MASTER

Future city, Cologne

a smart sustainable rehabilitation of an existing office building with an approach to double-skin - façade system

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Sara Nikouyeh
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A Smart Sustainable Rehabilitation of an Existing Office Building with an Approach to Double-Skin Façade System

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Abstract

This project aims to establish a framework to design a system for a sustainable smart building for future cities. Since there is a serious need to develop a solution for a sustainable and intelligent future to have a kind of living environment in cities which offer a healthy, comfortable and advanced way of living.

The future city of Cologne with its 2000 years of history needs to have a proper image of how it would look like in 50 years from now as a city which was always ahead of its time. The famous headquarter of WDR broadcasting company, has a great role in planning the city of Cologne since WW II up to now. And can empower its role by developing its dominant over city. This can lead to rebuilding and renovating the city to offer a new character for Cologne as a media city.

According to this goal there is framework defining a sustainable building with definition of triple bottom line of Economical, Environmental and Social. In other words a Sustainable development requires a balance between human, energy and money consumption, the environment and the available resources.

With these three factors, an Architect has to conceive to design a system as solution for a world that pay attention to human needs for intelligent lifestyle, comfort and green growth with considering the fact that there should be the same opportunity for future generations to fulfill their similar need.

The system which is designed in this thesis is based on triple bottom line of sustainable design and focus on Double skin Façade system which according to Author's studies has been a proper solution which includes almost all features of a sustainable smart building.

Since 1970 Double skin façade has been experienced and became known for architectural community as a system providing a fully height glazed façade while improving aesthetics and daylight penetration without causing thermal problems.

Double skin Façade system offer a green and sustainable technology while affording natural light and managing heat and thermal loads, providing health and comfort for occupants.

The project desires to brighten this specific point that all three feature of sustainability are tangled up together therefore any effort regarding to have a green building would help the community to achieve its goal toward a sustainable future in a city.
Acknowledgment

This project would not be possible without supports and helps of these people:
I would like to express my gratitude to my supervisor, Jos Bosman, who was always understanding and patient toward my process and whose knowledge and expertise developed me and added considerably to my graduate experience and his perfect characteristic will always remain as an inspiration for me.
I would like to thank Daan Lamers with his remarkable ideas and his ability to brighten your process with enticing your attention to different ways of looking and thinking. My special thanks goes to Maarten Willems who was so helpful and supportive and his innovative thoughts and positive energy always find its way through the process even in gloomiest moment of this year. Any words of him was a motivation for me during my project.
I would like to thank my family for their care and kindness even that they were not here with me. I want to thank my friends, especially Ali Afrasiabi whom without his extreme helps and creative ideas and energy this process would not be easy.
And in the end I would like to thank my friend, Mohammadreza Gaeini who was always there for me and his kindness and love supports me unconditionally and always has eliminated frustration from my hard days.
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Introduction: Future City, Cologne

The city of Cologne with its 2000 years of history from Roman times to Middle Ages and along with its sad experience during World War II still has its role as a leading city in Germany and Europe.

Chageshiemer one of the Germany's most important photographers in post-WW II period worked on a series of photographs collected in a book named: Cologne, 5:30 AM, 1970. In this book there is different image of Cologne: a cold isolating city, as a result of a modern city. He photographed concrete highways, street signs and buildings in a time when the city was almost empty of people.

In 1995 another German Photographer Wolfgang Vollmer retraced Chargeshiemer's steps and photographed the exact same locations, which can now be found in the book Cologne 1970/1995.

The aim of this project to provide a visual picture of Cologne, 2050 by designing a futuristic building. This building is based on principles of Sustainable development and intelligent future which would introduce new image of a future city.

Along with this idea Nord-Sud-Farht one of main Axes of this city has been analyzed and Speer’s master plan focused on this area has been analyzed while WDR ensemble has no place in master plan of Albert Speer this project tend to design a characteristic future building bordered with Nord-Sud-Farht defining the Filmhause as a new Gate for inner city highway.
Figure[1] Exterior, Filmhaus
Chapter 1: Media City Of Cologne:
Development of old Opera house vs. WDR ensemble
Media City Of Cologne:

Cologne has been known as one of the famous and well-known media metropolis, with its numerous TV channels, shows, magazines and popular soap operas. A great percent of people of cologne are working in broadcasting companies or careers related to media. There are different opportunities in this industry and a good range of professions which varied greatly.

In 1949 the foundation of a brand new broadcasting company started in cologne and this city started its reputation as a media city since then. Nowadays with an annual Media Festival, Cologne seems to insist on saving its position as a media city in Europe. There is also a university which is exclusively for media studies and courses. In these years many TV shows and films have been produced in this city and many stars and producers have started to establish their works in Cologne.

These all introduce cologne as Media Capital of Europe. Regarding to holding this character of the city a big plot in east border of Rhine River is hosting a number of famous broadcasting
Development of old Opera house vs. WDR ensemble

A study on old opera house

Following there is a brief research on the history of AlteOpera (Old Opera House) and its influence on the period of its development.

History

In 1899, an architectural competition was held for designing the new Opera for the city of Cologne. The winner of Competition was Carl Moritz, whom was responsible for historicism construction which was holding in the city of Cologne in that period of time. Before the Opera House was built in Habsburgerring, the Altes Schauspielhaus, the theater situated at Glockengasse (the same location as the current Opera House in Nord Sud Fahrt) was used for operas and dramas; A Neo-Renaissance theater built by Julius Raschdorff.

Carl Moritz, Architect of Historicism

Architect Carl Moritz (1863 – 1944) was a construction inspector in Cologne till 1898, a career which he gave up in order to participate in the competition Design for Opera. His career as an independent architect started with Building Opera which was his first major work and soon after that he became one of the leading architects in Germany. He was the project manager and architect of many other buildings such as Kaufhaus Peters (Karstadt).

The Opera Building became official Opera House of the city of Cologne in 1906.

Opera House, Interior and characteristic

The Opera was built on a 5950 m² plot and had approximately 1806 seats which made it one of the largest operas in Germany in its own time. The construction started in 1900 and the official opening ceremony took place on 7 September 1902.

The building was constructed by the latest technical construction methods of its time. It was composed of three different parts. The main building which includes auditorium and stage hall, and two additional buildings which constructed in a later time: an Office and a Tea House in the garden around the building.

The opera had high performance quality and used new methods and ideas like smoke machine to make clouds while there was a performance. The interior of this five story building consisted of a wide entrance hall, a stylish auditorium and a spacious two story foyer which was richly decorated with figural and floral decoration in form of frescoes, stucco and wood carving and it was colored with bright colors. The walls and ceiling was covered with paintings and symbolic representations. There was a painting in ceiling represented Prometheus with divine vital spark. There were also amazing murals and artworks on the wall of the lobby by which had been done by "Sascha Schneider", the famous illustrator of "Karl May" books. The finishing was presented with turrets and cupolas with a sloping roof with bronze covered gables.

The other important quality of this building was its fantastic acoustic. It had hosted too many famous singers and artists and before bombing of world war, too many festivals were regularly holding in Cologne Opera.
Figure[2] Opera House in Habsburgerring, 1902

Figure[3] Opera house in the entrance gate, 1902

Figure[4] Additional building namely Tea House, 1927
Figure 1: Main Performance Hall with ornaments

Figure 1: Opera Building After WWI, 1946

Figure 1: Opera Building After WWI, 1946
**WWII and Demolishment**

In National Socialism Era called as “degenerate” - a term adopted by the Nazi regime in Germany to describe virtually all modern art, declaring it "un-German" or Jewish - the theater forced to get rid of its jugendstill elements inside and outside. This also happened to Nurnberg Opera. However Cologne Opera tried to remain almost the same and to be faithful to its original decorations. The Building considered as a small shelter for artists in the period of Nazi regime in the country.

The old opera was bombed a couple of times in 1943 and 1944 - The rumors which remained till now said that it was a misguided bullet from Nazi Army since there was no warning and alerts for a air raid before it - although the attack did not make serious damage to the building and although it was quite worthy to reconstruct but after the war somehow the function of opera changed but still was used as rehearsal stage and administrative office.

In 1958 the city council decided to demolish the Opera and built the new one in inner city. The remaining material was reused in reconstruction that was planned after the war, like the bricks of opera which was used for renovation and reconstruction of St. Alban church. But It is still unknown that what happened to the ornaments and figurative elements of old opera. In the pictures from 1950 it can be seen that the crafted stonework had survived the war and air raid but it is unclear what happened to them afterward.

