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"Investigation of double skin facades: Irish buildings between 2012-2006"

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Synopsis

Name: Aidan Walsh

Title: Investigation of double skin facades: Irish buildings between 2012-2006

The aim of this research is to evaluate the use of double skin facades on public buildings with particular reference to Irish buildings between 2012 and 2006. It is to examine the typology and evolution of double skin facades and how they have developed in Ireland.

To achieve the above, the research follows a set five step methodology. The first step is to outline the aims and objectives to outline what exactly it is that the dissertation is hoping to achieve. Then the study area within which the research will be carried out is identified. The next step involves the gathering and organising of source materials, both primary and secondary. The research will then be narrowed down by using dimension sampling. Step five evaluates the data gathered throughout the research. The sixth and final step outlines the conclusions and recommendations obtained from the research.

The research has found a number of things. The first being that the design of a double skin facade greatly dictates the benefits it will bring to a building. The main benefits of a double skin are Day lighting, natural ventilation, sound barrier, thermal barrier. There have been problems in some cases of excessive solar heat gain due to poor design but these problems can be irradiated by installing the correct shading devices. Maintenance and upkeep of facades can be quite difficult and costly and as they are largely glass facades they require regular upkeep. Comparisons can be made between all types of double skin facades but essentially they are grouped in to certain categories that perform certain tasks differently.

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Chapter One

Introduction

Double Skin Facades

Chapter One

Introduction:

1.0 Introduction.

The aim of this chapter is to offer introductory information in support of this research investigation into double skin facades. Section one offers background information and details pertaining to the development of this research. Section two changes the focus to concentrate on the rationale for the research, while section three explores the methodological framework of the dissertation. Section four will overview the main conclusions. The sixth and final section offers concluding remarks.

1.1 Background to research.

The idea of a building envelope is to protect the building within it. The building envelope controls all aspects of the building such as thermal load, ventilation, solar heat gain and noise pollution. Originally the building envelopes only purpose was to serve as a barrier to protect the internal environment. The more an envelope protected the interior of a building the more efficient it was considered to be. The internal building environment is then controlled by mechanical means.

However as time has passed there have been many developments in the area of building envelopes. More and more people began to realise that the building facade can be used as a way of moderating the internal and external environments. The building facade should be designed so that it both protects the building and serves as an efficient mediator form the internal and external environments. The type of facade will differ from country to country. This is due to climatic conditions and different types of technologies in these countries. There are a number of strategies being developed in lots of countries that plan to use the building facade as a way of saving energy. Double skin facades were mainly produced in Europe but have since been developed in countries like Australia and the America. The idea and concept of double facades has been around for a long time. The concept of double skin has only come about in more recent years. These double skins are constructed mainly of glass and are seen as an environmentally friendly form of building envelope design. Double skin facades is basically two sets of glass skins

separated by an air space. This is quite similar to a standard cavity wall. The purpose of this air space is to provide a form of insulation from climate, wind and sound. These reasons have led to the choice of double skin facades as the dissertation topic.

1.2 Rationale for the study.

The research into double skin facades comes from the benefits it brings to a building in terms of achieving a lower carbon footprint and making it more sustainable. Double skin facades bring a whole new dimension to buildings and can benefit it in a number of ways. This research will explore the development of double skin facades. It will investigate the types of facades available and look at the double skin facade buildings that have been constructed in Ireland between 2012-2006. It will explore all the benefits of using a double skin facade on any particular building.

1.3 Research Methodology.

1.3.1 Aims and Objectives.

History:

- Investigate the history of double skin facades.
- Look at how it has modernised and come along since the concept of double skin facades was first introduced.
- Look at its history in terms of Ireland

Typology:

- Investigate the different types of facades and see which types are best suited to certain climates and in particular Irelands climate:
 - Buffer Façade
 - Extract-Air Façade
 - Twin-Face Façade
 - Hybrid Façade
- Look at the details that define a double skin facade.
- Investigate the different parts of the facade

- Look at the benefits of using a double skin facade.

Case study:

- Investigate 6 buildings in Ireland between 2012-2006 and observe how they work
- Compare and contrast each of the facades.

Recommendations:

- Investigate all the research and information gathered and try to make some recommendations as to how a double skin facades performance can be improved.

1.3.2 Study Area.

There is a need to have a specified study area within which the research for this dissertation shall be carried out. The study area will start off as a very broad topic when it comes to history. It will then start to narrow down as it starts to describe the types of facades that are available. Finally it will focus in on Irish buildings. The research is focused mainly on award winning public buildings in Ireland.

1.3.3 Source Materials.

In carrying out the research for this dissertation a number of source materials are required. These will consist of both primary and secondary source materials. The key source materials that will support the research for this dissertation are as follows:

- Internet.
- CIT Library.
- Published journals.
- Architectural firms.
- Research conducted throughout the dissertation

The source materials will be utilised and dissected using the following techniques:

- Documentary analysis
 - Interviews
 - Questionnaires
 - Photographs

1.3.4 Sample Selection.

A list of buildings in Ireland will be investigated for the case study in order to give a better understanding of Irish double skin facades. Dimensional sampling was used to gather the list of buildings. The dimensions were as follows:

1. The building must contain a double skin facade.
2. The building must be constructed in Ireland.
3. The building must be constructed between 2012-2006.
4. The building must be semi-public.
5. The building should be an award winning building.

As a result of this list of dimensions six buildings were chosen for the case study section and they are as follows:

1. John Paul ii Library, Dublin.
2. Wexford County Council Headquarters, Wexford.
3. The Criminal Courts of Justice, Dublin.
4. Commissioner of Irish Lights, Dublin
5. Cork Civic Offices, Cork
6. Cork County Hall, Cork

1.3.5 Data analysis.

Humanistic analysis will be used to analyse the data throughout this dissertation. The first step of the analysis is to identify a research statement in relation to double skin facades. The statement is as follows: " Investigation of double skin facades: Irish buildings between 2012-2006". The next step was to formulate a Hypothesis. This was as follows: " Double skin facades benefit Irish buildings". The third step involves outlining the aims and objectives which have been previously mentioned. The next step was to set out a conceptual frame work which showed a list of aims ad objectives as well as the techniques and source materials that were going to be used to research them. Next it was necessary to create a filling system to organise all the work as it was coming in. The work was then organised and placed into the relevant chapters. The final step is to ensure that all of the research gathered and being used is relevant to the dissertation.

1.3.6 Limitations to Research.

Throughout the dissertation there were a number of limitations on the research. The first limitation comes in the form of the lack of literature available. The literature available was scarce and quite difficult to obtain. Another limitation that occurred was the time given to complete the dissertation.

1.4 Guide to the Report.

The report will follow on from the introduction chapter and go straight into chapter two. Chapter two will look at the history and development of double skin facades and investigate where the concept originally came from. Chapter three looks at the typology of double skin facades as well as the benefits it brings to a building. The fourth chapter is the case study section. This section will involve looking at six Irish double skin facade buildings on their own and then comparing and contrasting them all together. The fifth and final chapter is conclusions and recommendations that will be formulated from the research carried out throughout the dissertation.

1.5 Conclusion.

In conclusion the introduction chapter has outlined where the topic of double skin facades has come from. It outlines the aims and objectives that the dissertation hopes to achieve and how the dissertation will be formatted. It outlines the topics that will be addressed in the following chapters of the research in order to fully investigate double skin facade.

Chapter Two

History and
Development

Double Skin Facades

Chapter Two

History and Development:

2.0 Introduction.

This chapter seeks to investigate the history and evolution of double skin facades. The concept of double skin facades has been around for a very long time. This chapter will start by looking at where the idea first originated from, it will then look at how it has changed and adopted to fit in with modern architecture. Section one will show where the idea for double skin facades was first generated and how the first building resembling a double skin facade was constructed. Section two will look at the development of double skin facades and the main designers and manufacturers involved in it. The third section will look at the oldest building that resembles a modern facade. The fourth section will look at the history from an Irish perspective and attempt to assess when the first double skin facade was constructed in Ireland. The fifth and final section will be a conclusion that will review the findings of the history chapter.

2.1 Beginning.

The concept of double skin facades first becomes evident in 1849. Jean- Baptiste Jobard director of the Industrial Museum in Brussels was one of the first people to refer to an element of the design of a double skin facade. He described an early version of mechanically ventilated multiple skin facade. He stated the fact that in winter hot air should be circulated between two glazings, while in summer it should be cold air (Braham, William 2005). This method of ventilation is very similar to that which is used in double skin facades in present day architecture. Jean- Baptiste Jobard did not design or construct any such façades but he was the first person to suggest them.

2.1.1 Development in facade technology.

Another form of construction that is believed to have contributed to the development of double skin facades is the development of the Trombe wall. This form of construction usually involves a sun facing wall that is separated from the outside environment using an air cavity and a pane of glass.

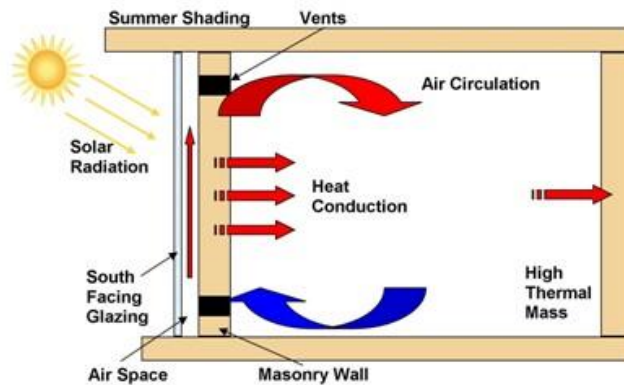


Fig 2.1- Trombe Wall.

Edward S. Morse was the first person to explore this idea in 1881. It wasn't until the 1960's that the idea was fully developed and used in buildings. This was done through a combining the talents of French engineer Felix Trombe and Architect Jaques Michel.

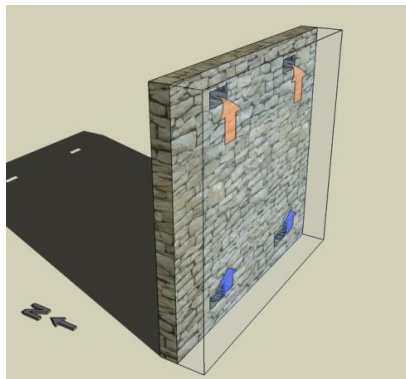


Fig 2.2- Trombe Wall.

Although this is a Trombe wall and not a double skin facade they are very similar in many ways. They both have an exterior glazed layer with an air cavity between that and the internal layer. They also both use their external layers to attract and keep in the heat. Therefore the concept of double skin facades and a trombe wall are quite similar and they share a lot of the same properties. (P, Torcellini and S, Pless. 2004)

2.1.2 First building.

In 1903, 65 years after Jean- Baptiste Jobard first proposed with the original concept. The first form of a double skin facade system was constructed. The first place where we see this form of construction is in Germany. The building was designed by Richard Steiff and it was built to accommodate a toy factory Berlin, Germany.

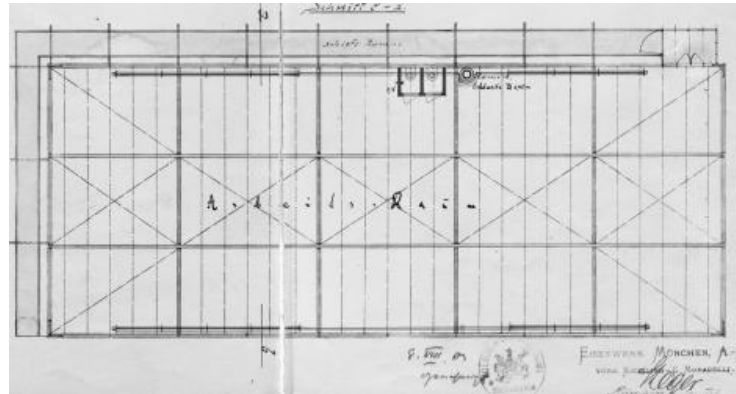


Fig 2.3- Second floor plan of the building permission, 1903.

“The external cover of the building was an innovative construction, consisting of a total floor-to-ceiling glazed double skin façade. The inner glazing of this façade goes from the upper edge of the floor to the lower edge of the ceiling, whereas the external façade covers the total height of the building. The specific characteristic of this external cover appears in its construction to be a pure curtain wall, as it is only fixed by butt straps punctually attached to the structure”

(Anke Fissabre, 2009)



Fig 2.4- The Steiff toy factory.

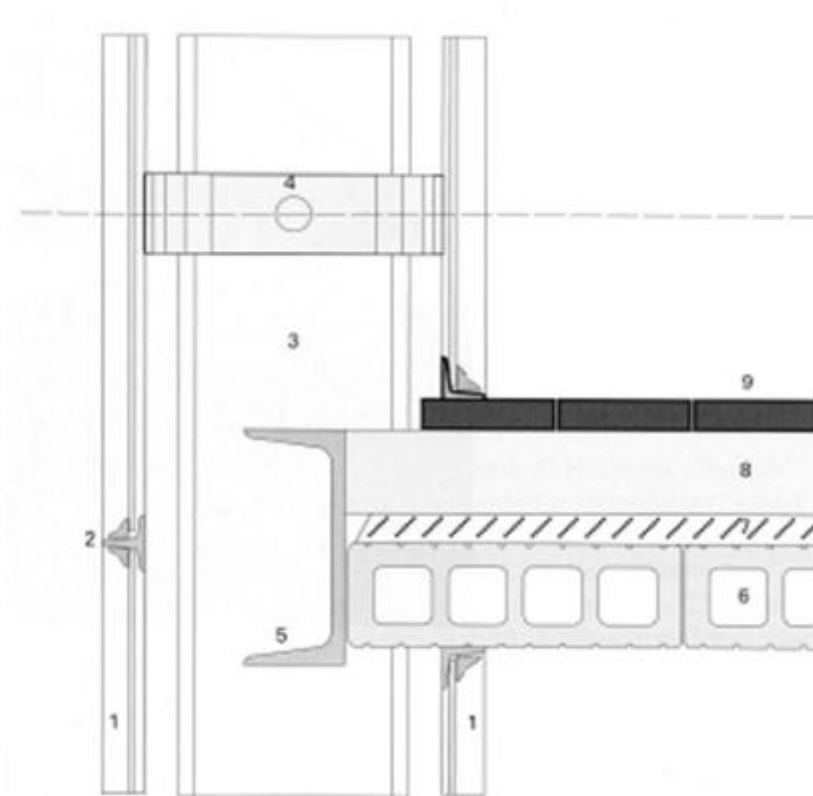


Fig 2.5- Section detail showing the butt strap (4) attached to the pillar

1. Cathedral glass 3mm
2. Steel rolling profile- 30x20mm and 35x25mm
3. Stop short of the vertical main plant contract I-profile
4. Mounting bracket for curtain facade
5. Crossbeam- 70x140mm
6. Hourdis infill elements
7. Equalization layer cement screed
8. Battens
9. Fohren floorboards



Fig 2.6- Butt straps punctually attached

The design of the building meant that the glazed facade only had to carry its own weight and withstand the pressure being applied to it by the wind. It was not a structural element and didn't carry any of the load from the building. The double skin facades is in its own right a self-supported and independent facade. The purpose of this facade was from the offset to provide the maximum amount of sun light into the building whilst at the same time providing sufficient heat insulation. Curtains were initially installed as it was thought they would reduce the solar gain of the building. This however did not stop the building from overheating and therefore ventilators had to be installed to solve this problem. (Fissabre, A; Niethammer, B. 2009)

This Steiff Toy Factory cannot really be compared to a modern double skin facade as they are completely different. However what it does give us is the first concept of two layers of glazing being spaced apart in order to sufficiently light and heat a building.

