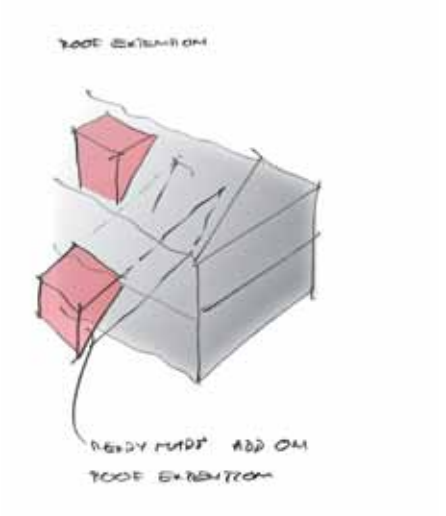
16-04-2010

IMAGINED BY Ulrich Knaack, Thaleia Konstantinou, Marcel Bilow
KEYWORDS architectural improvements, add-on

Apart from solving the technical problems an existing building may suffer from, refurbishment also aims to provide architectural improvements. One way to increase the architectural quality of a building is to add extra space. This addition may come in various forms; such as an add-on roof extension or an extra layer creating a buffer space or even a new unit in the yard, which can change the use of external spaces.







TEMP AND SPACE AGENCY

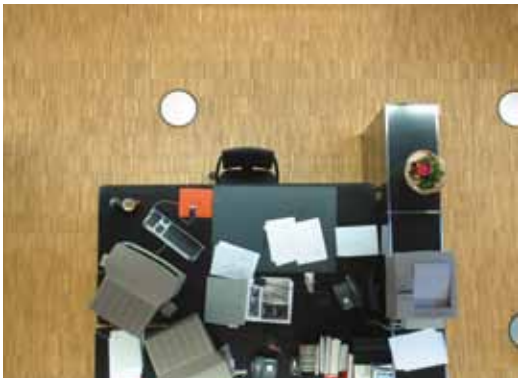
13-10-2011

IMAGINED BY IPC Workshop session “Re-Imagine the Envelope”
KEYWORDS add on, shelter, provide labor, additional floor surface

This is a business model rather than a technological principle, based on a frequent need for quick solutions to accommodate additional staff and/or space: There is a limit to the number of additional employees you can place within an existing office environment. If this number is exceeded, the business either stops growing or a company needs to expand to additional locations – neither of which are satisfying solutions.

Therefore, an optimum product would not only include temp agencies, providing the companies with short-term staff to address temporary labor shortages as they are commonly known, but would also include the necessary office space – maybe even including technical equipment.

In order to install such additional office space quickly, constructions that can be installed onto standard façades and structures are needed. This could be developed either as a hire or a leasing business, depending on the request. Building codes and permissions would need to be addresses – but this should not be a problem when great business opportunities strike!