On the site of the former opera, a high rise building was built which at first used to be the provincial insurance building and today It is Crown Plaza Hotel. In 1990 a memorial stone was placed in the garden of this hotel.
Old Opera House
development in
east-west axis

In 1881 the city council decided to remove the city wall and demolished it in order to make it possible to extend and develop the city for the first time since the Middle Ages. Therefore the decision was to design an urban boulevard with prestigious building around. Between 1881 and 1885, when the city wall was razed, a circular boulevard was constructed and new cultural facilities such as Opera and Museums was planned deliberately. It can be seen from the maps of 1870 to 1902 that how the situation of the plot that was chosen afterward for Opera was changed.

According to this plan a new theatre on Rudolfplatz was envisaged. Opera Building in Habsburgerring was factually in the place which can be assumed as a gate to the city. It was placed in east-west axe and was simply accessible for people living in inner city and also by whom were entering the city. It was built on an empty plot which in the time was assumed as the outer city but after demolishing the wall around the city, placing a phenomenal building for Opera can be considered as first steps to develop the city in west part.

The façade of Building in two border of street in South and East side was fully designed and decorated to have its influence on urban character of Cologne. The Façade was somehow like a numerous sculpture and figurative ornaments which demonstrated it as a symbol for city.

The exterior mainly was related to German Late Baroque style when it has a discernible tendency to Art Nouveau style in its additional building.

After the main building was built, around 1920-1925 another part was added to the building which worked as a terrace for the building to act as a tea house.

The architect—who according to some sources is Clemens Klotz, an architect related to Nazi regime—designed a modern oval pavilion in deliberate contrast to the neo baroque style of the main Opera. This mixture somehow in its time was discussed as partly inappropriate and partly congenial. Another function of this additional building was acting as a guarding wall and isolator for performance hall form the increasing traffic noise around the building.

We can perceive from the images that how the building was situated on the crossroad in the entrance of city and this defined its symbolic appearance and shows the tendency of Carl Moritz to design a very great representational building for the city of Cologne to be defined as an element for whole city.

After demolishing the wall around the city the main decision of city council was planning a ring with cultural symbolic buildings to show the great history and culture of Cologne and according to this plan an Opera would worked as a Landmark in the start point of East-West access.

After war the idea of a new Opera house was a political and financial idea because the city council assumed that the cost of renovating and reconstructing the old opera would be much more than building a new one.

According to Schwarz new plan for city of Cologne and his idea of inner city "Hochstadt" the new location in Nord-Sud-Fahrt appears to be a decent choice for a significant building as an Opera house which always acted strongly in Cologne. With this design he was able to give a new character to the inner city which was still harming from war disaster.
Figure 5: 1902. The construction of winner design of Opera House competition by Carl Moritz started in 1902 when the wall around the city had been demolished in 1885.
Figure[6] 1920 – 1925. The Additional Tea House was built in front of Opera house to give an Art Nouveau appearance to the surrounding area and developed a new character for Habsburgerring area.
Figure[7] 1925. The opera house with additional Tea House in Habsburgerring.
Figure[8] 1957. The new building of currently Crown Plaza Hotel took place in empty plot after demolishing the rest of the Opera house which was partly destroyed during war.
Figure[9] Future. The new Design for Habsburgerring in Speer's plan. An additional building is designed in front of current hotel building in the plot of former opera house.

In the plot adjacent city gate and in front of former opera house a new set of plan is designed to develop this plot to a shopping area with a high-rise building in center surrounded by at least two floor buildings around functioned as shops and etc.
A study on WDR ensemble

History
WDR, standing for Westdeutscher Rundfunk (West German Broadcasting), is a German broadcasting company based in Cologne. It was founded in 1954 in Cologne and started its two radio channels afterward. This led to a fast growth in the development of this industry in Cologne, and soon Cologne became the center of media not just in Germany but in whole Europe.

strategy of WDR after WW II

After the World War II and after several bombings, Cologne almost lost all of its buildings and urban fabric and after years of struggling, WDR got its role within the urban area of the time. WDR started to have a prominent position in city planning of Cologne with starting one of the greatest construction projects after war.

The new broadcasting center "Funkhaus" was one of the earlier buildings in reconstruction of the city and was built in 1952 on the foundations of the former "Monopol Hotel" located at the 'Wallrafplatz'. This square is one of the most important squares of Cologne which links Höhe Strasse with Dom cathedral and its surrounding square in the heart of the city center. It is remarkable that this first building of WDR ensemble designed in a plot close enough to Dom Cathedral and city center.

Rapid growth of television and media caused a huge demand for more space for WDR in the center of Cologne. In 1965 the WDR expanded their company by two empty plots, one alongside the previously built 'Funkhaus' and the other one several blocks away. As many historic buildings surrounded the new Funkhaus, the only direction to grow was towards the West where was a large gap in the center of the city regarding to bombings and extreme demolition during war. A few years after the WDR's previous expansion, a new building was erected on an empty plot. This was actually not an existing empty plot, as the new building was built above the new Nord-Sud-Fahrt bridging the two separated parts of the inner city.

"The solid structure serves as the WDR's archive and hovers above the busy Nord-Sud-Fahrt making all the passengers on car or food speechless. When approaching Cologne by car, the 'Archivhaus' acts like a gate for entering Cologne's inner city and introducing the WDR as an institution in Cologne. The dark terracotta colored stone building confronts the users of the Nord-Sud-Fahrt both on departure as on arrival with the same expression of the generic façade with only the large WDR logo clarifying its identity."

The 'Archivhaus' plays an important role in the expansion of the WDR ensemble. It gave the WDR new possibilities to expand. The archivhaus gave the possibility to connect WDR's buildings to one another. Now, employees in the ensemble can move from the Funkhaus to the Filmhause and WDR-Arkaden, almost two blocks further without coming outside.

In 1991 the WDR added one of its most recent expansions to their ensemble. WDR-Arkaden reduces the contrast between the WDR ensemble and the surroundings. WDR-Arkaden is more expressionistic and transparent than past buildings and it also has a public area, which is not designed in other buildings of WDR.
### WDR Ensemble

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<td>1970</td>
<td>Hause Berlich</td>
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<tr>
<td>2000</td>
<td>Viertelhazehouse</td>
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<td>2005</td>
<td>Filmhazehse</td>
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<td>2010</td>
<td>WDR Arkaden</td>
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<td>2015</td>
<td>Ilse-Haase</td>
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*Figure[10] WDR Timeline*
Figure[11] 1950, Funkhause

Figure[12] 1958, Haus Rechtschule
Figure[13] 1965, Hause Berlich

Figure[14] 1965, Archivhaus
Figure[15] 1972, Vierscheibenhouse

Figure[16] 1974, Filmhaus
Figure[17] 1990, WDR-Arkaden

Figure[18] 2010, LLive-Haus
Ensemble characteristic
The WDR ensemble is no more expanding rapidly comparing to its growth in 60’ and 70’. It is most renovation plans and rehabilitation to adapt more to urban fabric. The most recent buildings in the complex of WDR, and also the renovation projects show the tendency of WDR toward a much more transparent ensemble while blurring the line between city and offices without losing the identity of the existing buildings. (InnercityhighwayStudio, 2012-2013)
Figure 19: WDR Archivehaus, Main element of WDR in the city
Chapter 2: Future and Cities
Framework definition

Future:
The indefinite time yet to come.
Future has almost different and comparative meanings for each person since it is not a specific period of time that could be defined clearly. In current study, future would states as a period of time from one moment after present till infinitive tomorrow.

Future vision of yesterday
The vision of future in about one or two hundred years ago was completely different from today. Around 19th and 20th century the cities around the world experienced a rapid transformation in many fields. The population of the world exploded suddenly and it leaded to crowded cities with homeless and slums around. The industrial revolutions resulted in to air pollution in cities and following, infectious and epidemic diseases grew fast among people. Furthermore with the entrance of cars in the streets of the cities, streets which were not designed for motor vehicles, the problems started to be more and more extreme. During this period many turned their efforts to plan better future cities than their own time.

They represented hopes and anxieties of their own era. However some of this planning remained and are still significant in contemporary urban design.