2.2 Evolution.

As the 1920's came to a close, double skins were developed in Russia in communal housing by Moisei Ginzburg. The Narkomfin building was an example of this; however this was more an office building. These communal buildings would not be considered a double skin facade in today's architecture. However they do hold significant importance when it comes to understanding the history of double skin facades and where the whole idea and concept came from.

Another architect dealing in this form of construction in the late 1920s was Le Corbusier. He produced a detailed set of working drawings for the Centrosoyus office building which was to be located in Moscow.

"There, he proposed what he called the "neutralizing wall," a double glass curtain-wall with air circulating in the place between the two glass walls. According to Le Corbusier, this arrangement allowed for excellent thermal insulation, since the air was to be circulated mechanically and its temperature controlled to respond to exterior climatic conditions."

(Taylor,B, 1987)

Le Corbusier proposed to do this by using heating and cooling pipes which were supposed to be placed between the two layers of glazing. This form of construction was going to provide the maximum amount of natural lighting for the interior of the building. However this facade was not constructed as the cost proved too great for the client, instead only a glass wall of single thickness was constructed.

2.3 First modern form of construction.

The first modern type of double skin facade that appears is in Niagara Falls, New York. The building in this case is the Occidental Chemical Building which was designed by cannon design and completed in 1980. This is the first example that bears any resemblance to what is now considered a modern double skin facade



Fig 2.7- Occidental Chemical Building.

This building contains all the attributes of a modern double skin facade. At the time it was one of the most energy efficient commercial buildings in the world and to this day is still more efficient than most modern commercial buildings. This building gives a great idea as to how much double skin facade can benefit a building as it has been around for years. The basic form of the building is a nine storey glass cube, with a four foot cavity between glass layers, which will pre heat the air in the winter and cool it in the summer.

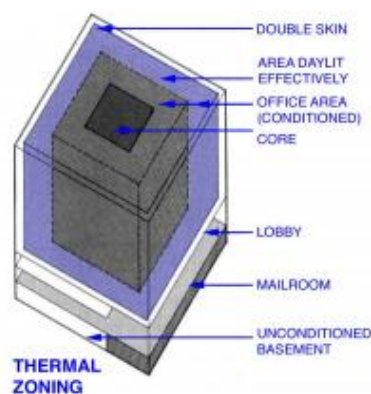


Fig 2.8- Different layers of building.

2.3.1 Design of the facade.

A Buffer Facade was chosen for the Occidental Chemical Building. It consists of an undivided air space that is consistent throughout the entire building with motorised dampers for air intake at grade and vents at the top. Fresh air is supplied to the building through a separate HVAC system.

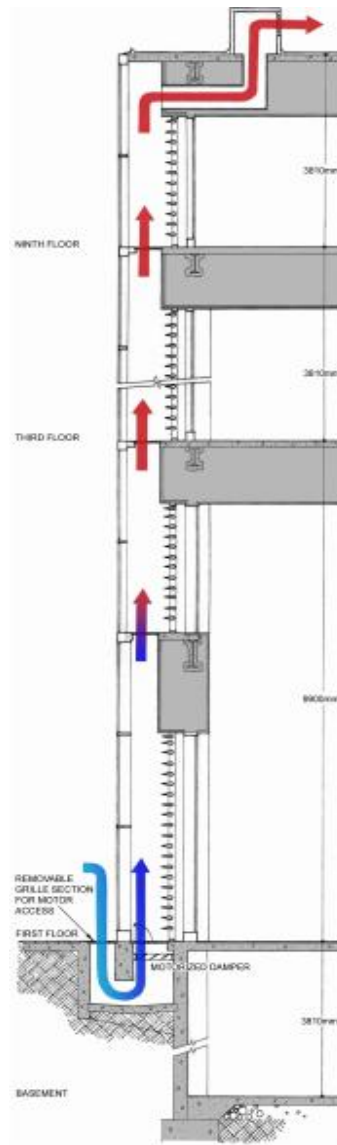


Fig 2.9- Occidental Chemical Building drawing.

The air cavity is controlled by a sophisticated set of louvers. These louvers are controlled by an intelligent light sensor system that responds according to the weather, time of day and season. There are several sensors placed in each facade and each facade is separated into a different zone. This allows the louvers to adjust to the amount of daylight that the zone is receiving throughout the day depending on the location of the sun. The sensors also allow a delay in response in order to cancel the effect of passing clouds.

2.4 History from Irish context.

There are many buildings built in Ireland that contain two facades in the shape of a curtain wall system. However these facades must not be mistaken for what is considered a modern double skin facade. Examples of these buildings are the Dunshauglin Civic Offices, Co. Meath (2002) and the Aras an chontae, Offaly County Council Civic Offices (2003). The first example of a modern double skin facade we see in Ireland is in the form of the EBS building, Burlington Road, Dublin in 2003. This building was designed by Brian O'Halloran and associates.



Fig 2.10- EBS building, Burlington Road, Dublin

The image shows how the building is completely clad in a glass double skin facade. It is a highly sustainable and energy efficient design. It is the first of a number of modern state of the art double skin facades built in Ireland.

2.5 Conclusion.

The concept of double skin facades has been around since 1849. In 1903 the first building that contained this concept was constructed in the form of the toy factory by Richard Steiff. In 1980, in Niagara Falls, New York, the first modern type of double skin facade was constructed in the form of the Occidental Chemical Building which was designed by Cannon Design. It was from here that the modern double skin facade began to grow and expand throughout the world. In European countries such as Germany and Austria it became an increasingly popular building feature. The concept of double skin facades did not reach Ireland till after the millennium and since then it has seen a steady growth of high quality, award winning double skin facades throughout the country.

Chapter Three

Building Typology

Double Skin Facades

Chapter 3

Building Typology:

3.0 Introduction.

The aim of this chapter is to thoroughly investigate the different types of double skin facades that are available to the modern designer. A double skin facade can be defined as glazing layers divided by a cavity. The main characteristics that define the type of facade it will be are the position and combination of the glazing layers. The glazed facade has a very large impact on the impression of a building and how well it performs. It affects the adjacent buildings through glare and reflection. The concept of a modern double skin facade system is to keep out the cold and the water and to let in the air and light. The facade can also be used as a form of better sound proofing a building in busy and congested areas. The type of facade being used will depend on the country and type of climate it is being constructed in. Double skin facades are most commonly used on large scale public buildings, such as offices. This is due to the fact that in order for the double skin facade to be truly sustainable it must span a large area of a building, whether it be vertical or horizontal. It can also be sometimes used on a smaller scale, such as a private home. However it is much more effective and efficient on larger scaled buildings.

The following chapter is going to be subdivided up into various sections. These sections will analyse and look at each type of facade that is available and how they work. The first section will look at the four different types of facades and what defines each of them. The second section will look at the air space between the internal and external glazed layer. This section will be broken up into three parts, divided airspace, undivided airspace and cleaning the airspace. Section three will look at the key features of double skin facades, such as, natural ventilation, solar heat gain, acoustic performance and day lighting. The fourth and final section will offer concluding remarks on the chapter.

3.1 Facade type.

There are many different types of double skin facades across the world and different continents have different classifications for them. The first system that really appeared was that of Dirk Saelens in which he broke the different systems into groups based on how they worked. He broke it up into three systems with different groups in each. These classifications are as follows:

1. Origin of the air flow into the intermediate space
 - I. Supply.
 - II. Exhaust.
 - III. Air curtain.
2. Origin of the air flow into the intermediate space:
 - I. Mechanically ventilated systems.
 - II. Naturally ventilated systems.
3. Compartmentalization of the cavity along the façade:
 - I. Facade.
 - II. Shaft.
 - III. Corridor.
 - IV. Window.
 - V. Box.

This classification system is quite complicated and involves a lot of different parts.

Most European countries follow the same classifications. This classification is broken up into five sections and was described by the Battle McCarthy engineers in London. These classifications were as follows:

1. Operable Inner and Outer skins
2. Sealed Inner skin
3. Operable Inner Skin either mechanically ventilated with controlled flue intake.
4. Acoustic Barrier.
5. Sealed Cavity

This classification system is again quite complicated and can be quite difficult to grasp and understand.

However the best and most in-depth classification system is the American one. The American system was originally designed by Werner Lang and Thomas Herzog. It has since been used and further developed by Terri Meyer Boake of University of Waterloo in her research articles (3-5) (YELLAMRAJU, 2004). In this system there are four types of classifications which are as follows

1. Buffer Façade
2. Extract-Air Façade
3. Twin-Face Façade
4. Hybrid Façade

This classification system is simple and easy to understand and is described in detail in the following pages.

3.1.1 Buffer Facade.

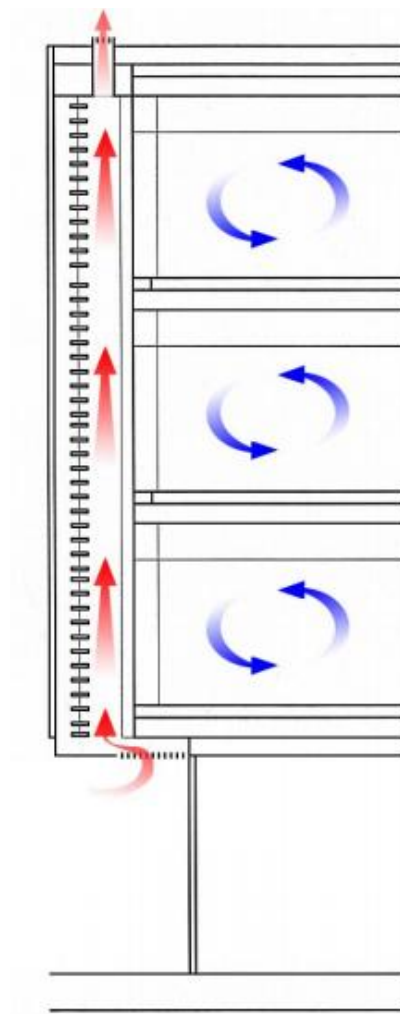


Fig 3.1- Buffer Facade.

The buffer facade is one of the oldest types of double skin facades. The concept and idea of it has been around for over 100 years. It was invented to allow more daylight into a building and also provides better insulating, ventilation and sound proofing properties. It predates insulating glass as an architectural feature.

The basic system uses two layers of glazing. These are usually both single layers of glazing, although in some cases the internal layer can be a double layer of glass. The clear air space between the internal and external layers of glass is usually somewhere between 250mm to 900mm apart. It is sealed off from the interior of the building and therefore other controlled means are required to ventilate the internal fabric of the building. The internal fabric is usually ventilated using a separate mechanical system or box type windows that cut through the overall double skin facade and provide a form of

natural ventilation. The mechanical system usually consists of some form of HVAC system. (Boake T M, et al. 2001)

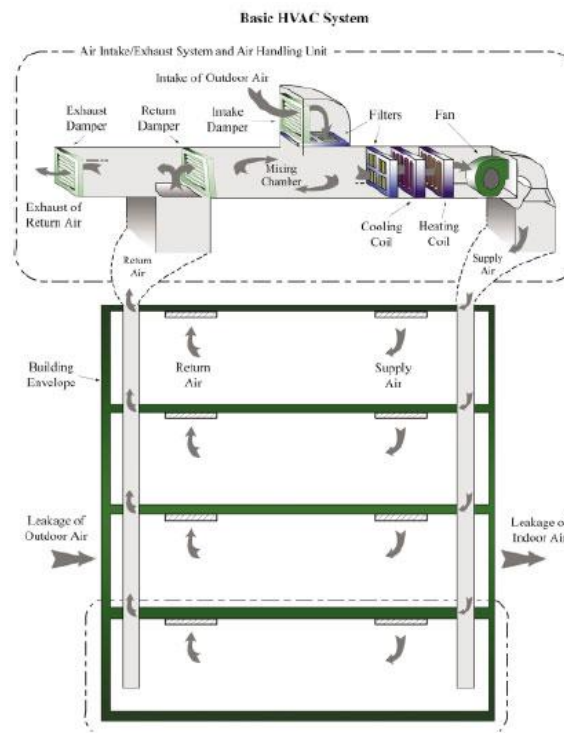


Fig 3.2- HVAC system

This is the basic HVAC system that would be used in the buffer facade system. HVAC stands for the heating, ventilation and air conditioning system. Its basic purpose is to control the movement quality and temperature of air required to ventilate, cool and warm a building. This is done through the heating or cooling of air or water, which is passed through ducts or tubes and enters the interior of the building through vents. It will usually be placed on the roof and this in turn will stop the vents and pipe from infringing with the double skin facade.

Shading devices can be installed in the cavity to avoid excess solar gain in certain climates. The first modern example of this facade is the Occidental Chemical/Hooker Building in Niagara Falls, New York. This building has been previously looked at in the history chapter of this dissertation.

3.1.2 Extract-Air Facade.

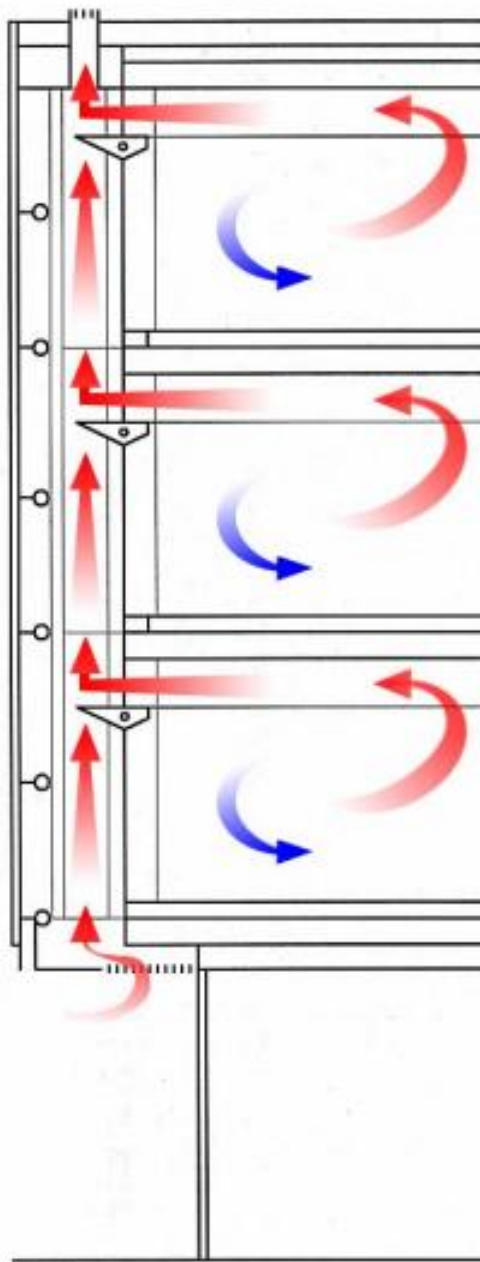


Fig 3.3- Extract-Air Facade.

