

THE GLASGOW SCHOOL OF ART

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Charles Rennie Mackintosh:
Composition and Geometry of Glasgow School of Art

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Diploma in Architecture

**Charles Rennie Mackintosh:
the composition and geometry of Glasgow School of Art**

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Diploma 1st year in Architecture

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Introduction

Glasgow School of Art by Charles Rennie Mackintosh is recognized as one of the outstanding urban building in transitional generation to modern architecture. Asymmetrical composition of this building tried to slough off from classical style architecture. Besides, the composition agrees with geometrical principle.

“Composition” is the significant vocabulary to define the post classic style architect. In addition, geometry administers arrangement of composition. Through the art history, architects have their own think of module and proportion which are based on geometrical principles for their design. Such as, in ancient age, the Façade of the Parthenon in Athens were formed by the golden section. Le Corbusier is the standard bearer of not only modern architectural movement, but also design by using geometry in modern age. Le Corbusier considered the golden section is ideal proportion. He analyzed villa Stein (villa Garches) by himself. Finally, the *Modulor* which is mixture of golden section and proportion of human was convinced by him.

Charles Rennie Mackintosh was working in the incunabula of the modern movement. Therefore, he has a different point of view for the composition of design from modernism and classicism. Colin Rowe had described the similarity and distinction of composition between Andrea Palladio and Le Corbusier. Besides, Peter Eisenman was interested generating process of architecture, and, analysed Giuseppe Terragni's works. On the other hand, this dissertation aims to explain the composition and geometrical principle in Glasgow School of Art. In addition, Mackintosh's intention will be revealed through the analysis of the plan and the façade.

The dissertation is constructed from 4 parts of analysis. Firstly, proper case studies which make mention of geometrical analysis will be gathered and the methodology will be distilled from these tendencies. Secondly, the plan drawing will be analysed to demonstrate asymmetrical composition of the building from geometrical point of view. Thirdly, the main façade will be anatomized to explain the relationship between the design of façade and the city. Then, the south elevation of the building will be compared with the façade of Scottish traditional architecture, the Fyvie Castle. In the end part of analysis section, the east and the west façade design will examined in order to define the transition in between two phases of construction. The important perspective for this study is to bring intention of design by Mackintosh into daylight, therefore, it will be discussed in all part of analyses.

Chapter 1: Case Studies

In this section, four examples will be shown with each analytical method. The first example is about the geometrical forms for room's proportion by Andrea Palladio. This study defined the ideal proportion for rooms. From this analysis, the standard for proportion of rectangle will be known. Then, the essay about Frank L Wright by Paul Laseau and James Tice is picked up to know how to analyse the plan drawing. In the same way, the analysis of Louis I. Kahn's buildings by Klaus-Peter Gast is reference to found a process of generating on the geometrical point of view. Colin Rowe's essay will be taken. He compared Villa Malcontenta by Andrea Palladio and Villa Garches by Le Corbusier in order to find the way of comparison. Therefore, Rowe's the point of view will be referred to defined similarities or differences between Glasgow School of Art by Mackintosh and the Fyvie Castle in Chapter 4.

1. The Room Proportions of Andrea Palladio

Andrea Palladio

The Four Books of Architecture, Dover Edition 1965

The most beautiful and proportionable manners of rooms, and which succeed best, are seven, because they are either made round (tho' but seldom) or square, or their length will be the diagonal line of the square, or of a square and a third, or of one square and a half, or of one square and two thirds, or of two squares.¹