Urban Theories
There are plenty different theories about future city in 19th century which would be analyzed orderly to have a clear definition of the future vision in the past.

Metropolis, King Champ Gillette, 1894
There were always proposals for future cities as vertical and industrial metropolis. In 19th century many architects brought in their plans for future cities and King Champ Gillette seems to be one of the earliest. He designed a Metropolis in his book “The Human Drift”.

He proposed a city with high-rise towers around located in Buffalo, New York city. 25-storeys residential towers are situated around domed atria. He designed hexagonal blocks which a modular arranged street network connection. There were three levels for public transportation and infrastructure of the city below the main level.

Visionary City, William Robinson Leigh, 1908
William Robinson Leigh was a painter of landscapes when he proposed his abnormal “visionary city”. He portrayed his imagination of urban structure of future with a background of a red glowing sunset. A mega structured city with well-connected street network with bridges floating in space around the city blocks.

City of future: Contemporary city for three million inhabitants, Le Corbusier, 1922
In 1922 Le Corbusier, Modernist European architects, shocked the Europe community by his “city for future” concept.

The city for three million inhabitants was filled with widely spaced modern skyscrapers with uniform height in city center. Public transportation was designed far beneath the surface. Finding a solution for traffic roads and accommodation people in appropriate places seem to be the most important issues of the time. He designed a city without a specific location or any historical and geographical background. in this proposal he managed all the control of the city by architecture.

The city has a business center with twenty four skyscrapers located in a large green area, in the center of this business area there is main station of the city and also a land for airplanes.
There are two main highways in North-South and East-West direction, passing through the city for vehicular traffic. In the green area around the skyscrapers in main center of the city there are restaurants, cafes, shops, theaters and leisure activities. Next to the business center there are the public buildings like museums and city hall. This commercial area is surrounded by residential area. The residential area is placed in a geometric zigzag pattern and there is a green border in the east side of this plan.

In Le Corbusier's theory, the concept of street was eliminated. He was opposite of the designing residences next to streets with a fundamentalist's fervor:

"The automobile ought to stop right in front of any given door which means that the houses open out onto the traffic lane. And that is what we can no longer tolerate: To live! To breathe! To live! Homes to inhabit, the present idea of the street must be abolished: Death to the street! Death to the street!" (LeCorbusier, 1967)

Le Corbusier rejected the American idea of vertical urbanism, calling it "new medievalism." However Le Corbusier rejected everything that didn't follow his opinions. He offered his perception of the skyscraper city:

"The skyscraper has petrified the cities. In an age of speed, the skyscraper has congested the city. A statement of fact: the skyscraper has reinstated the pedestrian, exclusively.

The pedestrian crawls at the feet of those skyscrapers like a beetle at the foot of a steeple." (LeCorbusier, 1967)

High-rise city, a city for a million inhabitants, Ludwig K. Hilberseimer, 1924

In 1924 Hilberseimer developed his high rise city, a city for a million inhabitants. The city designed in two levels, one lower level for business and vehicular traffic. The entrance of five stories office buildings is also located in this level. On the second level there is pedestrian path with sidewalks and bridges over the boulevards. In this level there is entrance for 15 storeys residential apartments. In his design there is yet no space for public buildings such as schools, museums, city halls or any park or green area around. However he has a solution for traffic problems with designing separate levels of transportation. Public transportation designed under the ground, vehicular transportation on ground level and pedestrian path on upper level. He separated vehicular traffic from pedestrian movement therefore to not influence each other.

Later, Hilberseimer himself admitted: "The repetition of the blocks resulted in too much uniformity. Every natural thing was excluded: no tree or grassy area broke the monotony ... the result was more a necropolis than a metropolis, a sterile landscape of asphalt and cement, inhuman in every aspect."

Also Le Corbusier had strong criticism for the vertical urbanism proposed by some modernists such as Hilberseimer:

"A wretched kind of modernism this! The pedestrians in the air, the vehicles hogging the ground! It looks very clever: we shall all have a super time up on those catwalks. But those "R.U.R." pedestrians will soon be living in "Metropolis," becoming more depressed, more depraved, until one day they will blow up the catwalks, and the buildings, and the machines, and everything. This is a picture of anti-reason itself, of error, of thoughtlessness. Madness." (LeCorbusier, 1967)
Figure 20: Metropolis, King Champ Gillette, 1894

Figure 21: Visionary City, William Robinson Leigh, 1908
Figure [22] City of future: Contemporary city for three million inhabitants, Le Corbusier, 1922.

Figure [23] High-rise city, a city for a million inhabitants, Ludwig Hilberseimer, 1924.
Figure [24] Triple Bottom line of Sustainability
**Today Vision of Future**

According to United Nations records and data, it has been predicted that by the year 2025 there would be almost 100 mega-cities with more than 5 million population in the world while around 80% of these mega cities would be in current developing countries. And finally in 2050 about 70% of the world's population will be living in the cities.

These changes and developments in cities are impressive and inevitable. This fact brings this question to mind that how the cities would be in fifty years from now. How the cities are going to change to be responsive to this population and to answer to their prerequisites? From primary needs such as: food, shelter, health care and energy to more advanced needs.

This explosion of population in the world and considering the important role of cities in daily life of people, and observing how the built environment around us is tangled with any piece of our routine life would bold this vital question that how we want to shape our future? How we are imagining our prospect ideal city?

Nowadays the development of technology has a huge impact on our lifestyle. With a brief comparison with a few years ago we would understand how technology is responding to our various needs. With fast development of technology in different fields such as connectivity, medical researches, smart mobility and smart building we should consider technology as the main material for any ideas and innovations. The main goal of this research is to design a system for future buildings to respond to people's expectations of future.

**Sustainability on Building Environment**

The World Commission on Environment and Development has established a definition for “sustainability” as meeting the needs of the present without compromising the ability of future generations to meet their own needs. (Our Common Future, Report of the World Commission on Environment, 1987)

Sustainable design is a style of design philosophy that seeks to maximize the quality of the built environment, while minimizing or eliminating negative impact to the environment. (McLennan, 2004)

The intention of sustainable design is to "eliminate negative environmental impact completely through skillful, sensitive design". John Elkington strove to measure sustainability during the mid-1990s by defining a new framework named the triple bottom line (TBL). The three components of the Triple Bottom Line are: Economical, Environmental and social...
**Economical**

Economic sustainability is the term used to identify various strategies that make it possible to apply available resources to best advantage. It manages income and expenses, taxes and business diversity factors.

**Environmental**

Environmental properties characterize measurements of natural resources. It includes air quality, water, and energy consumption, and natural resources, solid and toxic waste. The world is facing challenges concerning environmental issues and this challenge is putting the responsibility on new design system for high efficiency and zero-energy buildings. Monitoring space conditions and implementing sophisticated strategies to reduce overall energy usage, improving indoor air quality and maximizing day light by automating shading systems are some example facilities defined as a framework for sustainable buildings.

**Social**

Social sustainability is social dimensions of a specific community and includes quantities of education, equity and access to health, well-being and well quality of life.

It refers to the idea that “future generations should have the same or greater access to social resources as the current generation, while there should also be equal access to social resources within the current generation”. It focuses on individuals’ behaviors, actions and reactions. (Sen, 2000)

**Smart buildings**

The smart building concept has been known for about two decades. It originated in early 1980 in United States and got wildly spread around the world with digital revolution. The definition and implementation of this concept varies and changes during the time with development of technology and knowledge.

In the first years of defining intelligent buildings there was this traditional view which determined intelligent buildings as managing and automating the whole system with a collection of innovative technologies when this view got clarified in late 1980 and early 1990 that an intelligent building is a building that respond to organized changes during time with tools of new technologies and passive and active design.
Chapter 3: Case Studies

Sustainable renovation
Most of the building from 1960 and 1970 are being renovated to be responsive to the needs of today such as energy consumption and acoustic insulation.

**Commerzbank Headquarters, Foster and Partners Frankfurt, German**

Commerzban building in Frankfurt is one of the tallest buildings in Germany and Europe. It is a 56-storey, 259 m skyscraper in the Innenstadt district of Frankfurt, Germany.