The extract air system is made up of three layers of glazing. There is an extra layer of glazing placed between the external and internal layers. The air space is now divided into two sections the internal and external air space. The air space between the two internal layers of glazing is used as part of the mechanical system. The internal airspace is heated and ventilated using the mechanical system. The used air of the inner layer is extracted using fans. The outer layer then acts as an insulating layer. This layer

reduces heat loss and seals the building off from the exterior elements. Fresh air is supplied to the building by a mechanical system and this in turn eliminates the need for natural ventilation. All the air in the building is produced and circulated using a mechanical system. This system tends not to reduce the energy efficiency of a building as the air changes must be supplied through mechanical means. The air space between the inner and outer layer of glass ranges from 150mm to 900mm. This in turn will allow the necessary space to access the cavity for cleaning purposes. Shading devices can also be installed in the cavity depending on the location of the building. This system is used in areas where natural ventilation is not possible due to high noise, wind or fumes (Boake T M, et al. 2001). One of the best examples of this type of double skin facade system is the Helicon Building, London.

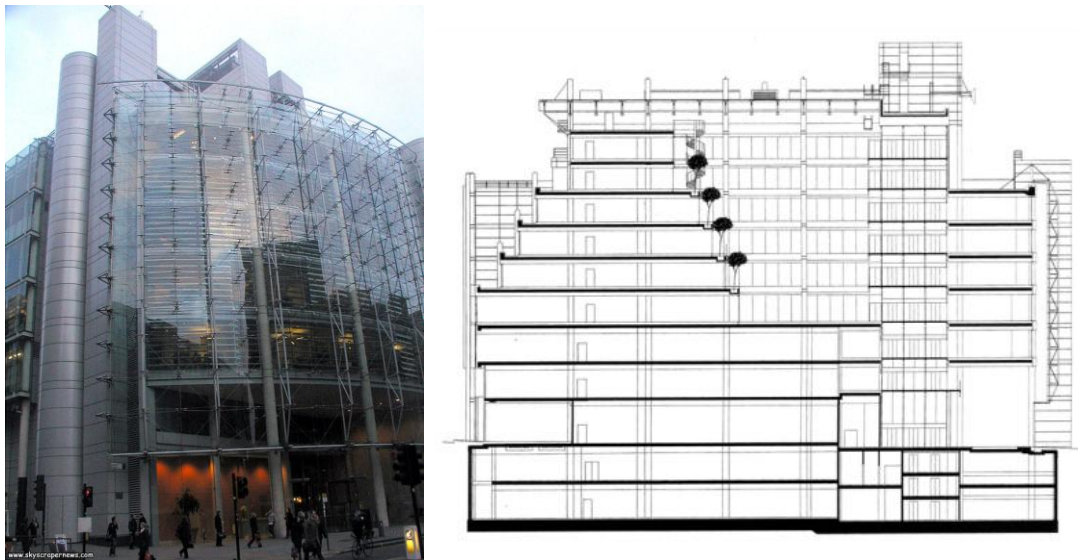
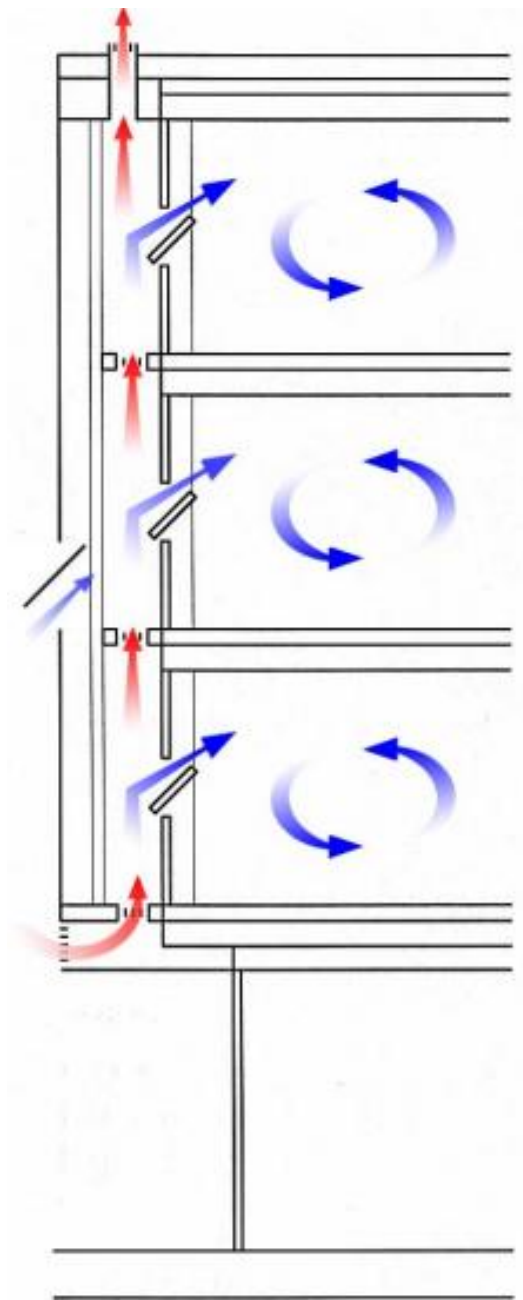


Fig 3.4/3.5 Image and section of Helicon building

The Helicon building was designed Sheppard Robinson and is located in Finsbury pavement in London. It consists of five floors of retail space with six floors of office space on top of them. The office spaces are provided with a large atrium space. Three sides of the structure are covered in the extract air facade system. The building was completed in 1996 and is a highly energy efficient building.

3.1.3 Twin face Facade.



Figs 3.6- Twin face Facade.

The twin face system must have an interior space of at least 500 to 600mm in width to permit cleaning. It is made up of a conventional curtain wall system with a single exterior layer of glazing placed outside of it. This exterior glazing can range from insulating glass to laminated safety glass. Like all the systems types of shading devices can be installed in order to prevent excessive solar gain into the building. The function of the exterior layer of glazing is to block the wind as the building rises in height. This

allows the interior layer access to fresh air without the noise pollution from the surrounding area. This in turn means the internal skin is used as the insulating layer for the building and it prevents heat loss. It is also used to protect the internal layer and its contents from weathering. The difference between this system and the other two is the fact that this system contains openings in the skin to allow for natural ventilation. The windows on the interior facade can be opened or closed at any time. There are also ventilation openings on the exterior skin. The openings on the external skin help to control the extremes of the temperature within the internal facade. The main problem with this system is the potential for noise pollution through the open windows. However this problem can be avoided or greatly reduced by simply staggering the openings on the exterior facade or by placing them away from the position of the openings on the internal facade. In warm climates this is a particularly useful system as the use of windows can allow for the night time cooling of the interior of the building. This in turn will reduce the reliance on the buildings mechanical system and will make it more sustainable (Boake T M, et al. 2001). An example of a building with this type of facade is the Telus William Farrell *Building* in Vancouver.



Fig 3.7/3.8- Telus William Farrell building, Vancouver.

The building opened in 2001 and involved the revamp of the original 1940s building. Both of these images can be seen in the picture on the left. The new building incorporates the twin face facade. This system provides natural ventilation to the building through windows provided. An image of this facade can be seen on the right above.

The building is designed to store heat in the winter and provides shading to cool the building form excessive solar gain. The air space cavity is controlled using louvers at the bottom and dampers at the top.

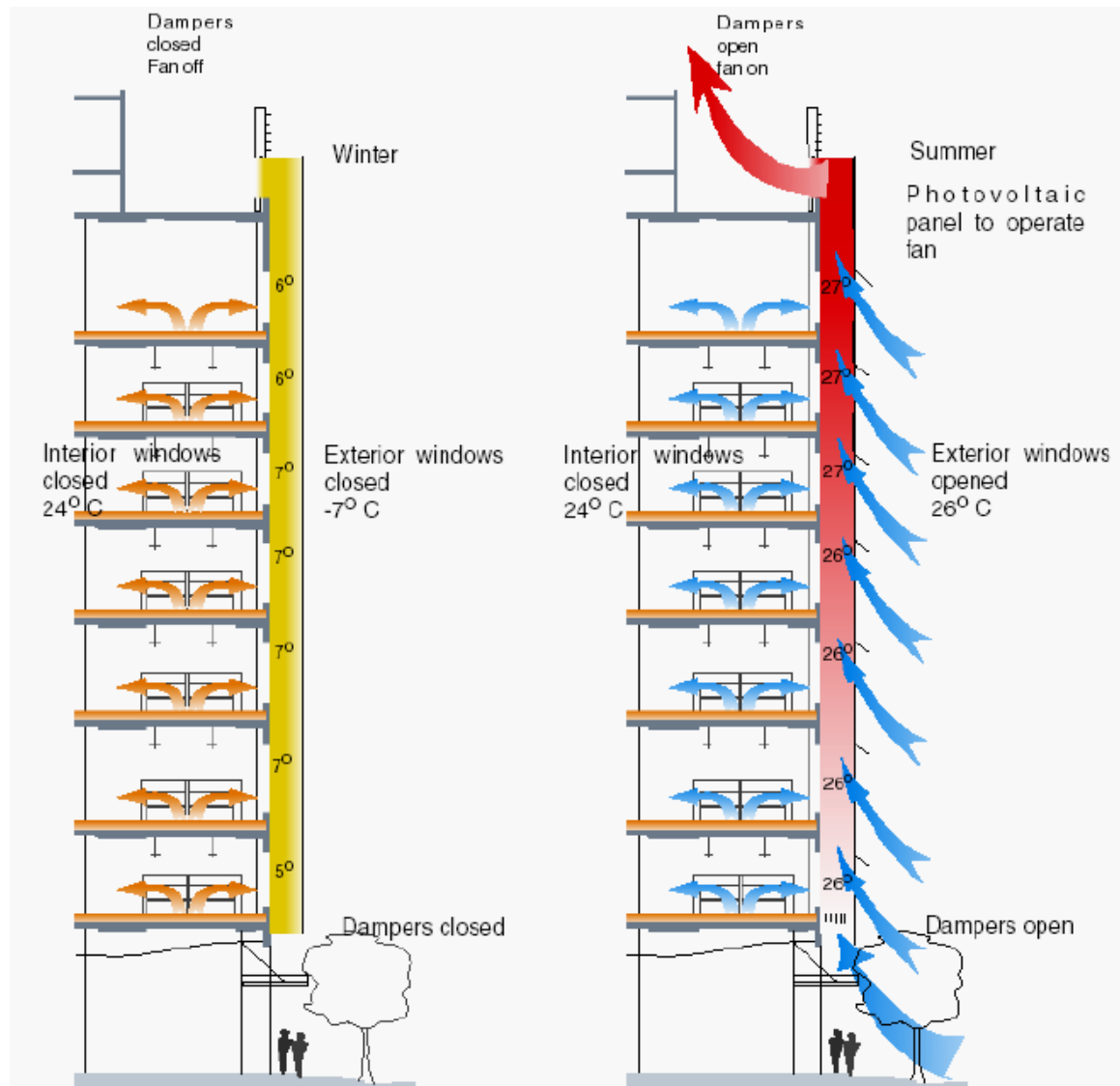


Fig 3.9- Operation of the facade in Winter and Summer.

Wall section in winter with dampers

closed.

Wall section in summer with dampers

open.

3.1.4 Hybrid Facade.

The hybrid facade by right has no specific definition. It can combine various aspects of all the facade types mentioned above. This type of facade is usually associated with buildings that use non glazed materials or a layer of screens on either the external or internal part of the building facade (Boake T M, et al. 2001). An example of this type of building is the Debis Headquarters which is located on the Potsdamer Platz region of Berlin in Germany. It was built for Daimler Benz.

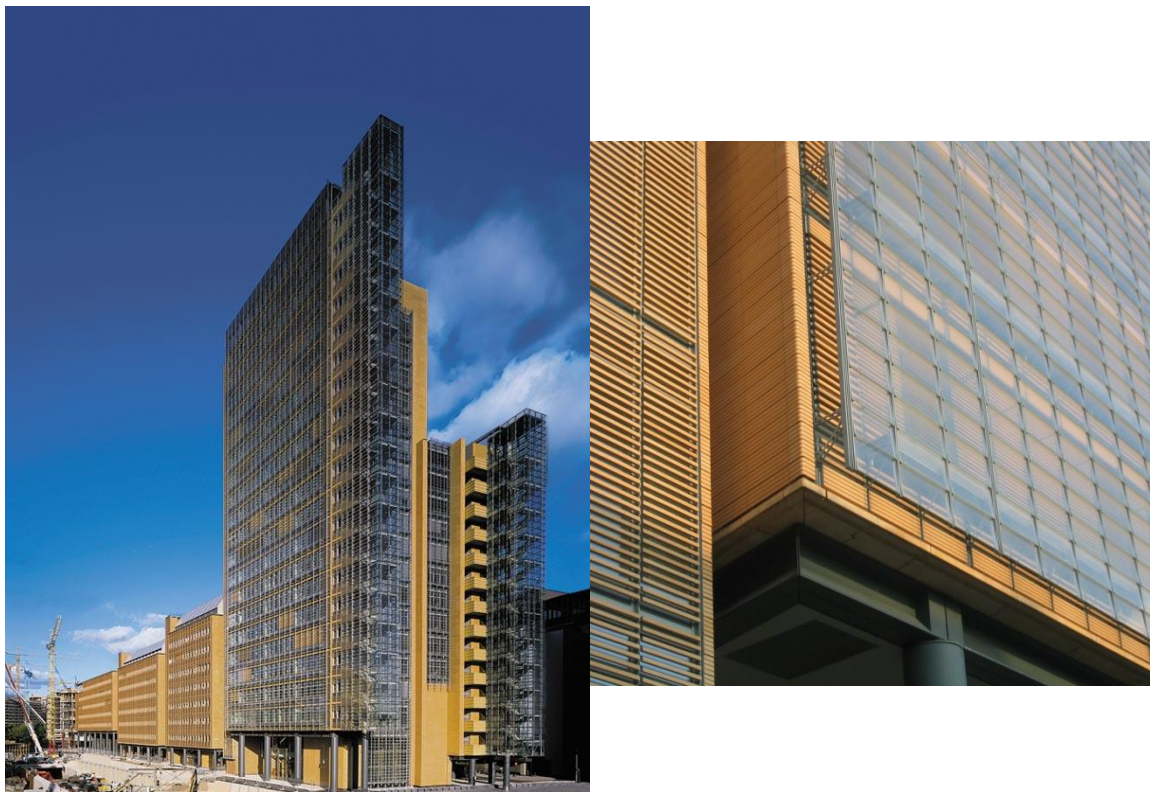


Fig 3.10/3.11- the Debis Headquarters, Germany

The building consists of a six storey broad part at one end and a 21 storey narrow part to the other end. The south, east and west elevations have the highest exposure to solar heat gain. The external walls on these elevations are constructed of glass. this wall is located 700 mm from the main internal wall. The internal wall is constructed of glass windows. The external wall is comprised of glass panels. These panels can open up to an angle of 70 degrees and they are controlled by sensors. These sensors will open the panels if the building reaches a certain temperature and therefore allows the building to ventilate itself in the case of hot weather. In cold weather the opposite happens and the panels close to create an insulating layer.