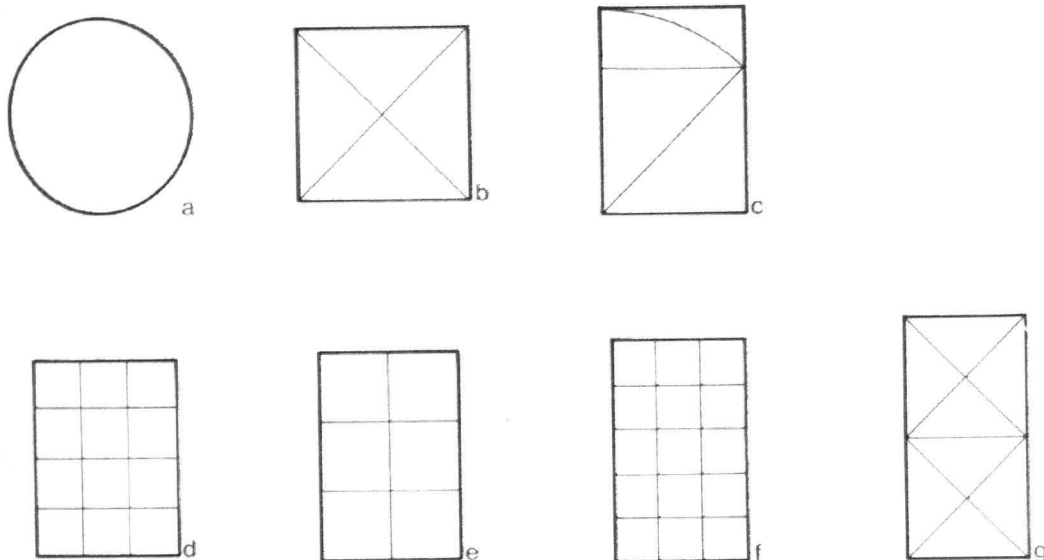


Fig01. the Ideal Proportion of the Room

This list of room proportion was defined by Andrea Palladio. Figure a. and figure b. are circle and square which are used for design widely. Figure c. is $1:\sqrt{2}$ rectangle which is known as a basic proportion of rectangle in the ancient Greek architecture. The 3:5 (figure f.) was expected Palladio's favorite proportion because the ratio is similar to the golden mean and it has odd number either long side or short side for securing a space to wall and column.

¹ A. Palladio, *The Four Books of Architecture*, page 57 line 18-22

2. Frank Lloyd Wright between principle and form

The basis of Frank Lloyd Wright's design is various geometrical principles. Circle, square, diamond, and triangle are integrated to his grid system. Paul Laseau and James Tice, the authors of "Frank Lloyd Wright between principle and form", described that a rectangle grid are used for Falling Water. Almost Houses by Wright have a fireplace at the centre of houses. In the case of Falling Water, rooms are expanded from centre in all directions. The centre living room which has fireplace is a rectangle shape which is formed by sliding square. Therefore, a grid becomes tartan. Shapes of Each room have $1:\sqrt{2}$ rectangles and golden proportion rectangles in order to make diversity.

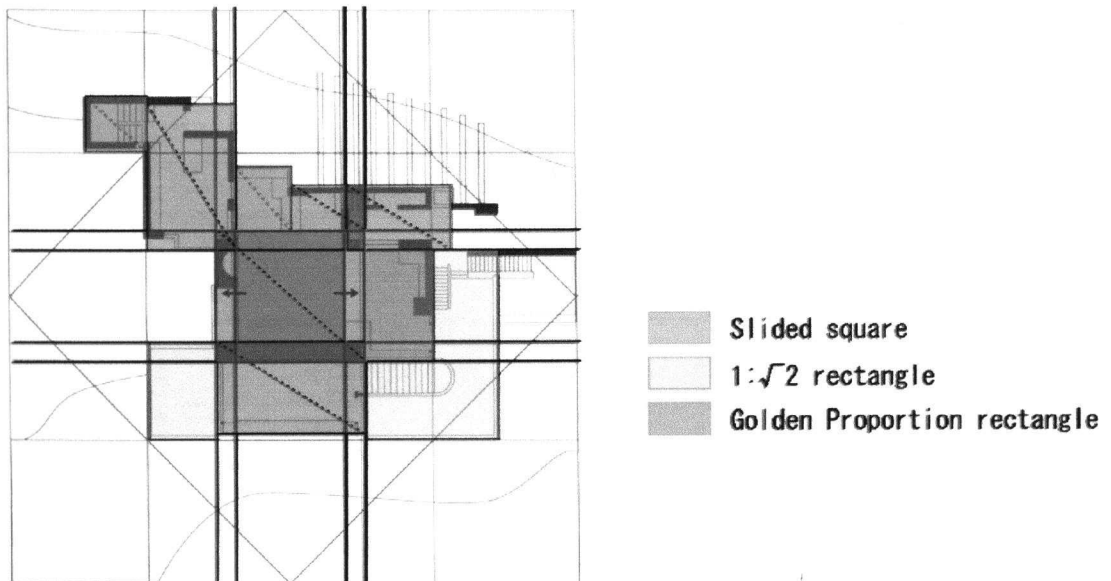


Fig02. geometrical composition – the Falling Water

The analyses are intended to reveal the process of generating Kahn's buildings. Through the essay, author finds the processes efficiently by his method based on the geometrical point of view. Especially, the description about Kimbell Art Museum is a representative case. In fact, the process is useful for finding the method to analyse design of Mackintosh. In particular, the process of shifting two squares to lap over each other and dividing into small modules from total volume will be effective ways.