While the tower empowers its role in Frankfurt skyline, it also attached itself to city scale fabric through rebuilding and renovating the border structure of the block. These buildings around includes shops, car parking, apartments and a banking hall, and help to forge links between the Commerzbank and the broader community. At the heart of this scheme is a public galleria. With its restaurants, cafés and spaces for social and cultural events, it has become a popular pedestrian thoroughfare.

This ecological office tower develops and applied innovative ideas for an environment friendly working space. The building advantages from natural ventilation and natural day light. Each office has its own windows letting the occupant to manage the comfort zone. The result is energy consumption levels equivalent to half those of conventional office towers.

"Dr Horst Gruneis, director of Commerzbank’s Central Building Department, reports on an MIT webpage that "We are given lots of praise when our office workers leave at night and tell us that they don’t feel tired –this means that their productivity increases. This is more important to me than great architecture or sky gardens" (Commerzbank,2007)."

The success of the double ventilated façade here is a direct result of intelligent, integrated design, starting at the overall building design level. In section, the building is a triangle with a full height atrium in the center. Four-storey Sky Gardens atriums placed in between the inner and outer layer of the glass façade, are placed on each side every eight floors. From the outside these gardens in the sky give the building a sense of transparency and lightness. Socially, they form focal points for village-like clusters of offices, providing places to meet colleagues or relax during breaks. Environmentally, they bring light and fresh air into the central atrium, which acts as a natural ventilation chimney for the inward-facing offices. Depending on each garden’s orientation, planting is from one of three regions: North America, Asia or the Mediterranean. This smart design allows every floor access to the massive atrium across the triangle atriums provide pollutant removal and humidification in dry winter weather when used in conjunction with the double façade system. Absorption refrigeration running on municipal steam chills the ceiling slabs on hot days.
Mediaset Broadcasting Company, Milan, Italy
Architect Franco De Nigris - Axistudio Milano

Mediaset is one of the largest commercial broadcasting companies in Italy which brings the programs of football champion league on free and premium TV channels around the world. This company started a renovation project, setting a new example of architectural innovation and becoming a communication symbol.

"The most important element of the design is its curved double skin façade with a 1500-square-meter Double Skin in laminated safety glass panels covering and protecting the Mediaset building. This double skin construction follows the curves of the historic building, creating the appearance of a huge sail made of glass. The panels, installed with the screen printed glass on the exterior, create an elegant effect of transparency and privacy. From a distance the façade looks like an opaque reflecting surface, then getting closer, the opacity magically transforms into an ethereal clarity that reveals the protected original construction.

Paolo La Varra, Senior Architect Technical Service department of CNS spa, explained: "The new system allowed us to confer a modern appearance to the project, with a smooth and monolithic visual impact. "For the new façade of the Mediaset building, CNS spa was awarded with the Special Prize at the '2008 RE Real Estate Awards', the Italian 'Oscars' for architecture and construction projects of significant proportions.

The result is a work of art for the most important media company in Italy that features a striking visual impact and also acts as enduring protection for the building.

[1]
Figure[25] Commerzbank Headquarters,

Figure[26] Commerzbank Headquarters,
Resting Garden
Figure[27] Commerzbank Headquarters, Offices

Figure[28] Commerzbank Headquarters, in between Floors Garden
Figure[29] Mediaset Headquarter, Italy

Figure[30] Mediaset Headquarter, Double Skin Facade
London's City Hall
Foster and Partners
London, England

Another curved form using the ventilated double façade comes from London. Once again, the building shape is of great importance to the performance of the building, so much that the glazing on the southern façade is unshaded. This modified sphere is designed so that on the southern façade each floor is shaded by the one above.

Due to the use of the double façade, the building is expected to save 75% of its mechanical system energy costs. When climatic conditions permit, the BMS deactivates that mechanical system, and opens the exterior façade vents. Ventilation then enters the interior through the under floor distribution system. During winter, heat and moisture are recovered from exhaust air. The most interesting adaptation of this system is that certain horizontal members on the diagrid framing structure are hollow, allowing both cold and hot water to flow through them.

"One of the capital’s most symbolically important new projects, City Hall advances themes explored in the Reichstag, expressing the transparency and accessibility of the democratic process and demonstrating the potential for a sustainable, virtually non-polluting public building.

Designed using advanced computer-modeling techniques the building represents a radical rethink of architectural form. Its shape achieves optimum energy performance by maximizing shading and minimizing the surface area exposed to direct sunlight. Offices are naturally ventilated, photovoltaic provide power and the building's cooling system utilizes ground water pumped up via boreholes. Overall, City Hall uses only a quarter of the energy consumed by a typical air-conditioned London office building.

Home to a workforce of some 15,000 people, More London integrates a broad mix of uses within a new network of streets and public spaces. A strong diagonal boulevard, which follows the ideal pedestrian route from London Bridge Station to Tower Bridge, is intersected by smaller routes and alleyways that forge links between the activity of the waterfront and the residential community of Bermondsey.

The landscaping in the streets and piazzas includes tree planting and water features and extends to the design of paving and street furniture. Alongside the offices, there are shops, restaurants and cafés, and the development includes the Unicorn Children's Theatre, a hotel, and supermarket and fitness club. Together they help to create a lively and congenial social environment on the riverside."
1 Bligh Office Tower,
Ingenhoven Architects,
Sydney, Australia

The building is known for receiving "Green Star"-standard, a "6 Star/World Leadership"-certification. The building has been designed for an international design competition by the Dexus Property Group by Ingenhoven Architects + Architectus.

The shape of the building is derived from the corridors around and the solar orientation. The 30-story transparent office building has elliptical floor plans with a clear view to Harbor Bridge of Sydney.

A public plaza complements the opposite Farrer Place to create one of downtown Sydney's most attractive urban spaces. A large grand staircase and the first floor are public. Two new cafes and a Kindergarten in the building help animate the space.

In the center of the building is an atrium as tall as the building which brings in natural daylight and let the wind flows inside for natural ventilation in offices and balconies. There is glass elevators inside this atrium, making travel to and from the workplace an exciting spatial experience.

Central element of the building is an atrium that is as tall as the tower. It offers natural day lighting and allows for a natural ventilation of the offices and balconies that face the atrium. Glass elevators go up and down in the atrium. A terrace in 15th and the roof top terrace 28th floor with harbor view are unique spots in the building.

The building is one of the first ones in Australia with Double-Skin Façade system and natural ventilation.

"The energy system combines cooling, heating, electric power generation (so called "Tri-Generation") and a vacuum tube solar collector that produces electricity on site. Because water is an especially precious resource in Australia, "1 Bligh" has its own filtration plant in the basement, capable of cleansing more waste water that the building actually produces. Because of that more waste water from the public sewage system is used, cleaned and brought back to the cycle. 300 safe parking spots for bikes make the environmentally friendly commute to the building easy and complete the ecological profile of the building."
Figure[31] London's City Hall

Figure[32] London's City Hall, Interior
Figure [35] London's City Hall, Sn Light usage for energy consumption

Figure [36] London's City Hall, Sn Light usage for energy consumption
Figure[37] 1 Bligh Office Tower, Sydney, Australia

Figure[38] 1 Bligh Office Tower, Roof Garden
Chapter 4: Design Strategies
In this chapter the strategies in process of design is separated in three different sections regarding to a smart sustainable system for design. The issues which have an significant role in design process for the Author. Each property of the renovation design will be categorized by three main frameworks.

**First Step: Framework**

**Framework: Economical**

**Rebuild or Demolish**

In the century that the focus is mainly on a sustainable development around the world, renovation calls for a feasible decision in the case of converting the existing building in to a sustainable unit which provide long lasting value for investors. A proper renovation strategy can manage the energy consumption of the building and solve the problems of the building such as indoor environment quality and user comfort and reduce the cost of maintain and operations.

According to the main issue for feasibility of the design, there are some main questions which would help through this main decision:
- Does Renovation cost more or less than rebuilding?
- Does Renovation solve all the current problems of the building?

**Economical Elements in Design:**

WDR broadcasting company now is struggling with this main question of renovating or demolition of Filmhause. However the decision of demolition of the building is not an easy one to choose. After submission of Cathedral of Cologne as an international cultural heritage, the master plans of the city all influenced from the major effect of the Cathedral. Cathedral as the decision should not lost its focus regarding to a new - maybe - high rise building. That is why construction of a new building is always a place of hesitation.