3.2 Air Space.

This is a crucial part in all double skin facades. The air space plays a key part in the control and upkeep of the overall double skin facade. This section will look at three sections of the air space, which are as follows:

1. Divided air space
2. Undivided air space
3. Cleaning the air space

3.2.1 Divided Air Space.

The idea of a divided air space is to help reduce over heating on the upper floors of a tall building. It can also help reduce the spread of noise and the spread of fire and smoke. By using a divided air space you are creating divisions between each floor of the building. This can have economic benefits as it means that the process for each floor is a repetition of the previous one. This will lead to a faster and cheaper building construction as it is a repetitive process. RWE building in Germany is an example of a building with a divided air space. There are two types of divided air space.

3.2.1.1 Shaft.

The shaft air space involves the vertical division of the facade into bays. This type of airspace will draw air across the facade through the openings and this in turn will allow the building to receive more natural ventilation. There are however various problems with this system. The main problem with it is fire protection and the ease at which it would allow the fire to spread. Other problems include the mixing of fresh and foul air and the transmission of sound around a building.

3.2.1.2 Corridor.

The corridor air space involves the use of fresh air and exhaust intakes. Every floor will have a fresh air and exhaust intake and this will allow for the maximum amount of natural ventilation. This type of divided air space is most commonly seen in twin face systems. It is also used more often than the shaft system above as it has less drawbacks.

3.2.2 Undivided Air Space.

The undivided air space in a double skin facade is a beneficiary of the stack effect. On cold days air is drawn in from the bottom of the double skin. It then reaches the top where the vents will be closed. This in turn will trap the air in air space. This will gradually heat up and therefore act as a natural insulator for the building. If the internal fabric of the building becomes uncomfortable or too warm, the vents can be slightly opened to bring the building back to a comfortable temperature.

However on warm days the opposite happens. The air is drawn in from the bottom. It is then passed up through the air space where it escapes through the vents that are fully opened at the top. This means that there will be a constant flow of cool air that will pass up through the void. Therefore cooling the internal structure of the building. If the building becomes too cool one can simply close the vents until the building is back to a comfortable temperature. An example of a building with an undivided air space is the Occidental Chemical Building located in Niagara Falls.

3.2.3 Cleaning the Air Space.

When designing a double skin facade it is very important to take the air space into consideration. The design of the air space will impact a number of things including the cleaning of it. Buildings with an undivided air space are cleaned using a platform or bosun's chair.



Fig 3.12- Bosuns chair

This is similar to a window rig and is used to gain access to the interior glass facade for cleaning. An example of where this type of mechanism can be used is in the Occidental Chemical Building located in Niagara Falls and the Telus Tower located in Vancouver.

In order for all air spaces to be fully accessible, all louvers that are located within it must be moveable and adjustable. This in turn will allow full access to the cavity. Some designers have even placed open steel grates on each floor. These will give the cleaners a platform to stand on, on each floor, but at the same time will not compromise the flow of air up through the cavity.

If the air space is divided then other steps must be taken to ensure that the facade can be cleaned properly. In this situation the interior windows will act as access points for people to enter the air space for cleaning and general maintenance. In order for an air space to be accessible it must have a width of at least 600mm. If it is less than 600mm then the cleaning is done from within the building itself. Where this is the case the air space would again be accessed through windows. These windows must be able to open fully in order to provide sufficient space for cleaning and maintenance.

Most double skin facades have both internal and external layers constructed of glass. In order to maintain the appearance of this glass maintenance and upkeep is essential. Due to this fact it is suggested that the facade be fully cleaned between 2 to 5 times a year in order to maintain its appearance. In some cases it is possible to cut down on the amount of time the facade must be cleaned. An example of this is the Telus Tower where they use dampers to seal off the air space at the bottom during times of peak traffic. This will stop harmful layers from coming up into the cavity and staining the glass.

3.3 Key Features.

There are many features that make a double skin facade a sustainable form of building construction. This section will look at the key features that make a double skin facade a sustainable form of building design. The features are as follows:

1. Natural ventilation
2. Solar heat Gain
3. Acoustic performance
4. Day lighting

These are only the key features that make this a sustainable form of construction. There are also lots of little features that help improve the buildings sustainability.

3.3.1 Natural Ventilation.

Natural ventilation is the best possible way to ventilate a building. It is the cleanest form of air and costs nothing. By using natural ventilation you are lowering the carbon footprint of a building and therefore making it a more sustainable building. Natural ventilation usually occurs through open windows and vents located around a building. It is only possible to naturally ventilate small scale buildings, due to the fact that air can easily pass through them. As buildings grow in size you must combine both natural and mechanical ventilation. It is not feasible to use natural ventilation on public buildings in built up areas. This is due to the fact that the building will be penetrated by noise pollution and the possibility of poor weather conditions depending on the location of the building.

The use of double skin facades in a built up area can be very beneficial in terms of natural ventilation. The double skin will allow fresh air to pass up through the air cavity. This fresh air will enter the building through vents and operable windows and will provide natural ventilation. Therefore the double skin will allow part of the building to be naturally ventilated while the air space between the internal and external layer will act as a buffer zone. This in turn will protect the interior of the building from noise pollution and poor climatic conditions. This system is extremely beneficial in high rise buildings as it allows them to be naturally ventilated without the risk of high winds affecting the interior of the building. In the case of countries with a hot climate this system would not

work as it would be pumping hot air into the building. However the system could be used for night time ventilation.

3.3.2 Solar Heat Gain.

Solar heat gain is a key factor that must be taken into account when designing double skin facades as they contain large glass facades. The location and orientation of a building play a key role when it comes to solar gain. If the facade is not designed correctly, excessive solar gain can lead to overheating of the building which in turn will make the internal fabric uncomfortable for the occupants. In order to control solar heat gain in buildings with double skin facades, shading devices can be installed in the air space. By placing the shading devices in the air space they will be protected from the external elements. These shading devices will attract the sun's rays and help keep the building cool. These shading devices are usually controlled mechanically and will adjust them to suit the buildings requirements. Below is an image of blinds being placed in order to avoid excessive solar heat gain.



Fig 3.13- Shading devices located in air space

There are other ways of dealing with solar heat gain in a double skin facade building. The most obvious one is to incorporate an air conditioning system which is used in most office spaces without double skin facades. However the shading devices are usually chosen as they are much more sustainable and will reduce the overall carbon footprint of a building. The key reason that shading devices are used over other systems is down to the fact that they reduce the solar heat gain whilst still allowing in the daylight.

More and more advancements are being made as to how to deal with the problem of solar heat gain. There are forms of glazing's being produced that can control the amount of solar heat gain entering the building. This glazing's are also clear and give the appearance of normal glazing. However these are new technologies and have not been tested over long periods of time and therefore it is not clear as to how well they perform after a long period of time.

3.3.3 Acoustic Performance.

Another major benefit of the double skin facade is its ability to block out noise pollution. The air space between the internal and external layers not only acts as a form of ventilation and insulation but also as a buffer for noise. It effectively acts as a sound barrier and is very beneficial in built up areas where noise pollution can cause a serious problem in buildings.

3.3.4 Day lighting.

Day lighting is a key feature in any building. This is especially the case in large public buildings where electricity bills can run very high. Therefore the more daylight you provide to the building the less electricity that will be required to light it. Day lighting is also better for people in general when compared to electrical lighting.

The designer has the opportunity to exploit the double skin facade and its large glazed layers. If a double skin facade is properly constructed it should allow in the maximum amount of daylight possible. However this amount of daylight directly entering the building can also cause problems. One of the main problems with this is solar heat gain. This can be avoided by using the methods described in the solar heat gain section above.

3.4 Conclusion.

The typology of double skin facades is quite a broad and open topic. There are various different opinions as to what exactly defines a particular facade. All in all the American style is the easiest to understand and gives a clearer understanding of what any particular facade can be defined as. Different types of double skin facades bring different benefits to a particular building. All classifications of double skin facades will make a building more sustainable. They do this by providing the building with an air space between the internal and external environment. This air space acts as a thermal and acoustic barrier and is used as a way of naturally ventilating and cooling a building. Double skin facades also allow a building to exploit day lighting and allow it to utilise and control solar heat gain.

Chapter Four

Case Study

Double Skin Facades

Chapter 4

Case Study:

4.0 Introduction.

This chapter aims to evaluate double skin facades that have been built in Ireland from 2012 to 2006. This chapter will be subdivided into various sections. The first six sections will involve the investigation of six buildings and their double skin facade. The seventh section will compare and contrast each of the building facades with each other. The eighth and final section will offer concluding remarks to the findings of the chapter.

4.1 John Paul ii Library.

4.1.1 General Information.

The original John Paul ii Library was opened in 1984. The new extension is located on the East face of the already existing Library. It was designed by Scott Tallon Walker Architects and constructed by Walls Construction. It will be joined to original building via a full height atrium and the new extension will have the same plan grid as the original building. The extension is of very similar height to the original building and the only real difference is the external appearance. The new extension contains a double skin facade (Build, October 1984).



Fig 4.1- Image of new and old building mixing together.

The above sketch up image shows how the original building is joining up with the new building via the glass atrium.

4.1.2 Double Skin Facade.

The buildings double skin facade is controlled by a Facade Management System (FMS). This system controls the dampers within the double skin facade and helps to maximise the operating performance of the double skin facade. It will minimise the energy influx into the building by increasing the temperature in the cavity during the summer conditions and it will reduce the thermal loss during the winter season. It is also used to naturally ventilate the first and second floors based on climatic conditions.

There is a weather station located on the roof. This weather station takes the climatic conditions at any given time and relays it to the Facade Management System. Sensors are installed throughout the air space. These sensors monitor the safety and performance of the air space within the double skin facade. There are two types of sensors which are as follows:

1. Walkway sensors: These are installed under the walkway and are mainly used for safety access. The purpose of these sensors is to monitor the temperature at every floor level.
2. Room temperature sensors will be installed on every level and will also be connected back to the Facade management system.
3. Damper temperature sensors: These are installed at the top and bottom of the air space. Their purpose is to control the intake and outtake of air within the airspace. It controls the airflow within the cavity. The sensors take into account the temperature within the air cavity, the outside temperature and the internal temperature of the building.

The facade management system operates as a standalone system. It has the ability to monitor, control and store data from a predetermined time. It operates on an open basis with the building management system and they will be able to transfer data to and from each other in order to further integrate the two systems. This allows the Facade management system to operate independently in the case of a failure in the building management system.

The weather station is used to communicate the following information to the facade management system:

1. Daylight.

2. Wind speed and direction.
3. Solar heat gain.
4. Humidity.
5. Rain sensor.
6. External air temperature.

Inlet louvers are used to ventilate the first and second floor levels during times of natural ventilation. There are vertical blinds covering the entire facade. These vertical blinds respond to the commands of the Facade management system and in turn open and close as they are required. Each damper spans a distance of around 6.5m and each of the vertical blinds spans the distance of a damper. This allows the dampers to control the position of the blinds depending on the position of the sun and the internal conditions at any given time during the day.

The building manager has the ability to override most of the controls to manually control each element of the double skin facade. The only elements they cannot alter or change is the wind and fire controls. A manual override panel is provided on each floor. There is also an access door provided on each floor for access to the air space of the facade. This allows people to gain access to the airspace for maintenance and cleaning purposes. (Scott Tallon Walker Architects)



Fig 4.2- Image of the new building and its double skin facade.

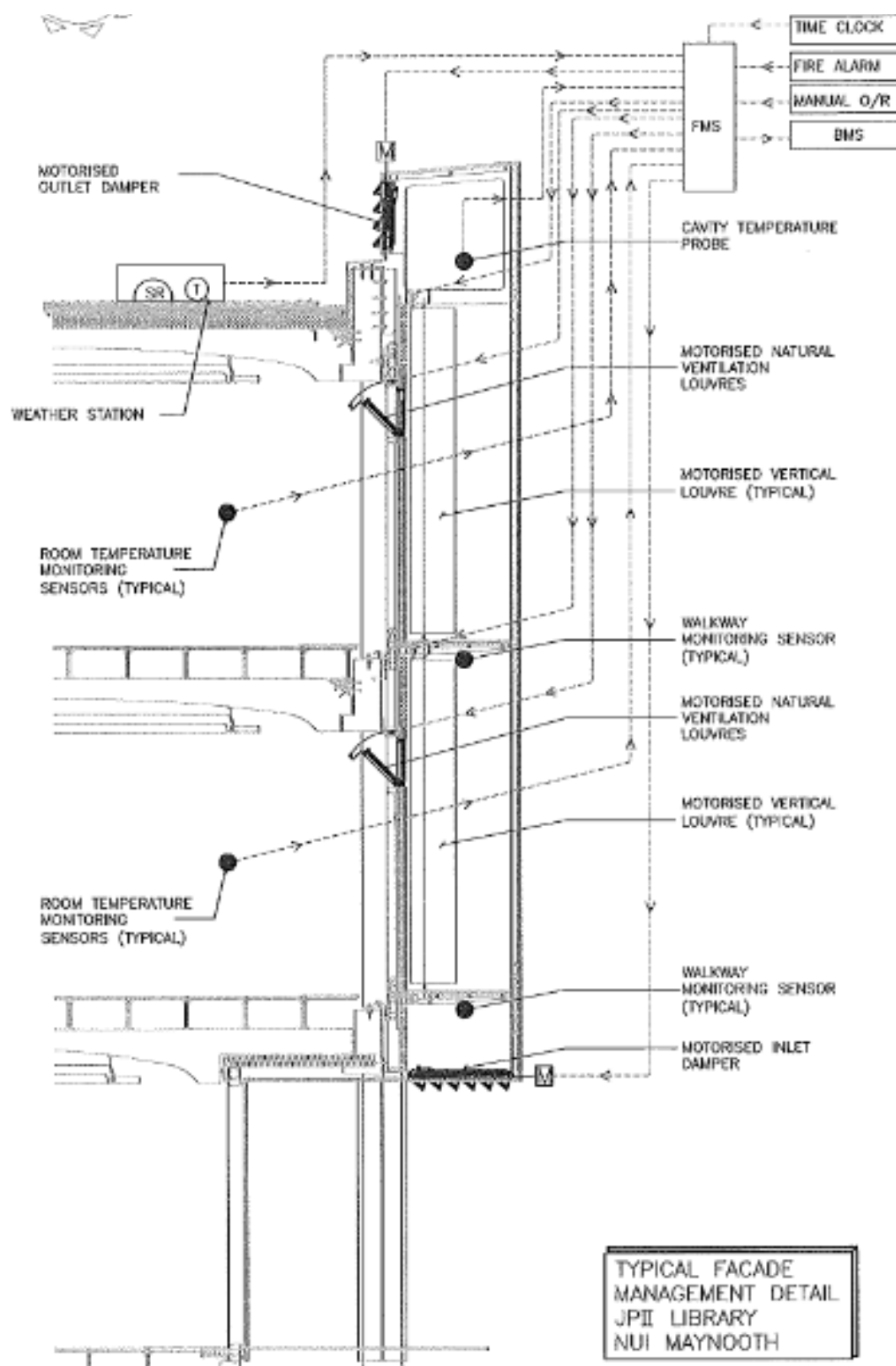


Fig 4.3- Drawing of the facade.