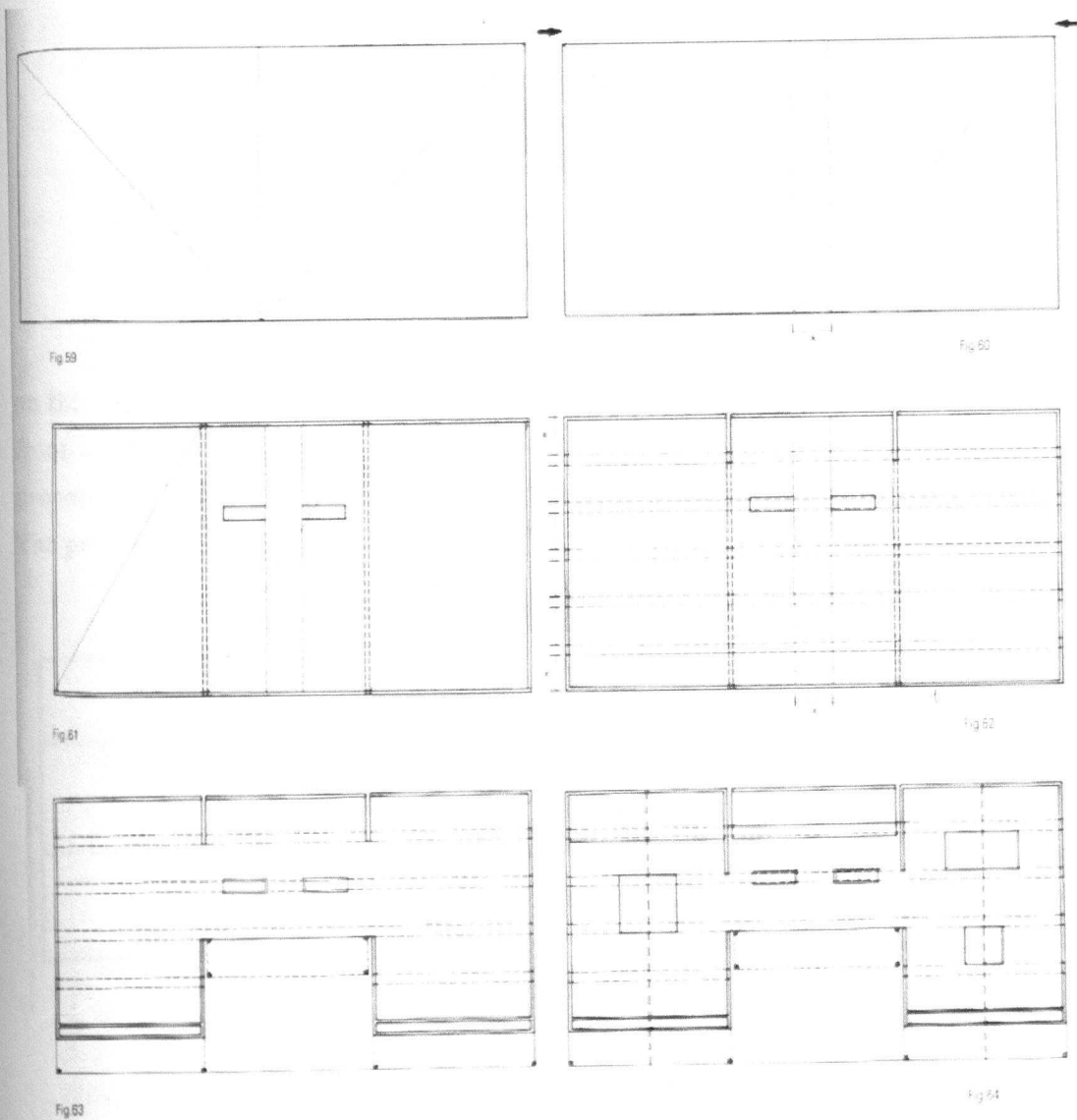


Fig03. Process of Generating – Kimbell Art Museum

4. The Mathematics of the Ideal Villa Colin Rowe

The essay is one of the most important analyses about architectural proportion. The author, Colin Rowe, describes comparison between Villa Malcontenta by Andrea Palladio and Villa Garches. The similarity of volume size which is composed by width, height and depth are recognized. Both building have ratio of width and height are 8 : 5 (fig1). In addition, the ratio of depth of these buildings is 5.5.