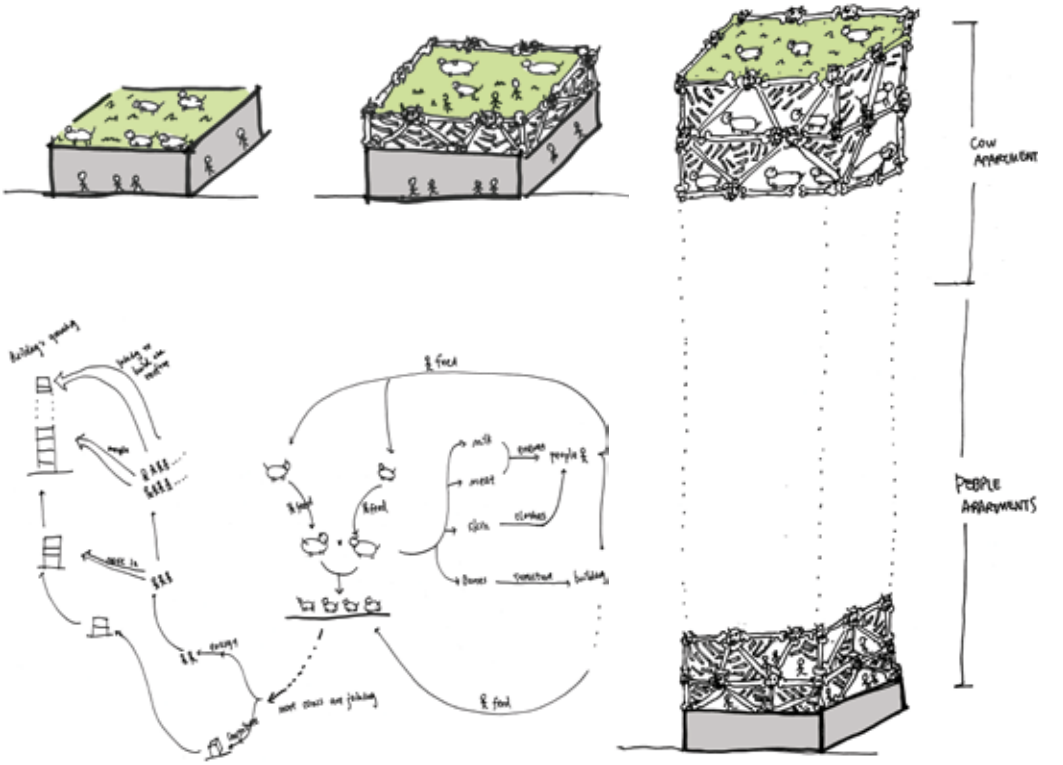


THE BONES

12-04-2011

IMAGINED BY Washington University St. Louis and TU Delft Workshop “Re-Imagine the Envelope”
KEYWORDS add-on, expand structure, organic material, waste

At the end of their life, productive livestock produces a large amount of organic waste material. Some of this waste material, bones for example, can be reused as structural material.
The idea is to create a self-sufficient habitat for animals and people, where the milk and meat of cows, for example, are used to feed the people, while the skin is used for clothing and the bones as a structural material. In the beginning, the habitat would only consist of a few animals and people, but as the number of animals increases, so can the number of people.
In terms of the structural material, the bones of deceased animals can be used to construct housing for the people and more sheltered space to breed more animals.
The more livestock, the larger the number of people they can sustain, the more bones are eventually available, the more space can be constructed. And the habitat will continue to grow.

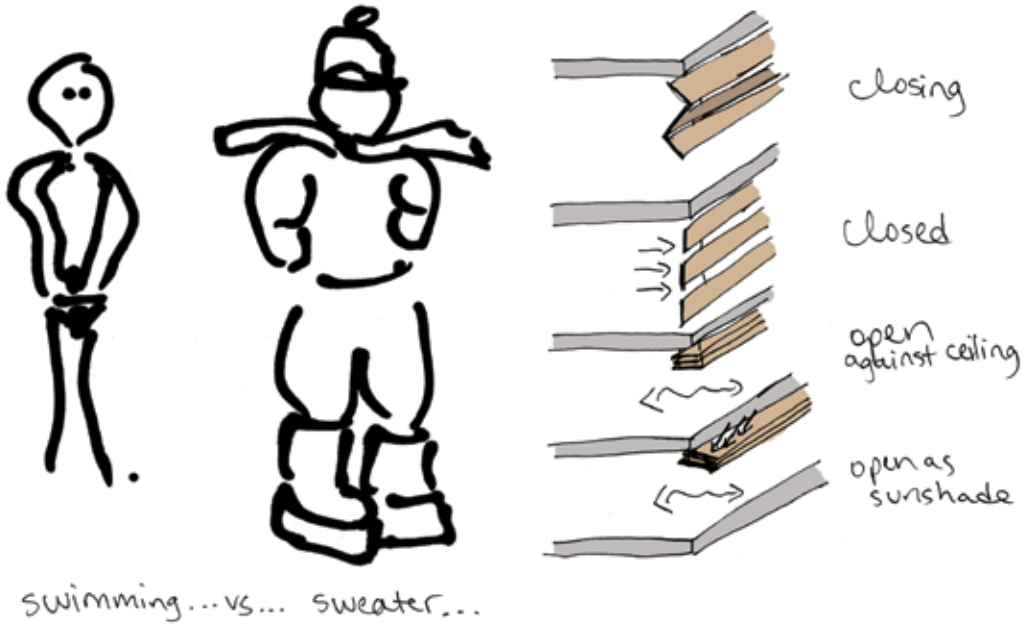


THE WALL CURTAIN

13-10-2011

IMAGINED BY IPC Workshop session “Re-Imagine the Envelope”
KEYWORDS replace, adaptive envelope