4.2 Wexford County Council Headquarters.

4.2.1 General Information.

This building was completed in 2011 and has won numerous awards since. It was designed by Robin Lee. Construction began in 2008 and the main contractor was Pierce Construction LTD. The facade consultants for this building were Burro Happold. A competition was held as to who could come up with the best design for the new county council headquarters. There were several entries but eventually Robin Lees design was chosen. (Robin Lee Architects)



Fig 4.4- Wexford County Council Headquarters.

4.2.2 Double Skin Facade.

The purpose of this double skin facade was to improve the thermal envelope of the building in both the summer and the winter. The external layer of the double skin facade on this building is completely glazed. However the internal layer varies from glazing to stonework. IPASOL glazing was used on the external layer of the facade. This is a specialist type of glazing that allows the maximum amount of daylight into the building but at the same time keeps out the solar heat gain due to the fact that it has a low solar energy transmittance. This type of glazing helps reduce the need for mechanical ventilation. In fact the building is 95-96% naturally ventilated. The glass also has a special coating that allows excess heat to escape from the interior to the exterior.



Fig 4.5- Back of Wexford County Council Headquarters.

The external layer of glazing wraps right around the entire building and forms a completely transparent external layer. It is made up of an 8.8mm thick single glazed laminated glass unit which is 3.45metres in height and 1.5metres in width. It is supported using an anodised aluminium curtain wall system which allows for a completely flush external appearance. The internal layer is made up of both double glazed units and walls clad in Kilkenny limestone. The glazed units are broken up into two parts. One side is tinted and the other uses blinds. the purpose of this was to reduce glare into the building. However there were problems with the body tint side of the glazing which has lead to excessive glare entering the building.

During the winter season the vents at the top of the facade are closed off. There is a continuous flow of fresh air then enters the airspace from the bottom and is essentially trapped inside. Eventually this fresh air builds up and begins to warm the air space. This in turn acts as an insulating layer during the winter season. During the summer season the opposite happens and the vents at the top are left open. These vents are controlled by a building management system which allows them to open when the airspace becomes too hot. This allows a continuous flow of cool fresh air up through the air space to cool the interior of the building, when internal temperatures exceed the comfort level. The Building management system opens the vents at night to provide night time cooling. (Robin Lee Architecture; Donovan, K. 2011)

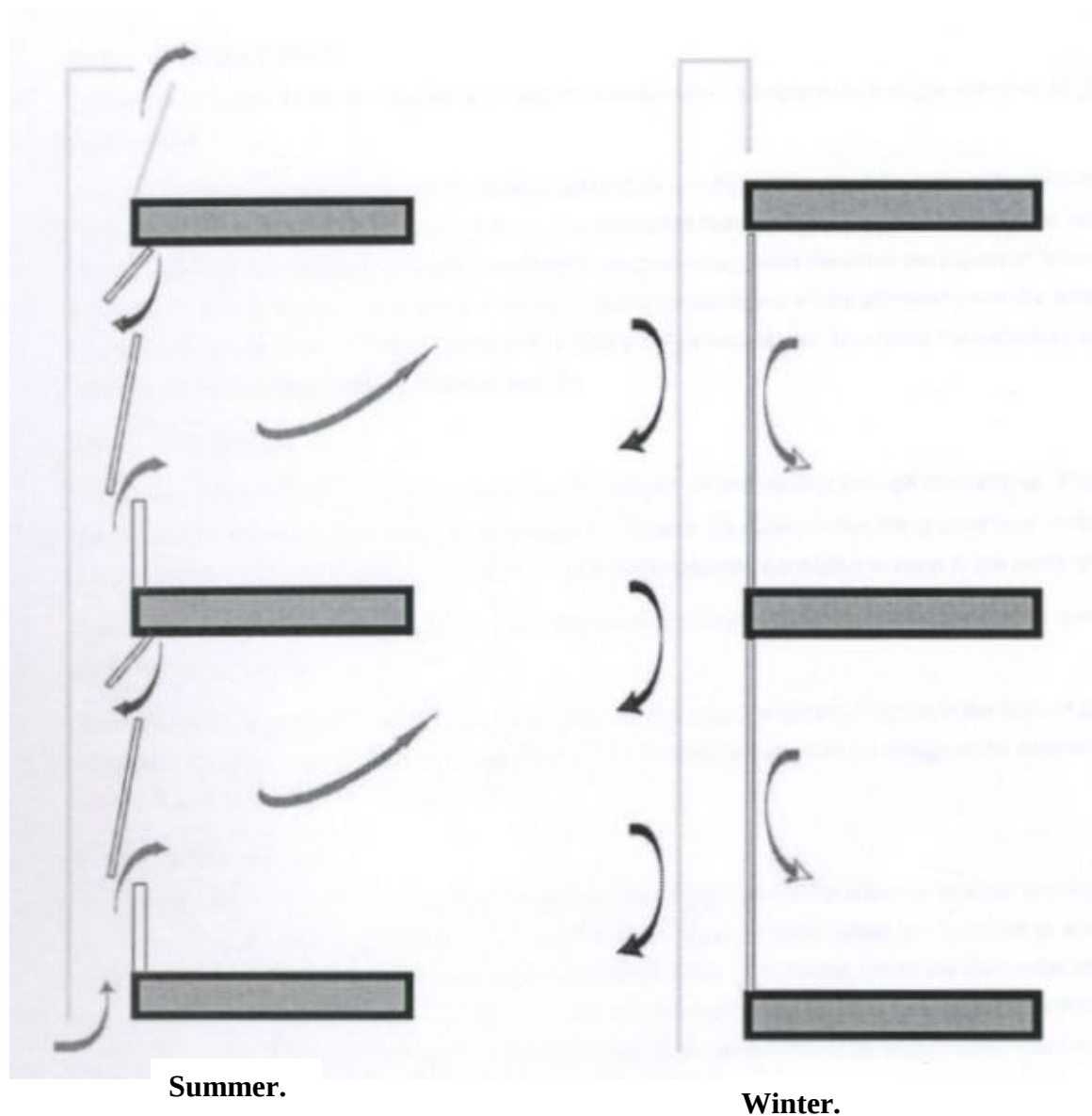


Fig 4.6- Operation of facade in summer and winter

The air space between the interior and exterior acts as a great sound barrier for the entire building and allows the building to be naturally ventilated. It is rare that a building can be naturally ventilated and have a good acoustic performance but the double skin facade allows this to happen. However even with the extra double skin layer there have been complaints of noise travelling in from the outside. There were also issues with trucks being parked around the building as the fumes from them pass through the grill, up through the air space and into the building. This causes an uncomfortable working environment for the people inside.

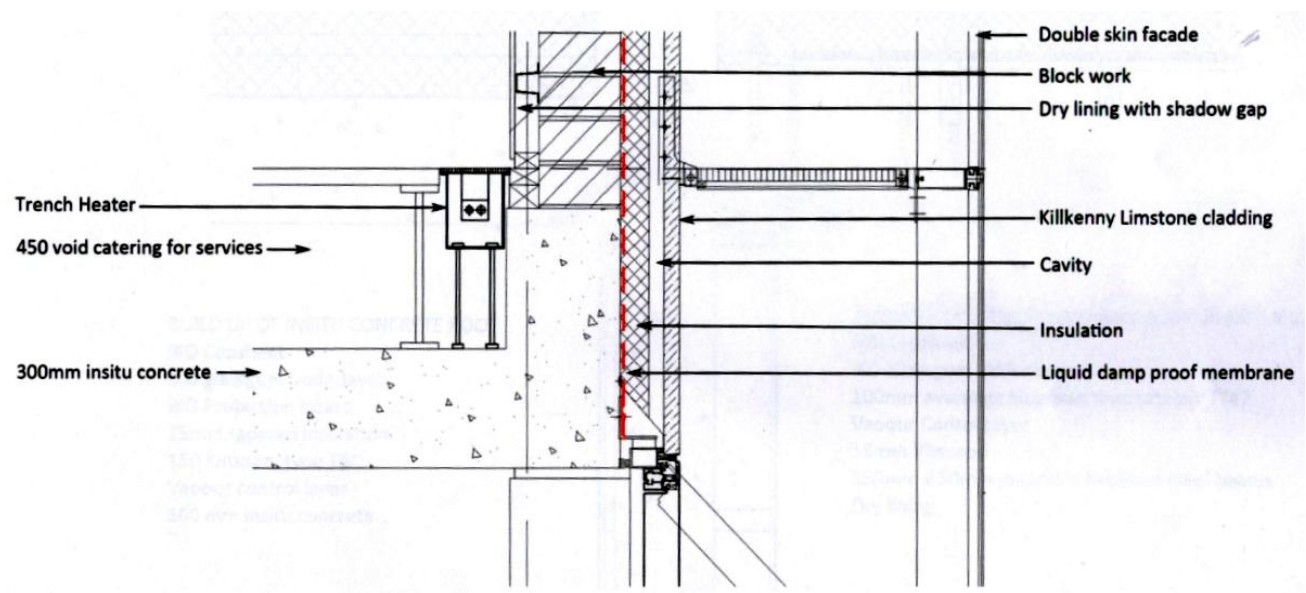


Fig 4.7- Drawing of the facade

4.3 The Criminal Courts Of Justice.

4.3.1 General Information.

The criminal courts of justice building is located in Dublin and it was completed in November 2009 before receiving numerous awards in 2010. The building was designed by Henry J Lyons architects and constructed by PJ Hegarty contractors. The facade consultants for this building were Billings Design Associates LTD. (Henry J Lyons Architects)



Fig 4.8 Criminal Courts of justice.

4.3.2 Double Skin Facade.

This building is used as a courthouse and therefore it is essential that noise pollution does not penetrate through the building envelope into the internal structure. The use of a double skin facade stops this from happening by using its air space as an acoustic barrier.

The overall design of the buildings double skin was influenced by a number of key factors which were both functional and conceptual. The exterior layer consists of a single layer of toughened laminated glazing with polished stainless steel framing. The internal layer consists of double glazing. In between the external and internal layer is another layer which is made up of a perforated aluminium screen. It is bronze in colour

and is used to control the amount of natural light being allowed into the building and helps to reduce the amount of glare into the building. It also stops people from looking into the courtrooms and during the day it will appear as a solid aluminium sheet wrapping around the entire building from the outside looking in. The double skin also works as a way of heating and cooling the building.

During the summer a vent at the top is opened and this allows a continuous flow of cool fresh air up through the airspace which in turn cools the interior of the building. During the winter the vent is closed and this allows the air to build up in the airspace. This heats the air space and therefore acts as an insulating layer for the building.

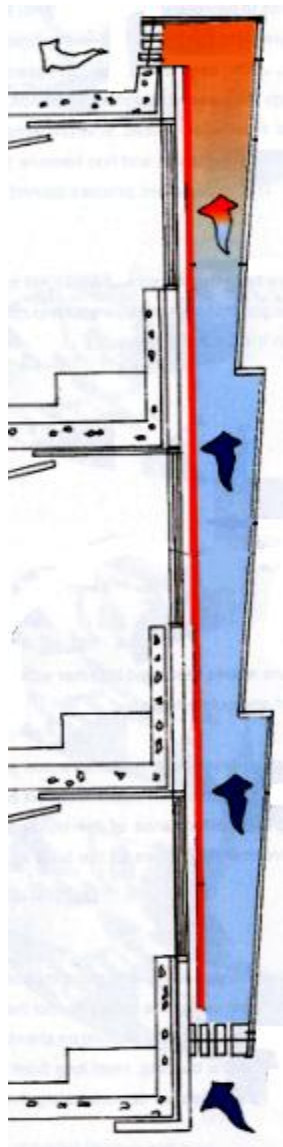
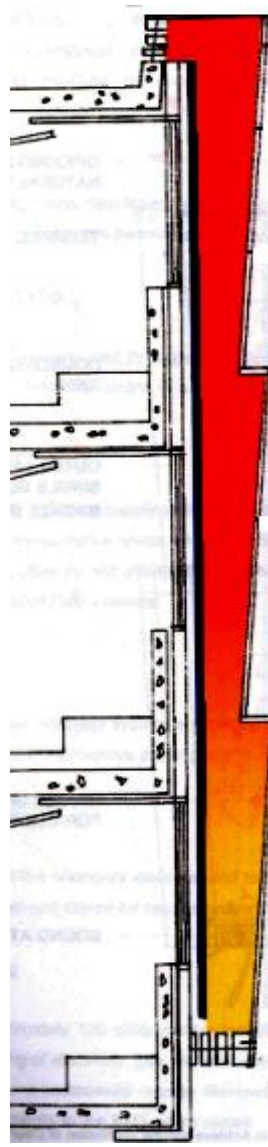
Summer.**Winter.**

Fig 4.9- Summer and Winter performances.

The outer layer is designed in a unique way. The outer glazed panels are placed in a saw tooth pattern around the curved internal layer. This allows straight sheets of glazing to be used around the external layer. This not only reduces the cost of using straight sheets instead of curved sheets but it also give the building two different appearances from the outside. From one view point the glazing is the dominant feature. However from another viewpoint the aluminium framing is the dominant feature.



Fig 4.10- Facade of Criminal Courts of Justice building.

There are also maintenance walkways located at intervals of 7.2metres in vertical section. This allows for the inner layer of glazing and the perforated aluminium sheet to be cleaned and maintained. The external layer is cleaned and maintained by abseiling down the facade using a bosuns chair.