The main problems of the “Filmhause” which is listed below shows that renovation in a lower cost can be a proper solution in this case:
- The need for a new energy system, lower energy and maintenance costs.
- Not enough fire escape stairs
- WDR tendency to be more public

Renovation seems to be a feasible solution regarding to a sustainable judgment.

**Existing Volume, transformation**

The whole volume of Filmhause building is a combination of different volumes differs in size and height. The height of the whole complex gradually increases in north-south direction and makes a step-step slope for the building. The design aims to save the whole shape of the building by adding one additional volume in south part of the building to create enough space for new programs. The building has high quality bearing structure with concrete cores inside the building and dense columns situated all around the volumes.
Figure [39] Rebuild would cost more than renovation.

Figure [40] Renovation is a feasible decision.

Figure [41] The process of Transformation.
Figure 42] Public Space in Ground Floor with 6m height

Figure 43] The bridge connecting inner block space to WDR Archivehaus.
Public Space

A public space belonging to the company not only strengthen the relation between city and company but also have economic benefits for WDR. Since most of the WDR incomes are from advertisements and on TV bills of each household. A public restaurant and cafe on a ground level of Filmhause in an open area would financially assist the whole complex.

The whole volumes of the building have been cut in two different parts. In the ground floor of the building these two sections work separately. One is as main entrance for the offices of WDR which made access to the whole building via 4 elevators. These elevators provide the vertical connection to all 11 floors and an escalator in which would made the access to the main lobby, information center and conference room in first floor.

In the other part an area as "WDR public" has been designed. A public area as a community center for WDR fans to link citizens of Cologne or tourist with WDR to make this broadcasting company more open to the city. A restaurant and a café have been designed in this part and a stage in the middle would have live programs for people. Also big screen boards around would cover WDR channel live for people.

Pedestrian and WDR

A main bridge is designed in the public area to connect the local neighborhoods in the inner block with WDR and Nord-Sud-Farht. The bridge has been designed with different cutting angle and transparent open view to encourage pedestrian to use it instead of the crossroad. By this bridge passengers could cross Nord-Sud-Farht while having a great experience by WDR complex.

The Archivehaus in the floor connected to Filmhause is supposed to be design with a member of the studio to functions as a meditation center.

The purpose of the bridge is not only to provide a route through the street but to
Framework:
Environmental

Double Skin Façade

Double Skin Façade have been developed and used in both new and renovated buildings to increase human comfort and decrease energy consumption.

The modernist movement in architecture has led to a building boom of a large number of high-rise buildings with glazed façades. This led to an increasing tendency between architects to apply double skin façade to their designs. Double Skin Façade System manages the interaction between the outdoor and indoor environments. A Double Skin Facade can balance the demand for energy saving and thermal and visual comfort.

A Double Skin Façade is an envelope type structure that contains two transparent surfaces separated by a cavity. The exterior surface is usually a hardened single-glazed pane, whereas the interior surface is an insulating double-glazed unit. Clear low-emissivity coating and solar-control glazing can also be used.

The air cavity between the two skins can be naturally or mechanically ventilated, and the width of the cavity may vary from 0.20 m to more than 2 m. This system can vary depending on the air cavity section arrangement.

"Double Skin Façade system is essentially a pair of glass "skins" separated by an air corridor. The main layer of glass is usually insulating. The air space between the layers of glass acts as Insulation against temperature extremes, winds, and sounds. Sun-shading devices are often located between the two skins. All elements can be arranged differently into numbers of permutations and combinations of both solid and diaphanous membranes". Harrison and Boake, (2003)

However we should take it to consideration that not all types of a double skin would be suitable for all designs. Diverse climates and locations make difference in type and style of this feature and this increase the attention for choosing a suitable and adaptable type to have a positive effect on the performance of the whole system.

If a Double skin façade system designed correctly it will provide a comfortable indoor air quality while reducing the energy use in the building.

The classification of the Double Skin Facades is important since the initial approach can influence the design stage. After selecting the type of Double Façade appropriate for the building, it is necessary to define the design and the technical parameters (such as the materials used) that can influence the function and the performance of the system and the physical properties of the cavity.

The design of the Double Skin Facades involves decisions on geometric parameters, glass selection, ventilation strategy, shading, day lighting, aesthetics, wind loads, and maintenance and cleaning cost expectations.

Experience, available performance data, and modeling capabilities are necessary materials to make the most of the potential of Double Skin Facades. Regrettably, most of these resources are currently unavailable in this period of time.

Most of the reasons for designing a Double Skin Façade system are listed below:
- aesthetic desire for glass façade for more transparency
- The need for improved indoor environment
- The need for improved acoustics in the noise polluted area
- The control and reduction of energy consumption

The benefits of double skin have been known in the properties of indoor environment such as:
- Thermal comfort
- Solar control
- Avoidance of overheating
- Acceptable internal surface temperatures during the winter and summer
- Visual comfort
- solar shading control
- Improved visual comfort: glare avoidance
- Acoustic comfort
- Acoustic performance of the second façade
- Ventilation
- Natural ventilation

Along with the indoor qualities double skin helps to improve the energy consumption of the building as:
- Decrease of heating demand during winter
- Decrease of cooling demand during summer
- Decrease of heating/cooling loads
- Natural daylight instead of artificial Light

It is clear that the concept of Double Skin Facades is a challenging issue which affects the building in different part and properties
such as: daylight, natural ventilation, indoor air quality, Acoustics, thermal and visual comfort, energy use, environmental profile, etc.

Nord-Sud-Fahrt appears to be a decent choice for a significant building as an Opera house which always acted strongly in Cologne. With this design he was able to give a new character to the inner city which was still harming from war disaster.
Figure [44] Structure of a regular Double Skin Facade
Guidelines and Performance Parameters

Unfortunately there are currently no specific guidelines for designing or analyzing a Double Skin Façade.

The National Fenestration Rating Council (NFRC) has created a standard for calculating and measuring the SHGC and U-Value of a façade system. Unfortunately, these typical façade parameters are not ideal for defining the performance of Double Skin Facades. Over the same range of environmental conditions, the SHGC and U-Value for a Double Skin Facade will have a much greater variability than with a typical façade system. In addition, the SHGC and U-Value for a Double Skin Facade will vary by the floor due to the considerable temperature difference across the height of the air cavity. Currently, the NFRC does not provide a standard SHGC and U-Value calculation procedure for characterizing the thermal performance of Double Skin Facades. The internal glazing temperature is another typical façade performance parameter because it has a large effect on the thermal comfort of the occupants in the perimeter zone. According to ASHRAE 55, the surface temperatures surrounding an individual in a sedentary environment should be within 5-10°F of one another. Any surface that exceeds this range causes asymmetric radiative discomfort.

The additional parameters used to define the performance of a DSF include the cavity airflow and temperature. These parameters show how well a Double Skin Façade expels absorbed solar radiation during the cooling season and its capability for providing natural ventilation between the air cavity and adjacent spaces.

Similar to the SHGC and U-Value, there is no standard procedure to calculate the cavity airflow and temperature in a DSF.

Seok et al. proposed a method for a simple design process that would consider the interactions between many of these design parameters. His results showed that the most significant parameters in terms of the total energy load are building orientation, cavity height, cavity depth, blinds position, outer skin U-value, and inner skin U-value. He also found that the interaction between cavity depth and aperture size is important.

Structure of Double Skin Façade

Double skin façade involves different layers:

**Exterior glazing layer**

The exterior layer is normally single-glazed and transparent.

**Interior glazing layer**

Insulated clear layer with solar control and shading devices. Mechanical and artificial openings would be integrated on interior layer.

(Oesterle, 2001) mentions that the effectiveness of the inner façade in terms of its ventilating function will depend on the opening movement of the windows of inner layer.

Cavity

The Cavity in between two layer is filled with air (can naturally or mechanically ventilate the space).

The width of the cavity differs from area to area and specific type of the double skin but it frequently varies from 200mm to over 2.50 meters. This width usually affects different issues as overheating, heat transfer coefficient, thermal resistance and thermal transmittance. The ventilation may be totally natural or hybrid and mechanical type, in some cases a mixture of different system may be used. The air allows passing through vents or louvers in a low toward top or in the bottom of each floor.
Ventilation

Double Skin Facade ventilates buildings which is an aid for energy saving of the whole system of building. The stack effect through the Double Skin Facade helps to improve ventilation. The performance of a Double Skin Facade depends on the type of ventilation.