Venetian blinds are an effective way to adjust lighting conditions according to individual or temporary demand. This concept can be translated to the entire façade by adapting the size of the blinds and incorporating higher insulation properties into the material. This means, that the openings of the façade would be adaptable, and the façade can function like an adjustable piece of cloth that can respond to changing conditions.

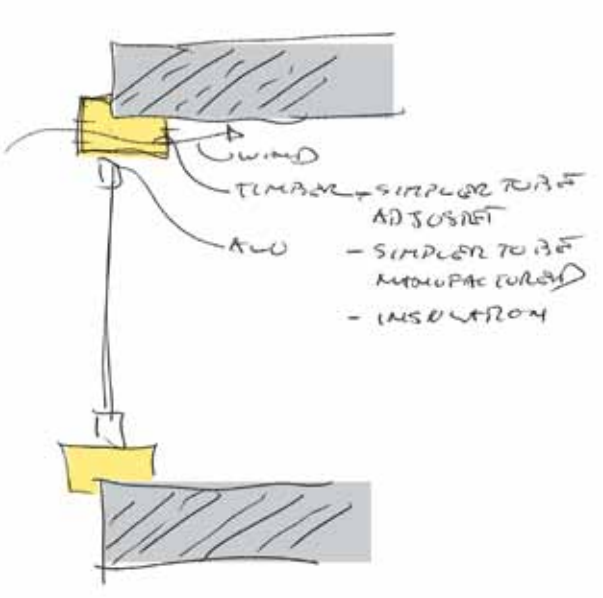


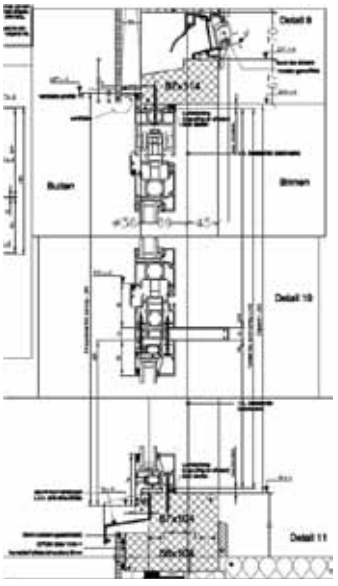
TIMBER 'SILICONE' FIXING

28-05-2010

IMAGINED BY Solarlux, Ulrich Knaack, Marcel Bilow, Thaleia Konstantinou
KEYWORDS replace, cladding, façade, tolerance, fixing

Rather than a new concept, this is more an observation of how a particular technical issue can be addressed in different ways. For example, the Dutch attach a wooden frame inside the window opening constructions, and then carve these elements to best fit the actual window element and the tolerances at the building site. The Germans, on the other hand create window elements of a particular size, which are directly inserted into the construction opening. Resulting gaps are properly sealed with silicone or other sealing membranes.