The double skin facade also serves other purposes to the building. Henry J Lyons Architects wanted to hide the true ten storey height of the building. They did this by masking the building in the double skin facade with glass panels of 7.2 metres in height. This helps give the appearance of a four to five storey building from the outside. The facade also serves a security purpose. Due to the fact that the outer and inner layers are not parallel it means that the trajectory of bullets through the facade would be disrupted. (McMahon, D; McBratney, J. 2010)

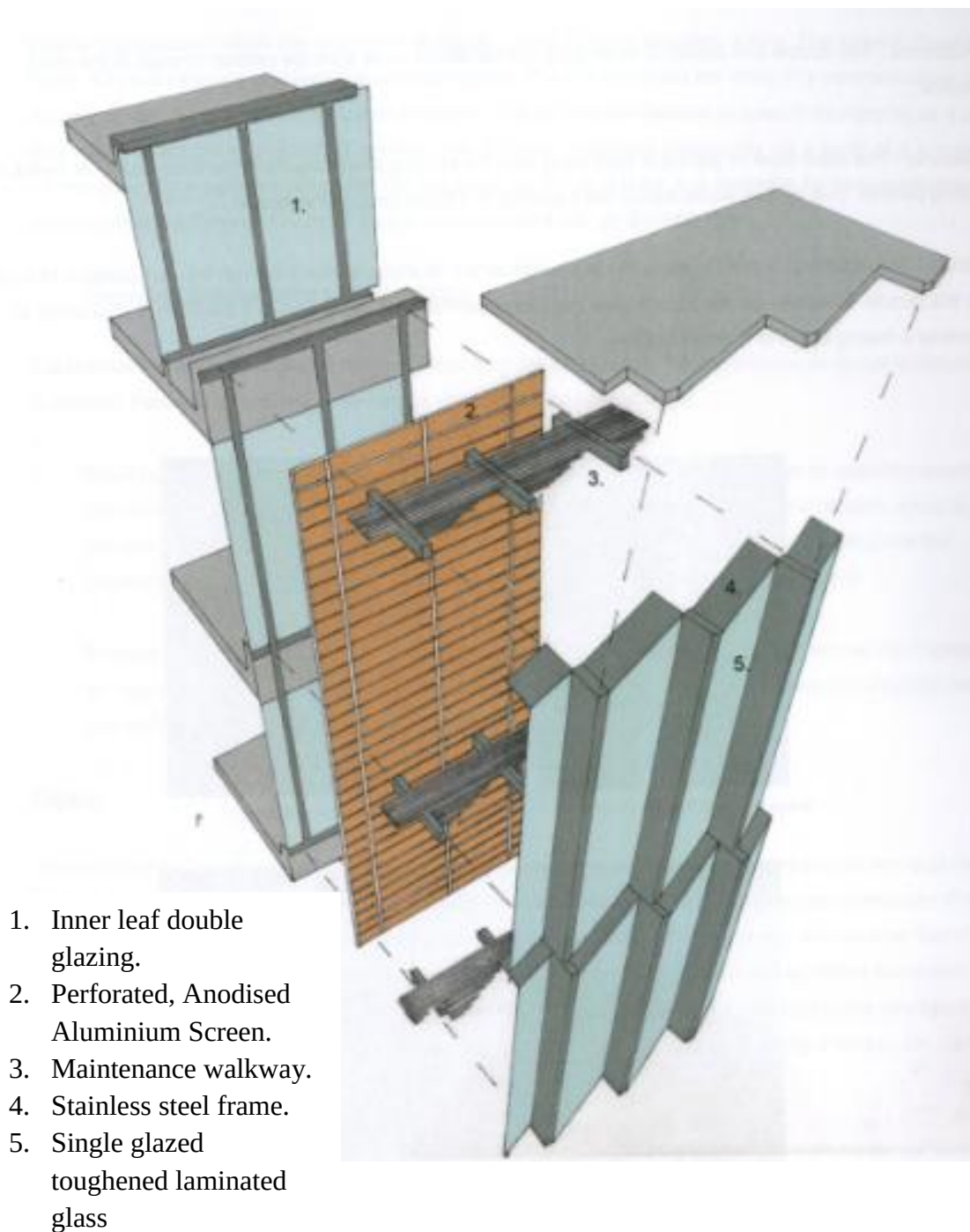


Fig 4.11- 3D drawing of the facade.

4.4 Commissioner of Irish Lights.

4.4.1 General Information.

The Commissioner of Irish Lights building was completed in 2008. The building has received numerous awards since its completion and it consists of two parts. One part is a rectangular building with a stone finish. This is the factory part of the building. The other part of the building is used for offices and it is circular in shape. It consists of a fully glazed double skin facade. The two parts of the building are connected to each other by a glass corridor on the first floor. The building was designed by Scott Tallon Walker Architects (Built environment.2009).



Fig 4.12- Commissioner of Irish Lights building.

4.4.2 Double Skin Facade.

The circular part of the commissioner of Irish lights building is completely covered in a curved double skin facade made up of glazing and fixings. It is a three storey building and has a distinctive lantern like roof light to give the appearance of a lighthouse. The glazed double skin allows for the use of floor to ceiling glazing internally without the risk of excessive solar heat gain or noise pollution into the building.

The use of the double skin facade with the floor to ceiling glazing allows the building to exploit the maximum amount of natural light. Not only is this natural light

scientifically proven to improve the working environment but the glazed facade also allows the occupants a fantastic view out over the ocean. The air space between the two layers acts as a buffer for noise pollution. It not only shields it from the noise pollution of the adjacent harbour road but it also protects it from noisy factory part of the building.

The air space also contains automatic blinds. These blinds are used to control the amount of natural light entering into the building. This helps to avoid excessive solar heat gain into the building and also helps reduce the amount of glare affecting the occupants. The blinds are controlled by a special facade management system. The facade management system resets itself throughout the day and this allows the blinds to adjust and stop the building from overheating. Occupants of the building can override the controls of the blinds should they wish to alter the views or the glare within the building.



Fig 4.13- Commissioner of Irish Lights building.

The double skin is also used as a form of natural ventilation for the building. The air is drawn into the building using fans. 'These Fans associated with the system are powered by glass-to-glass photovoltaic brise soleil, which surround the top level boardrooms on the southern elevation'. This ventilation system like the blinds can be controlled by the occupants within the building. 'All of these services are controlled by a sophisticated interactive BMS, which 'talks' to the facade management system to ensure optimum conditions for the Commissioner of Irish Lights staff' (Architecture Ireland incorporating Irish architect, 2008).

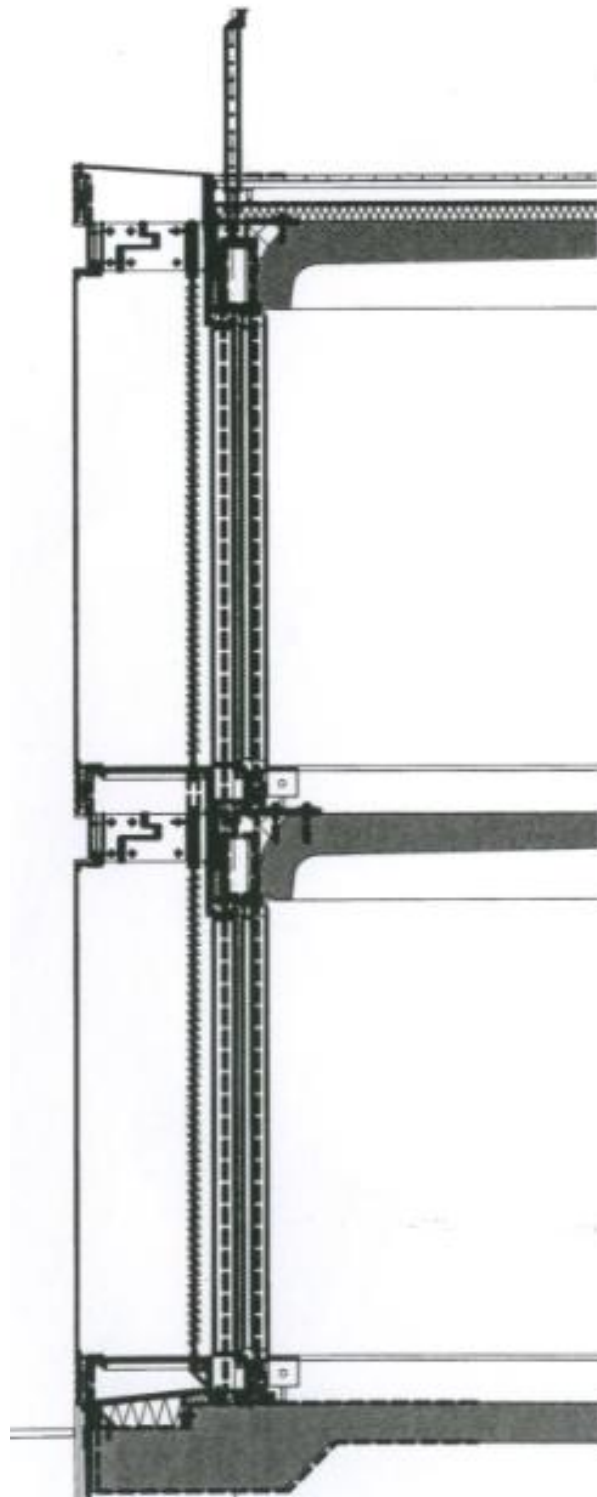


Fig 4.14 Drawing of the facade

4.5 Civic Offices Cork.

4.5.1 General Information.

The Cork Civic Offices were completed in 2007. They were built as an extension onto the original City Hall which was opened in 1936. The original building was designed by Jones and Kelly. The new Cork Civic Offices were designed by ABK Architects and the main contractor was Cleary and Doyle Ltd. Like most of the double skin facade buildings constructed in Ireland between 2012 and 2006 it has received numerous awards.



Fig 4.15- Cork Civic Offices.

4.5.2 Double Skin Facade.

There is a large portion of the cork civic offices that is covered in a double skin facade. The southern facade is completely covered in a double skin facade. The Facade is constructed of galvanised steel and glass. The external leaf of the facade is constructed using galvanised steel flats suspended from galvanised steel trusses that are cantilevered from the roof. Beneath the galvanised steel are single glass panels. These panels are designed with a solar control pattern. They are fixed in place using galvanised steel beads. The solar control pattern is done using a ceramic coating. This is done using the

silk screen process. After it has been applied the glass is heated to ensure that the ceramic coating is fixed to it sufficiently.



Fig 4.16- Air space between internal and external layers.

The design of the external skin was given careful consideration. The glazed panels allow for the maximum amount of daylight to enter the building while the ceramic coating helps to control the amount of solar heat gain entering the building. The ceramic coating also stops excessive glare on the internal structure of the building. Besides the obvious natural day lighting advantage it also serves other purpose. The double skin facade acts as a buffer for noise. This is a key feature of the building as it is located in the city and the south facade faces out onto the road. The facade also allows the occupants to open the internal windows no matter what the conditions are outside. This allows a continuous flow of fresh air into parts of the building.

“A double facade, consisting of angled leafs of fritted glass was designed as a buffer from wind and city noise, allowing perimeter windows to be opened in the most inclement conditions. Gaps between vertical leafs allow sufficient air to enter in summer, while in winter the double skin facade generates a microclimate, allowing staff to open perimeter windows during the coldest months.”

(Parker, J. 2007)

One of the most interesting features of the double skin facade on this building is the fact that it can be disassembled. The building's double skin facade is bolted together and therefore means it can be easily disassembled. This adds another dimension to the building and makes it all the more sustainable. If the building is no longer in use the facade can be easily disassembled and taken apart where the parts can be reused and recycled instead of just demolishing the building (Architecture Ireland incorporating Irish architect. 2007).

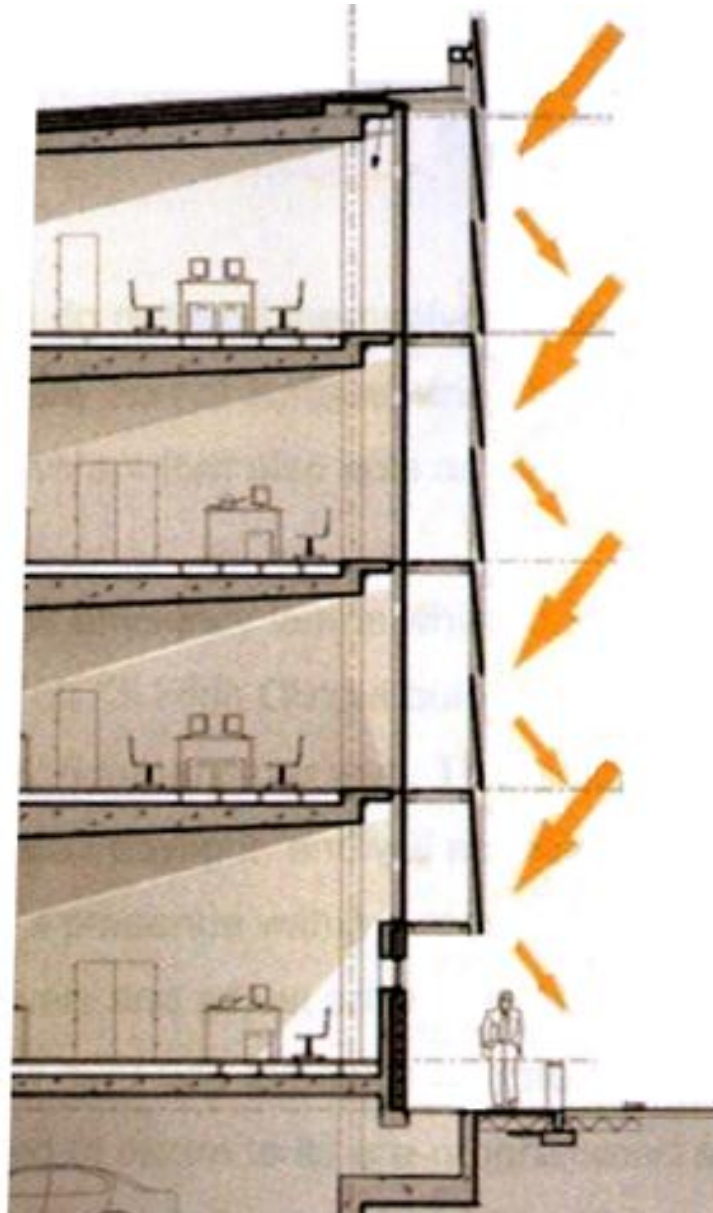


Fig 4.17- Drawing of the facade.

4.6 Cork County Hall.

4.6.1 General Information.

The original building was constructed in 1968 and was designed by the county architect Patrick L McSweeney. The building was a total of sixteen stories in height. However by the 1990s parts of the building began to deteriorate. The building was redesigned and upgraded. The original building was retrofitted with a double skin facade and there was also a new extension added to the building. It was completed in 2006. The main architects were Shay Cleary and the main contractor was Rohcon Ltd. Arup Facade Engineering were the specialist consultants in charge of the facade construction. (Cork County Council, Costal Recreation)

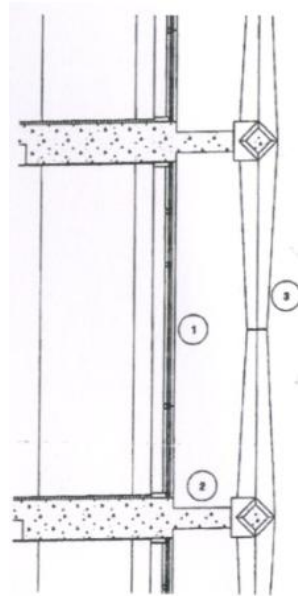


Fig 4.18- Cork County Hall.