Naturally, a ventilated DSF seems very interesting from an energy point of view, but good design and a proper operation of the system are crucial to improve the energy saving.

Kragh, (2000) categorized Double Skin Façade based on the ventilation type of the cavity in three categories:

Naturally Ventilated Wall:

"An extra skin is added to the outside of the building envelope. In periods with no solar radiation, the extra skin provides additional thermal insulation. In periods with solar radiation, the skin is naturally ventilated by buoyancy effects. The air in the cavity rises when heated by the sun. Solar heat gains are reduced as the warm air is excluded to the outside. The temperature difference between the outside air and the heated air in the cavity must be significant for the system to work. Thus, this type of façade is not recommended for hot climates".

Active Wall:

"An extra skin is applied to the inside of the building envelope; inside return air is passing through the cavity of the façade and returning to the ventilation system. In periods with solar radiation the energy, which is absorbed by the blinds, is removed by ventilation. In periods with heating loads, solar energy can be recovered by means of heat exchangers. Both during cold periods with no or little solar irradiation and during periods with solar gains or cooling loads, the surface temperature of the inner glass is kept close to room temperature, leading to increased occupant comfort in the perimeter zone, near the façade. This type of façade is recommended for cold climates, because of the increased comfort during the cold season and the possible recovery of solar energy".

Interactive Wall:

"The principle of the interactive is much like the naturally ventilated wall with the significant difference that the ventilation is forced. This means that the system works in situations with high ambient temperatures, as it does not just depend on the buoyancy effect. The system is ideal for hot climates with high cooling loads. During cold periods with no solar radiation the ventilation can be minimized for increased thermal insulation.

Apart from the advantages in terms of solar and thermal performance the system allows the use of operable windows for natural ventilation, even in high rise buildings".

The Natural ventilation system is the type of ventilation which is focused on in this renovation design.
Figure 45: Ventilation in Double Skin Facade system of Project
Advantages of a Double Skin Façade System

Following there is some advantages of double skin façade which clarifies Author’s reasons according to appliance of double skin façade system.

Acoustic insulation
Interior Noise would be decrease according to two layer insulation and there is reducing of the noise transmission from outdoor sources such as traffic and city noise pollution. This could be calculated based on the size of openings in skins and the type of double skin façade.

Regarding to the Authors priority sound Insulation is one of the significant properties of a Double Skin Façade System.(While the building of this thesis which is going under renovation is alongside Nord-Sud-Farht, a main traffic base highway).

Natural Ventilation
Natural ventilation occurring in the cavity of the double skin envelope is determined based on the air temperature in the cavity.

Natural ventilation is one of the most important advantages of double skin façade system. That will allow ventilation most naturally or by supporting of mechanical systems.

The type of double skin would vary in different climates, orientations; locations and regarding to the program of the building. A proper double skin which is designed well reduce the energy and improve the comfort of occupants.

Thermal Insulation
In cold seasons such as winter the exterior layer would improve insulation with external heat transfer resistance .while the temperature inside the cavity is increasing and the air flowing speed on the other hand is reducing, then the heat transfer rate on the surface of the glass would also get lowered which leads to the total reduction of heat loss. In hot seasons the air inside the cavity gets warm and can be extracted while ventilating.

The type of the panes and also the shading device should be selected carefully for a suitable ventilation system since these directly affect the overheating of the cavity and interior space. The size of the cavity and openings are critical parameters and can affect airflow and temperature inside the cavity.

During hot days it is a suitable solution for overheating problem of the interior space. Pre-cooling the spaces during night could be a thoughtful solution .In this case the interior temperature would be lowered in early morning hours and provides thermal comfort for occupants. It also affects the heat storage of the material in floors, ceiling and walls.

Since the air inside the Double Skin Façade cavity is warmer (compared to the outdoor air temperature) during the heating period, the interior part of the façade can maintain temperatures that are more close to the thermal comfort levels (compared to the single skin facades). On the other hand,

It is crucial that system is well calculate and designed so that the temperature inside cavity will be under control and manage to not increase.

Energy savings and reduced environmental impacts
“Significant energy savings can be achieved only where Double Skin Facades make window ventilation possible or where they considerably extend the period in which natural ventilation can be exploited. By obviating a mechanical air supply, electricity costs for air supply can be reduced. This will greatly exceed the savings mentioned before”. According to Arons(2001), “energy savings attributed to Double Skin Facades are achieved by minimizing solar loading at the perimeter of buildings. Providing low solar factor and low U Value minimizes cooling load of adjacent spaces”. (Oesterle, 2001)

Transparency
It is always the desire of architecture to have wide opening and glazing surface. For years the aim was to have an aesthetic design and transparent envelop with a proper energy consumption and indoor air quality. A double skin façade with lower solar gains in summer and with thermal insulation in winter and a proper ventilation system is a technology in today’s architecture which still needs to be researched on.
Figure 46: Structure of a Sample Double Skin Facade
Disadvantages of the Double Skin Façade

Regarding to studies there are some disadvantages of using double skin. These parameters would be described following:

**Reduction useful office space**

As mentioned, the width of the intermediate cavity of a Double Skin Façade can vary from 20 cm to more than 2m. According to the cavity space in between two layer of a double skin façade it would resulted to less useful and convenient space therefore it seems to be an important issue to calculate an optimum depth for the cavity in order to not losing space and also to utilities correctly as a proper ventilation with thermal comfort for each floor.

**Additional maintenance and operational costs**

With a comparison between a regular single façade and a double skin façade system it would be clear that the latter façade has obviously higher construction cost, following by cleaning operation, servicing and maintenance.

**Overheating problem**

It is possible that regarding to a wrong design and system for a double skin façade the system doesn't work properly and as a result the temperature of the air flowing in between two layers may increase and cause an overheating in the indoor environment. One of the ways to avoids this overheating is to calculate the cavity not be less than 200mm the most important issue to avoid overheating in this type is to calculate the width of the cavity properly (not less than 200 mm) and the size of the openings and vents in the interior layer.
Materialization

The main attention for choosing the material for a double skin façade system is on the type of panes and shading device.

Internal skin: a double insulated glass is a common material. The gaps between the panes of glass are filled with air, argon or krypton. The interior glass normally has low-remittance coating to reduce the harmful heat gains.

A double insulated glass have been chose for the interior layer, this would cover the whole glass walls around the building.

External skin: A tempered double glass or laminated safety glass is common.

Double skin laminated glass is used in this design since it has much higher sound insulation rating, due to the damping effect, and also blocks 99% of incoming UV radiation. It also is safer according to its anti-shattered feature. To prevent the possible brittle fracture of a glass pane, laminated safety glass - usually based on the most common plastic interlayer PVB - is specified in lieu and place of monolithic glass and designed to meet expected performances under most conditions. This type of glass presents excellent performances in terms of durability and integrity under high temperatures, high wind loads, voluntary or accidental impacts.

The modules which formed the façade are presented in different colors to create the floating image for the ones who are crossing Nord-Sud-farht with cars. So two kind of clear and coated glad would be used for the east façade. The coated glass would changes in color and appearance encountering different light. It is obvious that the speed of the motorist on each side would create difference in the vision that they will have from the façade.

Selection of shading device

The design of sun shading device could vary from case to case. There could be a smart shading device to work with a sensor which is placed on outer side of interior layer to determine the proper light and disturbing light. Or the occupant can decide about the proper amount of light that he needs inside the space or a combination of these two systems.

In this Design a sensor has been placed on outer side of inner skin to manage and control the shading device, there is also self-controlling devices for the louvers inside he office buildings to let each employee manage his own space during a working day.

Even in moderate climate zones fully glazed buildings need shading devices in order to reduce cooling loads. External shading devices are much more effective than internal shading devices. However external shading devices are not very popular due to mechanical, cost and aesthetic reasons.
Figure[47] Double Skin Facade Structure in the Project
Roof Garden

Green Roof is a vegetative layer which is grown on rooftops of buildings. These layers would help to decrease the heat temperature regarding to evapotranspiration.

Green roofs despite of giving an aesthetic vision to urban environments can also manage energy saving of the building. With green roofs, the rain water is stored then will be used for irrigation of plants. Green Roofs reduce the energy consumption of the buildings and moderate interior temperature of the building since roof tops have the maximum heat loss in cold seasons and the maximum temperature in hot seasons.