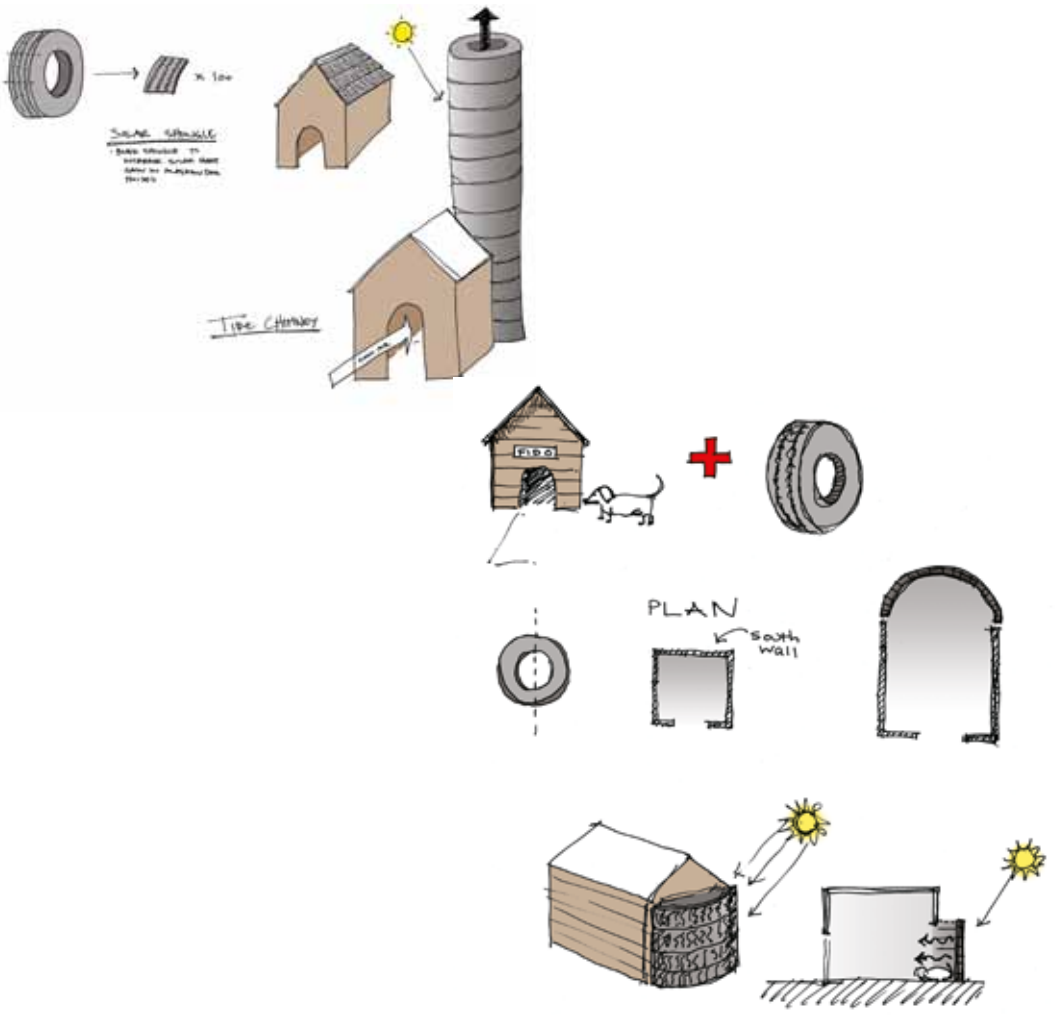
TIRE SHINGLES

12-04-2011

IMAGINED BY Washington University St. Louis and TU Delft Workshop “Re-Imagine the Envelope”
KEYWORDS add-on, roofing material, solar chimney, waste material, tires

The thermal properties of rubber make it an attractive material for retrofitting. Rubber can be found in abundance in waste material such as old tires.

One application is to use it as roofing material for insulation and construction mass. A single tire can be cut into several roof tiles, making it a cost efficient solution. Another way to re-use old tires is to stack a pile of tires in a chimney, located next to or inside the existing building. The sun heats the top part of the chimney; thus the tire stack will function as a solar chimney, enabling natural ventilation.