4.6.2 Double Skin Facade.

An outer skin was incorporated onto the original building. The purpose of this layer was to make the overall building more sustainable and to allow the external envelope to take full advantage of climate control. The outer skin of pre-cast concrete cladding was replaced with an active glass louver system. This new cladding system covers the entire east and west facades. The external facades have vertical mullions running from floor to floor up the height of the building. These mullions are running in line with the existing grid of the internal layer. The vertical mullions are sub divided

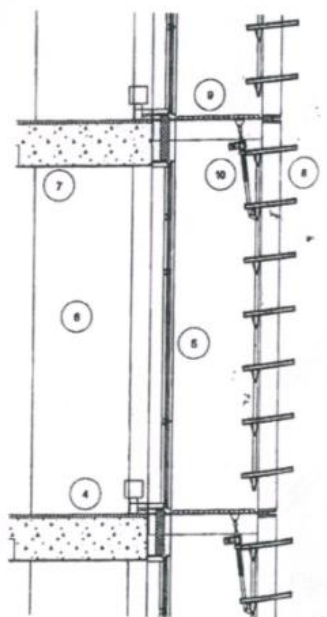
horizontally at 1.2 metre centres. Each of the grids on the external layer consists of a glass louver system. These glass louver systems are made up of several pieces of 16 mm laminated glass blades. All of the blades are supported using aluminium extrusions, which in turn are pivoted on the supporting mullions.



Existing facade detail:

1. Existing gold anodised aluminium glazing.
2. Existing RC concrete support
3. Concrete cruciform tracery.

Fig 4.19 Drawing of original facade.



Existing facade detail:

4. Existing parquet floor refurbished.
5. New gold anodised aluminium glazing.
6. Existing columns refurbished and plastered.
7. Existing ceilings replaced.
8. New active facade louver system in aluminium frame applied to exterior of tower linked to building management system.
9. Metal access deck to facilitate cleaning louvers and glazing.
10. Motorised actuator.

Fig 4.20- Drawing of the new facade.

The upgrading of the external facade has led to a large reduction of the buildings carbon emissions. The new facade has also allowed the building to be naturally ventilated. There are operable windows located all over the internal facade which allow the building to be naturally ventilated. The tilted glass blades on the external layer stop draughts and high winds from entering into the building through the open windows. The buildings narrow width and low floor to ceiling height allow for the natural ventilation to work more effectively. During the cold winter months the glass blades of the external layer can be closed. This creates a buffer which not only acts as a thermal insulator but also a sound barrier.

The buildings double skin facade is controlled using a sophisticated Facade Management System. This system takes into account the external conditions and adjusts the facade to suit the climate at any given time. The system takes a number of things into account before adjusting the glass blades to the optimum position. These are as follows:

- Luminance.
- Solar Radiation.
- Wind Speed.
- Wind direction.
- Rain detection.
- Humidity
- Air temperature

The Facade Management System gathers all this information through sensors which are placed all around the facade. In the case of the buildings power failing, a backup generator will kick in and power the systems. The building manager has the ability to override the automatic controls of the Facade Management System. There is a control panel located on each of the floors for each of the facades which allow them to manually control different parts of the facades

(Payne, R. 2006)

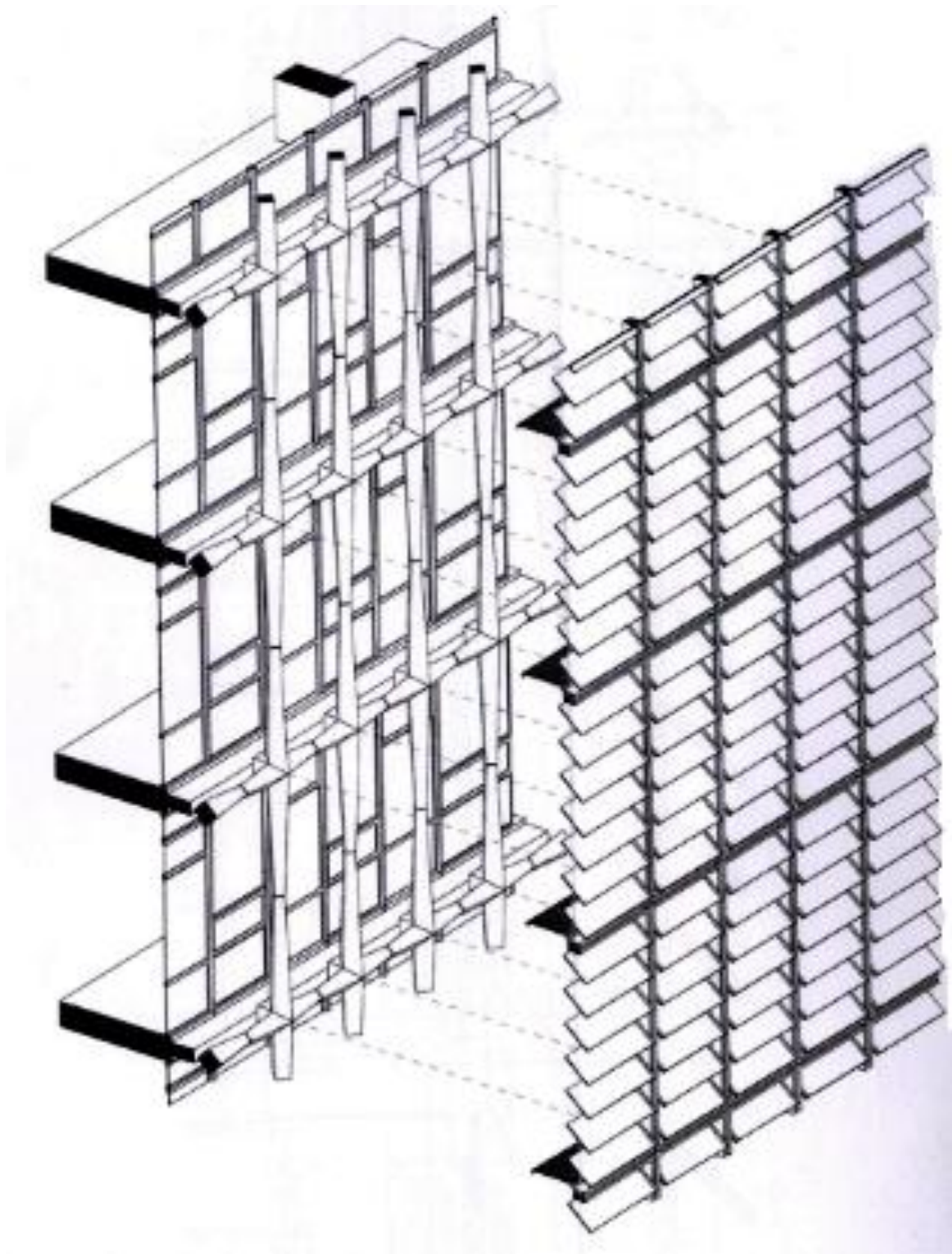


Fig 4.21- 3D view of the new facade.

4.7 Compare/ Contrast.

All of the double skins are unique in their own little ways from the scale of them to the design of them. However they also have lots of similarities in terms of purpose and function. All of the buildings used the air space between the internal and external layer as a buffer zone which not only worked as a sound barrier but also as a thermal insulator. The Cork County Hall may be seen as an exception to this as its external skin is open for periods during the year and therefore allows the transmission of sound and does not act as a thermal barrier.

The buildings mentioned in the above case study all share the same desire to exploit the maximum amount of daylight in order to create a more pleasant working environment. In doing this they are opening the buildings up to the risk of excessive solar heat gain. Each of the buildings has counteracted this problem in their own way, from using blinds to using a special type of ceramic coating.

The one thing that all of these buildings double skins have in common is their use of it to naturally ventilate the building. The double skins allow the occupants to open internal windows of all the buildings (without the risk of noise or strong winds) in order to naturally ventilate them. In some cases this natural ventilation only occurs for a small section of the building (Cork Civic Offices) but in other cases it might work right through the building (Cork County Hall). Whatever the case natural ventilation is occurring in all the buildings in some shape or form and this is down to the fact that the buildings contain a double skin facade.

Another similarity which can be seen popping up in most of the facades is their ability to be exploited as a form of night-cooling. Leaving the internal windows open at night will allow cool fresh air to be drawn into the building. This in turn will cool and naturally ventilate the building during the night. This is not really seen as a major feature in Ireland as the climatic conditions don't really permit the use of night time cooling.

The following page contains a wall section through each of the facades. These drawings show how the facades may look completely different but most of their basic functions are the very same with the exception of one or two. It will break the facades up into either the Buffer, Twin Face, Hybrid facade systems. There will be no extract air facade systems as this type of system is designed for areas where natural ventilation is not

possible due to high noise, wind or fumes. None of the double skin facades in Ireland are constructed in areas that require the use of an extract air facade.

4.8 Conclusion.

Double skin facades are quite new when it comes to Irish architecture. They only really started to appear in Ireland over the last ten to twelve years. Since that time however we have seen a growth in their design and construction. The above six buildings have all been designed and built by Irish architects in the past seven years and have all received some form of award from the RIAI. They all have double skin facades that use different materials and look completely different, but at the end of it all they are all providing the same basic functions for the building. The double skin facades have vastly reduced the buildings carbon footprint and made them more sustainable.

Chapter Five

Conclusions and Recommendations

Double Skin Facades

Chapter 5

Conclusions and Recommendations:

5.0 Introduction.

The purpose of this section is to provide conclusions and recommendations to the findings of the overall research. It will be broken up into two sections. The first section will offer concluding remarks in relation to the findings of the research. The second section will offer recommendations as to how double skin facades can be modified or changed to improve their performance.

5.1 Conclusions

5.1.1 Definition

The purpose of the research in this dissertation was to investigate double skin facades in general and to observe the double skin facades that have been built in Ireland between 2012-2006. After conducting the research of the history and typology of double skin facades, it can be clearly seen that a double skin facade can be defined as "Two layers of glazing with an airspace between the two". Sometimes the exterior layer may vary and change from what is considered a standard double skin facade. One example of this is the use of glass plates on the Cork County Hall building. The interior layer may also vary from a mixture of glass and solid material. A good example of this is the Wexford county council offices where there is a fully glazed external skin wrapping around the entire building and an internal layer consisting of both glazing and limestone finishes. There may also be a third layer located within the air space and it usually serves the purpose of a shading device. The best example of this is the Criminal Courts of Justice where there is a third layer of bronzed perforated aluminium. This concludes that a double skin facade requires two layers, which usually consist mostly of glazing and an air space to divide the two.

5.1.2 Advantages and disadvantages.

5.1.2.1 Advantages

- **Acoustic barrier:** The use of a double skin provides fantastic noise insulation for buildings. It not only blocks out the external noise of traffic and busy streets, it also reduces internal noise levels by reducing the sound transmission from room to room. The type of double skin facade and number of openings are crucial in deciding how well it works as an acoustic barrier.
- **Thermal insulation:** Double skin facades can be used as an excellent thermal insulator if they are built correctly. On cold winter days the top of the double skin can be closed off which allows the air to build up in the airspace. This air then heats up and acts as the thermal barrier.
- **Day lighting:** Double skin facades can be utilised in order to achieve the maximum amount of daylight into a building by using large glazed facades. This is scientifically proven to create a better and more productive working environment as well as reducing the energy costs of artificial lighting.
- **Natural ventilation:** when a double skin facade is constructed and orientated correctly it will allow for a certain amount of natural ventilation up through the building depending on the scale of it. The double skin may be also used as a way to cool the building at night. By opening up all the windows at night it will allow for the night time cooling of the building. Naturally ventilating and cooling more of the building will lead to a reduction in energy bills and reduce the carbon foot print of the building.
- **Reduced energy use:** The use of a double skin can greatly reduce the energy use of a building as it provides, day lighting, natural ventilation, thermal insulation, acoustic barrier and a form of cooling.
- **Low U/G-value:** The use of a double skin facade greatly reduces the U/G value of a building.
- **Protection of shading devices:** When the shading devices are placed inside the external layer they are protected from all of the elements such as wind and rain.
- **Thermal comfort:** When a double skin facade and a facade management system are combined they can control the temperature of the air within the airspace. This air can be adjusted to the temperature of the internal comfort levels. On hotter airs

this air can pass right up through the air space. This provides a continuous flow of fresh air and can help to cool the building.

- Other: Transparency in the use of glazing and reduction of wind pressure on high rise buildings

5.1.2.2 Disadvantages.

- Reduction of floor area: double skin facades can range in thickness of anywhere between 200mm to 2m. This will therefore reduce the overall internal floor area of a building.
- High construction costs: The design and construction have proven to be very expensive when compared to a standard external envelope.
- Glare and overheating: If a double skin facade is not properly designed it can lead to uncomfortable working conditions for the occupants. This can happen where the shading devices of the facade are insufficiently designed.
- Acoustic problems: There can often be problems of noise travelling up through the air space and passing into the building through the operable windows of the internal facade. This problem is again down to poor design.
- Fire protection: A Poorly designed facade can lead to the transmission of smoke from room to room through the air space in the case of a fire.

5.1.3 Irish Double Skin Facades.

Double skin facades are still quite a modern phenomenon in terms of Irish architecture. They may lower the carbon footprint of the building but they also increase the cost of building it in the first place. There is also the need for constant maintenance and upkeep of the Irish double skin facades which again leads to increased running costs. They are however still more beneficial to buildings than most other forms of facade construction and will save the owners a lot of money in the long run. However as this type of construction is still only quite new to Ireland it is not yet known how these facades will be performing in the Irish climate in another 10/20 years down the road. There could be various problems with the Facade Management Systems, shading devices and various other things. Therefore at this point in time it is hard to say if this type of construction would actually be suited to the Irish climate.

5.2 Recommendations

Double skin facades have a lot of benefits in terms of what they bring to a building. There are however some flaws in their design that could possibly be improved in order to enhance the overall performance of the building even further.

The first flaw can be seen in the form of gasses and fumes passing up through the air space and into the building. This creates an uncomfortable working environment for the occupants inside. The Wexford County Council Headquarters is an example of where this occurs. Occupants complained of trucks pulling up outside of the building and the fumes from them passing up through the airspace and into the building. One way of fixing this problem would be to fit a chemical air filter down at the bottom of the air space.



Fig 5.1- Chemical air filters.

This is a PuraGrid chemical air filter. It comes in all shapes and sizes and would filter the fumes and gasses out of the air. It is a new form of technology and is very energy efficient. Although it would add to the overall cost of the building it would improve the internal environment and create a more pleasant work place for the occupants.(Purafill)

Another flaw comes in the form of upkeep and maintenance of the facade. In all of the case studies looked at there was a need for constant maintenance. A way of reducing the amount of maintenance would be to use self-cleaning glass on the external layer of the double skin facade.



Fig 5.2- Self cleaning glass.