On the other hand the plants which are growing on the roof help through daily dew and evaporation cycle to cool surrounding urban area and to reduce what is called urban heat Island effect. It also help through the procedure of reducing distribution of dust and noise pollution and smog in the city especially in polluted center areas. This will decrease greenhouse gas emissions in cities too.

The green landscape and little Gardens inside the building create micro environments and moderate the urban heat island effect which will improve the local microclimate with increasing the evapotranspiration level and reducing extra loads.

Green Roofs also could be mentioned in the category of social growth which increases the amenity and comfort; it can serve different number of functions such as communication areas and commercial spaces. Also the visual and environmental effects of green roofs have positive impacts on psychological well-being of people.

Elements in Design

In the design, according to the sloping and stepping type of the existing buildings which have been saved for renovation- there is a perfect space for roof garden on the roof of 6th, 7th and 8th floor while there is a big roof terrace on the last two floors which provide a magnificent place for a meeting or resting area.

The green roof provide the ability to manage the raining water as irrigation and also to re-use this waste in toilet flush and irrigation of landscape and gardens inside each floor. The gray water reuse strategies will reduce demand for city-supplied water.

“Using solar hot water collection, the OBF will reduce energy requirements for domestic hot water by 50 percent, almost 5 percent of its total energy demand. With the best currently available photovoltaic panels on the roofs, the OBF will generate 1.4 percent of its annual electricity. Building-integrated photovoltaic made of amorphous silicon and laminated into sunshades and skylights will act as both shading device and electricity generator, producing just less than 1 percent of the building’s needs. Future improvements in photovoltaic technology will allow the OBF to outperform current estimates.” (Chilton, 2012)

Using solar energy is a green sensible and safe natural energy source which provides long term environmentally friendly energy. These panels are highly efficient even in diffuse light and cloudy conditions.
Figure[48] green roof would increase health and has effect on energy consumption of the building.

Figure[49] Solar wall, the panels placed on the facade would use Sun energy to provide electricity for the building.
Solar Roof

"Using solar hot water collection, the OBF will reduce energy requirements for domestic hot water by 50 percent, almost 5 percent of its total energy demand. With the best currently available photovoltaic panels on the roofs, the OBF will generate 1.4 percent of its annual electricity. Building-integrated photovoltaic made of amorphous silicon and laminated into sunshades and skylights will act as both shading device and electricity generator, producing just less than 1 percent of the building's needs. Future improvements in photovoltaic technology will allow the OBF to outperform current estimates." (Chilton, 2012)

Using solar energy is a green sensible and safe natural energy source which provides long term environmentally friendly energy. These panels are highly efficient even in diffuse light and cloudy conditions.

The solar panel façade has been designed for buildings with high architectural standard that meet the terms of environmental regulations. A solar panel façade is the easiest and most effortless way for a building to generate electricity. The system is based on modular solar power or PV panels which allow the size and shape of the other components in the façade to be freely defined. The solar power system does not depend on the sun's warmth, only its radiation. The system enables power to be produced even in areas with no direct sun rays.

Elements in design:

There is a solar wall in the southern part of the building. The exterior skin modules are covered with semi-transparent solar panels instead of Laminate glass to use as much as energy from south which receive the most sun energy in a whole day.
Framework: Social

“In February 2012, a team of multidiscipline professionals stepped into this stream of futuristic imaginings and discussed and identified trends, advances and opportunities for potential incorporation into the design of an Office Building of the Future (OBF) for the year 2030 as part of a national competition sponsored by NAIOP. This article is a summary of the team’s award-winning submission.

The OBF team included Pickard Chilton, design architect; Magnusson Klemencic Associates, structural and civil engineer; Atelier Ten, sustainable design; Cosentini Associates, MEP engineer; IA, interior architect; and Gilbane Building Company, cost estimator and scheduler. The proposal is grounded in the pragmatic realities of the most accurate and latest data of building science available, the design nearly limitless in its potential configurations and bound only by the imagination.” (Chilton, 2012)

“The OBF will meet the owner’s business objectives by providing a value-based yet high-performance architectural solution. A number of emerging trends in office design will impact the design and construction of the OBF.

Office Building of the Future

DISTRIBUTED WORK
On any given business day 30 to 40 percent of physical workspaces are vacant. By working in an increasingly social, mobile and collaborative fashion known as “distributed work,” companies can enjoy the benefits of substantive cost savings and greater space utilization.

GREATER OCCUPANT DENSITY
The next generation of workspace will move away from dedicated offices and workstations. The current average occupancy density of 150-200 square feet per person has been continually trending downwards.

MAXIMIZING FLOORPLATES
Consistent lease depths of 45 feet offer many advantages including: unobstructed and column-free floor plates, maximum flexibility and efficiency, access to natural light, and customization for greater leasing capability.

GREATER MODULARITY IN INTERIOR FIT-OUT
The flexible design allows for the building to be easily repurposed accommodating new technology, amenities and tenants.

PERSONALIZED COMFORT CONTROLS
Personalized environmental controls provided at workstations enhance office comfort and improve productivity. They also contribute to reduced construction Pand energy costs.

INTEGRATED DESIGN
The Building Information Modeling (BIM) platform will facilitate integration and coordination of design, engineering and construction. Its advantages over traditional delivery methods include greater precision and reliability; easier identification of inter-discipline conflicts; broader project understanding; more precise cost estimates and control; and more secure data transfer.

FASTER CONSTRUCTION DELIVERY
A shorter schedule means fewer days that accrue general conditions costs. Efficient schedules equate to more effective use of labor, which is the largest percentage of the construction budget.” (Chilton, 2012)
Figure 50: open plan. A flexible layout for all floors has been designed.

Figure 51: Layout of Section
Open plans

Open plan is the kind of plan with large and open spaces which prevent the design of small traditional office rooms placing around a narrow hallway.

The digital area will soon let each employee to work from anywhere he wants, this is one of the reasons why companies are trying to encourage their employees with creating innovative and comfort working spaces. The speed of digital communication has made open floor plans a solution for future office building to offer mobility and flexibility.

One of the important issues in designing an open office is to consider different kind of activities in an office building and consider the jobs which need concentration and separate them from team work and communication units and determine various aspects in relative location of workspaces. Also there should be a proper balance between communication and privacy in an open plan setting and design and orient the workspaces to provide users with a managing control over their own space and their visual access. The amount of enclosure can be provided for each employee by overall amount of panel height and internal layout and the visual permeability of the materials around workspace.

Elements in Design:

The floors have been designed as open floor plans to present a flexible use; therefore in the reason of any changes in the purpose of the building or any possible function changes, the building would adjust itself with changes.

Also the whole design have been separated in two parts, one part with individual working space separated from each other with partitions and the other part glass cubical exclusively designed for team work, there is also spaces with different kind of furniture named as "think tank" area to help employees to have brain storming while helping each other to develop new ideas.

The aim is to reduce close working space and encourage employees to contribute with each and communicate in working area, and to give them the opportunity to select their own working area.

Resting and meeting area

In order to encourage employees to leave their working area and walk around spaces should be created which attract them for spending a short break time there. Some places for less formal collaboration like cafes, resting areas, game rooms, etc. these spaces should be furnished with comfortable furniture and have a great access to outer space and offer a good view and atmosphere.

The Author's goal in designing social sustainable plans is to blur the thick line between outer life and office life and to make the office as a place where employees can work, rest, meet their family and take care of their children.

Elements in Design

The resting and meeting area in each two floors provide this opportunity for employees to have their own time of relaxation or communication in a comfortable space.

The design of this eleven storeys building provide a meeting area in every two floors,

There would be two storeys high fully transparent and open space operated as meeting area, canteen and communication area. These places supposed to be as an area for the employees to relax, enjoy their day in a cozy space and communicate and discuss with each other in a more friendly space. These spaces are furnished with cozy furniture with unique natural south light. The plants and small trees planted in these spaces make the place more relaxed and calm.
areas
between floors existing

Figure (52)
Natural light

Light is a fundamental element in designing office buildings since most of the communication and activities occur visually, some primary working needs such as reading, writing and the necessity to interpret with surrounding environment. The amount of light also impacts health and behavior of the employees. Natural light surely have a strong and positive effect in the working spaces and will increase the productivity among workers. The natural light with an open view to outdoor urban area will increase the motivation and satisfaction and comfort of each employee and improves employee’s productivity.