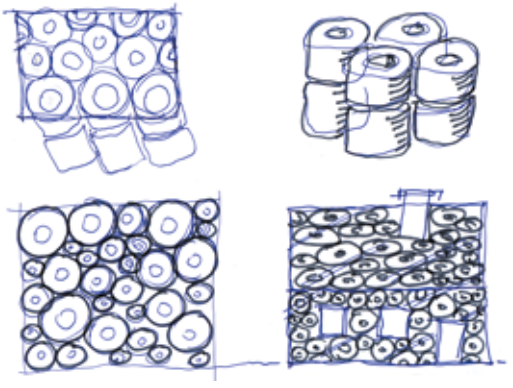


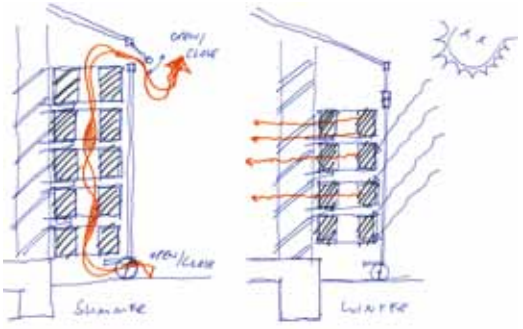
TROMBE TIRE WALL

12-04-2011

IMAGINED BY Washington University St. Louis and TU Delft Workshop “Re-Imagine the Envelope”
KEYWORDS dd-on, Trombe wall, waste material, tires

A Trombe wall is a sun-facing wall separated from the outside by glass and air space, which absorbs solar energy and selectively releases it towards the interior at night. In order for the Trombe wall to work most efficiently, high thermal mass is required. Imagine using waste material as thermal mass for the wall. Used tires are an ideal material for retrofitting and increasing the mass of walls. By simply adding an extra layer of glass on the outside, they can be heated up by the sun during the day and then radiate the heat into the space. The material, i.e. used tires, isreadily available, and their shape makes it easy to pile them up to construct a wall; all at minimum cost and construction time.





VILLAGE IN A HANGAR

14-10-2011

IMAGINED BY IPC Workshop session “Re-Imagine the Envelope”
KEYWORDS cover it, surface reduction, superstructure, light structure, covered environment

This principle addresses the potential of covering buildings in order to decrease the exposed building surface by employing the glasshouse principle. In addition to positive climate design impact and the extension of usable surfaces, there is the added benefit of not having to refurbish all surfaces.

Depending on the dimension of the construction and the outer surface qualities, the principle can be extended to provide shade or generate energy.

APPENDIX

CVs

ULRICH KNAACK (*1964) was trained as an architect at the RWTH Aachen, where he subsequently obtained his PhD in the field of structural use of glass. In subsequent years, he worked as an architect and general planner with RKW Architektur und Städtebau, Düsseldorf, winning several national and international competitions. His projects include high-rise buildings and stadiums. Today, he is Professor of Design and Building Technology at Delft University of Technology, Netherlands, where he established the Façade Research Group and is also responsible for the Industrial Building Education research unit. He has organized interdisciplinary design workshops such as the Highrise XXL. Knaack is also Professor for Design and Construction at the Detmolder Schule für Architektur und Innenarchitektur, Germany, and author of several well-known reference books. He is co-founder of imagine envelope B.V., established in 2008.

TILLMANN KLEIN (*1967) studied architecture at the RWTH Aachen, completing his studies in 1994. He subsequently worked in several architectural offices; from 1996 onward he was employed by Gödde Architekten, focusing on the construction of metal and glass façades and glass roofs. At the same time, he attended the Kunstakademie in Düsseldorf, Klasse Baukunst, completing his studies in 2000 with the title of “Meisterschüler”. In 1999, he was co-founder of the architectural office of Rheinflügel Baukunst with a focus on art-related projects. His practical work includes the design of a mobile museum for the Kunsthaus Zug, Switzerland, the design and construction of the façades for the ComIn Business Centre, Essen, project management for the construction of the Alanus Kunsthochschule, Bonn, and project management for the extension of the University of Applied Sciences, Detmold. In 2005, he taught building construction at the Alanus Kunsthochschule, Bonn-Alfter. In that same year he was awarded the Art Prize of Nordrhein-Westphalen for young artists. Since September 2005 he has led the Façade Research Group at Delft University of Technology, Faculty of Architecture. He is co-founder of imagine envelope B.V., established in 2008.