There are many types of self-cleaning glazing on the market. It reduces the need for cleaning of the glazing through a dual action process. This is a special type of glazing that uses rain and daylight to break down and wash away organic material. This will reduce the maintenance costs of cleaning the external facade. (Pilkington Glass)

Double skin facades are a relatively modern technology in terms of an Irish context and there are constantly new technologies coming out that are being used in their design and construction. This means it is hard to say if there will be more problems and flaws in their operation. Therefore it is quite difficult to make further recommendations without seeing how these buildings stand the test of time.

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Appendixes

Appendix A

Appendix B

Appendix C

Double Skin Facades

Appendix A

Interview Schedule/
Completed
Interview

Double Skin Facades

Appendix A

Interview Schedule:

"Investigation of double skin facades: Irish buildings between 2012-2006"

Structured Interview Schedule

Name of Interviewer: Aidan Walsh

Name of Interviewee:

Date:

Venue:

1. What are your views on the double skin facades that have been built in Ireland in the past 6 years? In particular what are your views on the Commissioner Of Irish Lights and the John Paul ii Library?
2. Can you please take me through the jobs file of both the Commissioner Of Irish Lights and the John Paul ii Library?
3. Can you take me through the project from inception to finish?
4. Where there any defects in Commissioner of Irish Lights building during the defects liability period?
5. Do you feel double skin facades are suited to the Irish climate?
6. Do you feel they are performing as well as they were expected to in relation to:
 1. Acoustic performance.
 2. Thermal performance.
 3. Natural ventilation.
 4. Day lighting.

7. What climate do you feel would be best suited to double skin facades?
8. Do you feel that Part L of the technical guidance documents hinders the design or development of double skin facades in Ireland in any way?
9. In my research I have come across a number of different facade types such as:
 1. Buffer facade
 2. Extract air facade
 3. Twin face facade
 4. Hybrid facade

What in your opinion is the best form of double skin facade construction?

10. Do you feel double skin facades will continue to grow in Ireland or have they reached their peak?
11. What in your opinion defines/ differentiates a double skin façade from all other types of facades?

Completed Interview:

"Investigation of double skin facades: Irish buildings between 2012-2006"

Structured Interview Schedule

Name of Interviewer: Aidan Walsh

Name of Interviewee: David Flannery

Date: 21/2/13

Venue: Webworks Offices, Cork.

Q. What is your role within the company?

A. Architect with Scott Tallon Walker Architects.

Q. Have you worked on the design of the John Paul ii/ Commissioners of Irish Lights double skin facades?

A. I did not Work on the John Paul ii facade. I did however work on the Commissioners of Irish Lights facade.

Q. Have you worked on any other double skin facade buildings in Ireland?

A. Yes I also worked on the McCann FitzGerald Headquarters in Dublin which consists of a double skin facade.

Q. Can you tell me a little bit about the building?

A. McCann FitzGerald Headquarters in Dublin is probably the biggest double skin facade in the country. It is a 10,000 square metre office building that to my mind is the best building we as a firm have produced in the last 10 years. It consists of a double skin glazed facade and it went on site in 2004 and was completed in 2006. It is currently up

for an award and is shortlisted for a gold medal in Architecture. It is a cellular office building. It is occupied by a bunch of solicitors who each have their own individual office space. Each office has control of the facade directly outside their office which enables them to control the amount of light entering the space. On top of that there is a building information model centralised in the system. This means that if a solicitor is out at court the computer system will kick in and take automatic control of the facade. It is a very nice feature as it allows the facade to have different appearances throughout the year. During the summer it shuts down essentially and appears as a timber facade from the outside. In the winter it opens up and regains its transparent appearance.

Q. Could you please take me through the commissioner of Irish Lights project from inception to finish?

A. The building itself was designed by Ronnie Tallon. It was designed in response to a very detailed brief given to the firm by the Irish lights organization. Their chairman was based in cork and he became the client. One of their requirements was that they wanted the building to reflect what they do. The brief was based on the functional requirements of fixing all the buoys and then the office requirements of running the business of the Irish Lights. The office space is used rather like an air traffic control tower and it keeps track of all the boats coming in and out of Ireland. The top floor of the building consisted of several boardrooms. What we wanted to do was to design a building that reflected the types of buoys that they utilised. They had immense expertise in photovoltaic technology as all their buoys and lighthouses are run on photovoltaic cells. We wanted to display this expertise in the building, so at the top of the building there is an array of solar panels which are used as shading devices for the glazed areas of the reception areas. Then we created an array of photovoltaics and installed a circular staircase up through the middle of the building. These are all similar to the geometries of the buoys that were being produced in the factory. The more functional component of the building is the square building where they produce and fix all the buoys. It is a very good project and the facade was done by permasteelis. Permasteelisa are an Italian facade company who have actually left Ireland. They have done a number of Irish projects which included, Commissioners of Irish lights and McCann FitzGerald Headquarter. Both these buildings were actually designed at the same time and they both consist of double skin facades.

Both of these double skin facades have an intergraded blinds system located within the air space of the double skin facade.

Q. What is the purpose of these blinds?

A. They are timber blinds and their purpose is to prevent excessive solar heat gain and glare from entering the building. Both sets of blinds are controlled by a sophisticated facade management system.

Q. Can You tell me a little bit more about either of the buildings?

A. Both of the buildings are modular. The Glass and its framing were constructed off site in factories. They then arrived on site and were actually installed by a robot. Little robot machines went around the sites and place the modules in position

Q. Was there any defects in either of the buildings double skin facade during the defects liability period?

A. No there were no problems with either of the facades. The Permasteelisa are world leaders in terms of glazing and double skin facades. The glazed panels were constructed at their maximum and produced in Ireland. Unfortunately the requirement for this glazing has severely reduced in Ireland over the past couple of years. We had a lot of great glass companies in Ireland but unfortunately a lot of them are going out of business or have gone out of business.

Q. Will this affect the construction of double skin facades in Ireland from now on?

A. The answer is yes. Nobody is building office buildings here anymore. The problem is we have built up an incredible amount of expertise and it's all gone. A lot of people including contractors and sub-contractors have left the country search of work elsewhere. It will take a very long time for enough momentum to be built up in order to bring these people back into the country.

Q. Is the Irish climate suited double skin facade construction?

A. Yes double skin facades are suited to the Irish climate. Going back to McCann FitzGerald they required a building with an extremely good acoustic barrier. In that building we also took the stale air from the office spaces and pumped it into the air space. This air was around 20 degrees and it started to build up in the air space. This essentially acted as a blanket around the entire facade and gave an incredible amount of heating. In office buildings, even in the Irish climate the biggest cost you have is cooling. There's a wish to have a maximum amount of glass that's going to get maximum daylight into the building. This creates a conflict as you are trying to maximise daylight and avoid excessive solar gain. That's where these facades perform at their best. They give you a maximum amount of glass with a minimal amount of solar gain. The air then essentially circulates up through the building and cools it during the summer.

Q. Do the facades have any other functions?

A. Yes they do. For example, it's got a fire function. In the case of a fire the facade system extracts the smoke into the air space and essentially uses it as a chimney to bring the smoke away from the building. They also have a solar control function, U-value function and it has such a variety of modes of functions that you can solve a variety of issues by using them. It reduces the cost of ownership of the buildings. To run either of these buildings is approximately a third of what it would cost to run them if they had your standard facade systems.

Q. Are the facades really worth the cost of constructing them?

A. Yes they are for a number of factors. The payback with the reduction of cost of cooling coupled with the rising prices of gas and oil means that it is only a matter of time before the facade pays for itself. We estimate that over a 25 year period the cost of constructing the building accounts for roughly 10% of the buildings life span. So what we tell our clients is that using double glass facades and getting natural light into the building improves occupant performance which means less absenteeism and an overall happier working environment. You are therefore getting a maximum performance out of your staff

which is effectively your main cost. The performance and benefits of the facade outweigh the costs of constructing it.

Q. Given the current economic situation can you see older buildings adopting there facades and installing double skinks? Similar to the re vamping of Cork County Hall.

A. Yes I do believe will begin to see this form of construction happening to older office buildings. In Ireland we are in a practice where a lot of our older offices buildings were constructed in the seventies and are now considered protected structures. The incorporation of a double skin will not affect the building in terms of conservation issues and is seen as a minimalist form of intervention. The Carroll's Factory of Dundalk is an example of this. So renovation of buildings will become big business because people can't get the finance to rebuild from fresh so there putting facades onto old buildings. One of the first revamps that took place in Ireland was the ESB building on Burlington road and it was designed by Brian O'Halloran. He covered a facade in a double skin facade. The down fall of the County Hall building is the fact that it is open and is unable to circulate air within the air space unlike the two buildings we designed.

Q. What in your Opinion makes them so good?

A. The great thing about double skin facades is that they react to the climatic conditions. They have a different function for each season of the year.

Q. Would you like to make any further comments?

A. In terms of quality of facade Germany is the centre of excellence. I would suggest taking a look at their buildings and how they are constructed and operate.

Appendix B

Questionnaire
schedule

Double Skin Facades

Appendix B

Questionnaire schedule:

"Investigation of double skin facades: Irish buildings between 2012-2006"

Questionnaire Schedule

Name of Interviewer: Aidan Walsh

Name of Interviewee:

Date:

Venue:

1. Do you feel that double skin facades are suited to the Irish climate?

- ☐ Yes
- ☐ No
- ☐ Maybe

2. How would you rate the standard of double skin facades in Ireland?

1

2

3

4

5

☐☐☐☐☐

3. Do you feel double skin facades are worth the high construction costs?

- ☐ Yes
- ☐ No

4. Has double skin construction reached its peak in Ireland?

- ☐ Yes
- ☐ No
- ☐ Maybe

5. How would you rate the performances of Irish double skin facades in relation to:

	1	2	3	4	5
Acoustic performance	☐	☐	☐	☐	☐
Thermal performance	☐	☐	☐	☐	☐
Natural ventilation	☐	☐	☐	☐	☐
Day lighting	☐	☐	☐	☐	☐

6. What in your opinion is the best benefit of a double skin facade?

- ☐ Acoustic Performance
- ☐ Thermal performance
- ☐ Natural ventilation
- ☐ Day lighting

7. Do you feel the idea of re-cladding an old building with a double skin facade is a good one?

- ☐ Yes
- ☐ No
- ☐ Sometimes

8. Do you feel that Irish double skin facades are aesthetically pleasing?

- ☐ Yes
- ☒ No
- ☐ Depends

Appendix C

Case Study
Research

Double Skin Facades

Appendix C

Case Study Research:

List of double skin buildings constructed in Ireland between 2012-2002

"Investigation of double skin facades: Irish buildings between 2012-2006"

Irish buildings between 2012-2002:

2012:

Building: John Paul ii Library

Location: NUI Maynooth, Dublin

Architect: Scott Tallon Walker Architects

Contact Info:

- Cork -Scott Tallon Walker Architects
Unit 36, Webworks,
Eglinton Street,
Cork.
- T: 353 (0)21 4320744
- F: 353 (0)21 4961820
- cork@stwarchitects.com



2011:

Building: Wexford County Council Headquarters

Location: Wexford

Architect: Robin Lee Architects in association with Arthur Gibneg and Partners

Contact Info:

- Address: Dublin
3 Clanwilliam Terrace,
Grand Canal Quay,
Dublin 2
- Telephone : +44 (0)20 3368 6724
- Email: info@robinleearchitecture.com



2010:

Building: The Criminal Courts Of Justice

Location: Dublin

Architect: Henry J Lyons Architects

Contact Info:

- Address: 16 Lavitt's Quay
Cork
Ireland
- Telephone : +353 21 422 2002
- Fax: +353 21 422 2003
- Email: Pat Hogan or Turlough Clancy



2009:

Building: 1 Heuston South quarter

Location: Killmainham, Dublin

Architect: Several

Contact Info:



2008:

Building: Commissioners of Irish Lights

Location: Dun Laoghaire

Architect: Scott Tallon Walker

Architects

Contact Info:

- Cork -Scott Tallon Walker
Unit 36, Webworks,
Eglinton Street,
Cork.
- T: 353 (0)21 4320744
- F: 353 (0)21 4961820
- cork@stwarchitects.com



2007:

Building: Civic offices Cork

Location: Cork

Architect: Abk Architects

Contact Info:

- Address: ABK Architects Dublin
34 Lower Leeson Street
Dublin 2.
- Telephone: 353 (0)1 678 9822
- Email: abk@abkdublin.com



2006:

Building: Cork County Hall

Location: Cork

Architect: Shay Cleary Architects

Contact Info:

- Address: Shay Cleary Architects,
18 Palmerstown park,

Rathmines,

Dublin 6.
- Telephone: 00 353 1 4125090
- Fax: 00 353 4978087
- Email: info@sca.ie



2005:

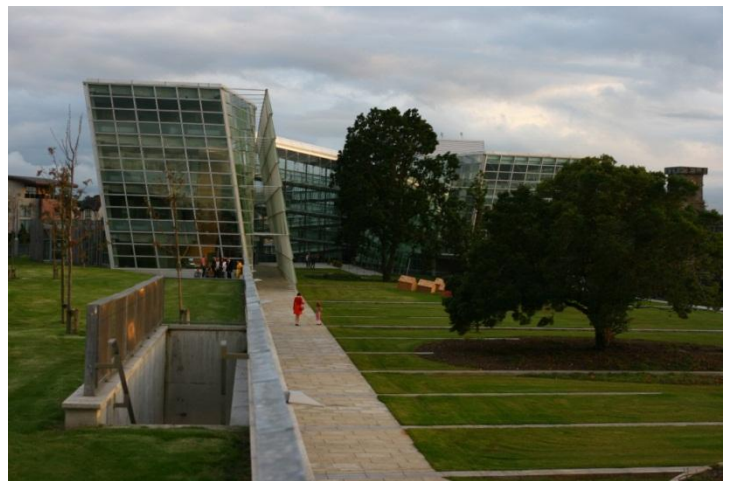
Building: ARAS CILL DARA / DEVOY PARK

Location: Leinster

Architect: Heneghan Peng Architects / Arthur Gibney & Partners

Contact Info:

- Address: heneghan peng architects
14–16 Lord Edward Street
Dublin 2, Ireland
- Telephone: 353 1 633 9000
- Fax :+353 1 633 9010
- Email: hparc@hparc.com



2004:

Building: No.2 Burlington Road

Location: Dublin

Architect: Brian O'Halloran and Associates

Contact Info:

- Address: 23 Herbert Place,
Dublin2,
Ireland.
- Telephone: 353 1 6764017
- Fax: 353 1 6762963
- Email: e-mail@bohaha.ie



2003:

Building: Aras an chontae Offaly, Offaly county council civic offices

Location: Offaly

Architect: Abk Architects

Contact Info:

- Address: ABK Architects Dublin
34 Lower Leeson Street
Dublin 2.
- Telephone: 353 (0)1 678 9822
- Fax: 353 (0)1 678 9298
- Email: abk@abkdublin.com



2002:

Building: Dunshaughlin Civic Offices

Location: Co. Meath

Architect: Grafton architects

Contact Info:

- Address: 97 Grafton Street,
Dublin 2,
Ireland.
- Telephone: + 353 1 671 3365
- Fax : + 353 1 671 3178.
- Email: info@graftonarchitects.ie.