Besides, using Natural light during day not only reduce the total electricity demanded by lighting and HVAC system but also reduces the peak demand, minimizing the use of the most expensive electricity. Saving one kilowatt-hour (kWh) of energy during daylight hours saves a building more money than saving that same kWh at midnight.

Therefore Natural light can simply promote occupant well-being, while reducing the amount of electricity used by the lighting.

Element in Design

The walls of the existing building have been demolished to use large window sections; these wide openings between the columns would allow natural light to penetrate the building to create a pleasant working space inside each floor.

The transparent double skin façade around the building demonstrate the distinct character of WDR and somehow connect the city and routine life with WDR working offices as one of the goals of WDR is to relate more to people and the city. It seems that the building is a part of outer city and with visual connection between the people who are passing by cars in Nord-Sud-Farht or people who are experiencing the building on feet.

Health and behavior

Nowadays, Health, safety, and comfort of employees in an office building are one of the important concerns of companies.

Applying fresh air ventilation, using non-toxic and low polluting materials and well managed indoor air quality monitoring system are the issues in the categories of sustainability which all working together for a better living and working area.

Provide individualized climate control that permits users to set their own, localized temperature, ventilation rate, and air movement preferences.

"While difficult to quantify, it is widely accepted that worker satisfaction and performance is increased when office workers are provided stimulating, dynamic working environments. Access to windows and view, opportunities for interaction and control of one's immediate environment are some of the factors that contribute to improved workplace satisfaction. See also the Psychosocial Value of Space."

The acoustical environment of the office must be designed and integrated with the other architectural systems and furnishings of the office. Special consideration must be given to noise control in open office settings, with absorptive finish materials, masking white noise, and sufficient separation of individual occupants.
Figure 53. Natural Light for offices. Save energy and provide health and comfort for occupants.
Figure 54] Facade Modules
Façade, Visual
Perception and Motion

The experience of surrounding area changes according to speed and proximity in an urban area. The more consideration of this point in design the more there could be a improved encounter with the city.

The speed of a motorist in a highway, the points of stop and peak, and the pedestrian roads all should be understood in an urban design. In different level of movement the visual understanding varies. To have a proper interaction between surrounding environment and urban area with citizens and the people who encounter it there should be an appropriate understanding of architectural forms and details from different point of views. This visual understanding can provide factors for a perfect design.

Lights and colors are the base material of visual understanding. The information which is obtained from a physical environment comes from the various reflection and hues that human eyes can detect. Human mind process the patterns affected by light and color, including sounds, smells, memories and provide us with an image of surrounding area.

According to the experience of motion in highways, understanding of city is on a complete different level than pedestrian view. Communication with motorist is needed without slowing down the movement but with slowing down the psychological process and simplifying the visual understanding from city story.

In an urban design adjacent highway a careful analyzes should be done on details, forms, orientation and colors. The more the structure is near the highway, less there is time for it to be viewed. In cases like this the designer should pay attention to the anatomy of eyes and image processing of mind. Most of the audience of urban architecture are in cars and experience it from highways in fast speed while experiencing their own worlds in their cars. They are listening to music while interior temperature let them close the windows. Vision is the only way motorist get data for analyzing the urban area. Building with a façade near highway should reflect these properties and differs in form and material.

Also we should consider the pedestrian and the way a walking person observe a building from neighborhoods.
Future city, Cologne
Figure[55] Facade visibility from highway
Highway Noise and Insulation

Noises and sound pollution is an undesirable effect of modern life of today which is annoying and in some cases may cause physical damage.

The wide range of activities in the inner City generates higher levels of external noise than in suburban areas. Noise from activities such as traffic, people on the street, operational commercial sites can unpleasantly affect the amenity of those living in the Cities. As low frequency noise is particularly invasive, reducing the impact of noise from street and highways and motorist vehicles need to be considered. To effectively lower the amount of external noise that enters a building and subsequently maintain the amenity of an inner city residence, particular attention to the construction detail of the external façade is essential. In a noise polluted environment, there should be a significant attention to openings in building envelop.

Providing an acoustic indoor environment will improve health and living quality, however a complete acoustic place is not considered as a comfort zone since any noise then would be annoying. In other words, more a space is insulated from its surrounding noise, the more its inhabitants will feel disturbed by any noise that would still get to their ears.

Elements in design

According to the Filmhause border with Nord-Sud-Farht, the major noise pollution form this inner city highway will affect the working space and offices. The main characteristic of a broadcasting company which contains studios, recording spaces and acoustic environment brought up the idea of an acoustic envelope as a concept of acoustic studios.

Double Skin Façade as an envelope covering the building offers and enhanced sound insulation against external noise and the cavity in between two separate façade which is filled with air would impair this function. The system has the benefit of reducing noise pollution to the interior occupants while providing natural ventilation, without the need for additional HVAC equipment.

A double skin façade in its base would decrease sound pollution and will increase the insulation which is needed for a comfort zone of human being. The special forms of a Façade can increase the insulation since it can works as an acoustical barrier.

Façade sound insulation can be improved by using high performance components or by modifying the shape of the façade.

The modules which forms the exterior Facade can also improve the accoustic factor of the facade with reflecting sound in different direction and acting as an aoustical barrier. The forms in exterior facade of Filmhaus led to a image of acoustic barrier.
Figure 56: Facade acting as an acoustic barrier
Conclusion:

A system for Life

Modern Life in any way would force human being to adjust himself with technology and smart way of living. Future have features which we cannot imagine in any way now, as our ancestor could hardly imagined this much of development during digital age.

This research provide a system for a sustainable future building based on sustainable design triple bottom line to brighten the point that all features of sustainability are related to each other. All the effort of today’s human being is to be feasible and feasibility would come after Sustainability.

There is a tangled relation between each of bottom lines of sustainability. It is clear in this chapter that when there is specific solution for environmental factor regarding to a green strategy, in the other hand and in same direction there is a control over economic issue.

As an example by applying a good ventilation system for a building not only you are using natural sources (wind) for ventilation (Environmental) but also you are reducing the energy cost of the building (Economical) and also you are providing occupant with pleasant and healthy indoor air quality (Social).

An integrated sustainable building is the one which all its features work in same direction an all help the system for reach to a perfect result.

“The OBF aims to produce just as much energy as it uses: it will be a high-performance building that improves indoor environment quality, enhances productivity, and encourages healthy behavior. Narrow floor plates and efficient facades use passive strategies to decrease energy consumption and costs while increasing occupant satisfaction. Radiant heating and cooling systems and efficient lighting, coupled with smart monitoring and occupant controls, provide users with personal control of their environments and thus greater comfort and productivity. Supplemental ventilation ensures optimum indoor air quality. Heat recovery ventilators capture waste exhaust heat to precondition fresh air intake. Open stairways and floors encourage greater collaboration and occupant activity while minimizing elevator trips.” (Chilton, 2012)

We are the designers of our own future, our children’s future and next and next generations. There is a need for a suitable system that economically helps us to save fuel energy and to use natural limitless sources to provide essentials of life and to create future cities a better place to live, work and study.

The point of the Author is to prove this fact that time will pass fast and all we have in our hands as an architect is first steps of designing for future, to design for future cities and who are the main masters of the city? People.

Therefore designing for people, designing for their health is the perfect way to be an ideal architect for future.
Chapter 5: 
Design elements
Filmhaus, The

existing building

Since the security unit for WDR broadcasting company do not let any information out, So the drawings and structural detail of the building are not accurate.

The building have been measured from outside but the interior plans, the place of columns and other details about this buildings are approximate.
Future city, Cologne
Site and Access

Figure[60] west Side, Filmhaus inside the block

Figure[61] East Side, Filmhaus boarding with Nord_sud-Fahrtn
Figure 62: Access to the site by car
Climate:

Wind And Sun

Figure 63: Sun and shades in different hours of a middle day of the year.
Figure[64] Wind direction and speed summary during the year
A Sample of approximate plan

Figure [65] plan of WDR, layout of Existing Building
Approximate Structure

Figure 6.6: Structure of existing building
Transformation

Figure 67: Step by step transformation in design
Renovated building

The Envelope

The Volume
Plans, Sections, Facades,

Details
Future city, Cologne

Figure 69: Ground Floor
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Future city, Cologne

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