MARCEL BILOW (*1976) studied architecture at the University of Applied Science in Detmold, completing his studies with honours in 2004. During this time, he also worked in several architectural offices, focusing on competitions and later on façade planning. Simultaneously, he and Fabian Rabsch founded the ‘raum204’ architectural office. After graduating, he worked as a teacher and became leader of research and development at the Chair of Design and Construction at the FH Lippe & Höxter in Detmold under the supervision of Prof. Dr Ulrich Knaack. Since 2005, he has been a member of the Façade Research Group at Delft University of Technology, Faculty of Architecture. He is co-founder of imagine envelope B.V., established in 2008.

THALEIA KONSTANTINOU (*1982)
Thaleia Konstantinou (1982) studied Architecture at the National Technical University of Athens. Since 2006, she has been a certified architect. In 2008, she graduated with distinction from the Master of Science programme on Environmental Design and Engineering at The Bartlett School of Graduate sStudies, University College London. During and after her studies, she has worked as an architect in Greek and international practices. Currently, she is conducting a PhD research at

the Faculty of Architecture, Delft University of Technology, The Netherlands. Her research on the topic “Façade Refurbishment Strategies of Residential Buildings” is part of the research programme “Green Building Innovation” and the Façade Research Group of the Chair of Design of Construction.

new tekst

BERT LIEVERSE (*1951) has a diverse professional background and therefore many different fields of competence. He started his career as a project manager in construction. As coordinator of knowledge centers he introduced a multidisciplinary approach of the different functions in the vast field construction. He founded a quality center for construction companies with offered training courses and consultancy services. Approximately 400 companies were certified for their quality management system.

From general construction Bert Lieverse shifted his focus toward the façade industry, were he became managing director and established the VMRG- network. The Dutch façade industry is organized within VMRG. VMRG formulates strategies for development and future positioning of the facade industry. The VMRG network consists of several companies such as KCG (knowledge center), ALUECO (sustainability), SKG (independent certification and testing), FAECF (European federation), Slimbouwen (organizational technology for construction). Bert Lieverse is an entrepreneur and actively consulting various companies.

Vision
It is obvious that companies are responsible for developing their own future. But it is also obvious that today it is no longer possible to do this entirely by themselves. The future is created by many different actors: companies, public and private persons, architects, clients etc. Good cooperation among companies is essential. It is our vision that the future will be created by a multidisciplinary network of companies, experts and other stakeholders. VMRG formulates the future and roadmaps for the façade industry and the companies involved.

Ideas creates by several groups are communicated and lead to practical new products and services that fit into the VMRG picture of the future. Extraordinary brainstorming techniques have been developed which contribute to the creation of new concepts. One of those concepts is the principle of the so called ‘Living Façade’. A façade that addresses 4 main focuses: nature, environment, outside and internal comfort.

For refurbishment, we will introduce completely new products and services. We can adjust façades based on these aspects permanently to the needs of present and future clients by lifecycle engineering.

Lifecycle engineering makes it possible to replace components during the exploitation periods of a façade or a building by modern and sophisticated components to allow such modern buildings and even modern cities to function permanently. The façade industry is a great opportunity for refurbishment.

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REIMAGINING THE ENVELOPE

Climate design and climate engineering are nowadays standard in the design process. The more successful we are in this, the less energy we need to run the building during its useful life and we can focus instead on an additional aspect: the embodied energy – the energy we need for the material production and construction process. Interestingly, the reduction in energy used in a climate-efficient building during its lifetime is equal to the energy consumption necessary to produce and install the building. This aspect triggers us to reconsider the design potentials of focusing on less energy in the construction. Which materials make sense energy-wise? Do we need to build with simple materials for 500 years or should we go high-tech and design the complete life cycle for a perfect reuse with maximum recyclable materials? Or should we build out of materials that can be used as energy after being a building? This publication focuses on the embodied energy aspects of building materials, their life cycle and their potentials for reuse as energy or in construction, and presents some far-reaching design ideas.