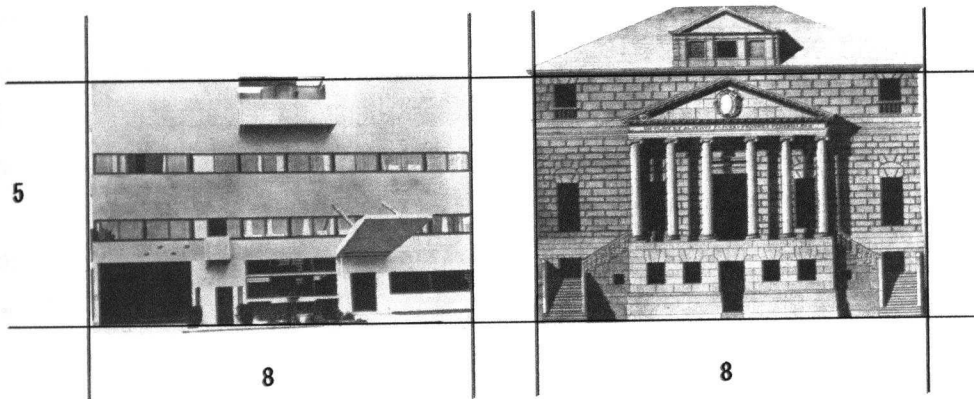


Fig04. Proportion of Façade

The span of the space which is defined by structure on their plan is compared on this essay as well as about facade. Villa Malcontenta has 2 : 2 : 1.5 proportion from front to back of the building. On the other hand, Villa Garches has 0.5 : 1.5 : 1.5 : 0.5 proportion. Though we could find the difference, their ratio from side to side is same. The proportion is 2 : 1 : 2 : 1 : 2 (fig2).

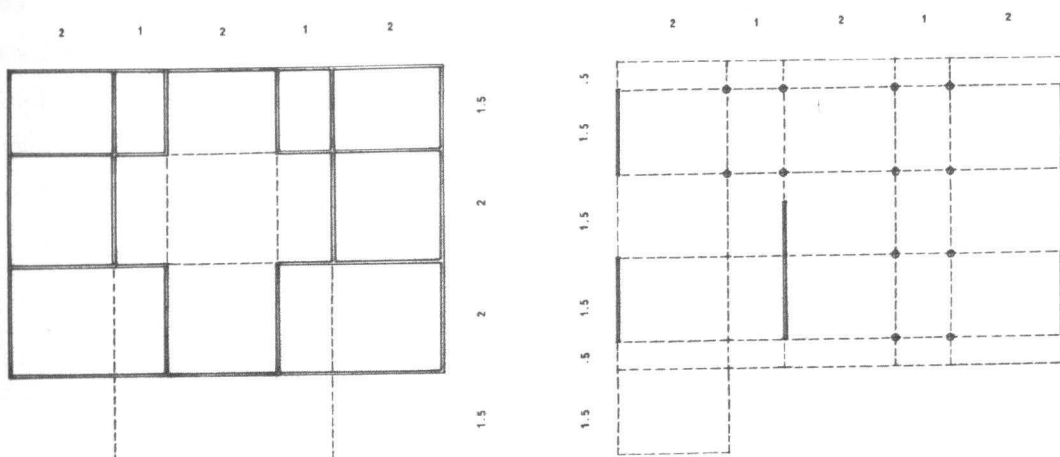


Fig05. Comparison of span on plan

5. Methodology

In this section, the method of analysis will be defined. One of the aims of dissertation is to reveal composition of Glasgow School of Art and its process of generating based on Mackintosh's geometrical principle. Therefore, it is necessary to decide kinds of ratios which are chosen in analysis.

In this case, the "Geometry" should be based of Euclidean geometry for analyses because of its simplicity and precision. The proportion of figure which is used for this analysis will be chosen from Palladio's 7 proportions such as circle, square, $1:\sqrt{2}$, $3:4$, $2:3$, $3:5$, $1:2$. In addition, $1:\sqrt{3}$, $1:1.618$ (golden proportion), $1:\sqrt{5}$ are added in the group. In the analysis, the habit of design and geometrical principle will be shown.

In the section of analysis on plan, whole process of design will be sought mainly. Planning is important process for framework of design obviously. Besides, figures which are based on the geometrical principal will be found with designing process in order to explain the asymmetrical composition. Mackintosh's building has thick stone walls for structure, therefore, it is difficult to decide the point to measure rooms. As a rule of drawing, baseline is the measured point. Otherwise, it is necessary to think about measured point flexibly on certain occasions because it is difficult to find the correct geometry on the plan. In other words, internal surface or external surface also could be measured point in this case.

Composition of façade is relied on the analysis of plan drawing basically. It is important that the analysis of plan drawing mentions position of the windows and doors which are relevant to façade design closely. This section describes the arrangement of ornaments and total composition of façade. The method which is described by Coline Rowe will be referred for comparison between the south elevation and the façade of the Fyvie Castle.

Chapter 2: Asymmetry on the Plan

1. Introduction

Symmetry is one of the most important principles in the classical style architecture. From ancient age, this strict composition has influenced the design of architecture in all ages such as pyramid, Greek temple and each styles of architecture. Pioneers of the modern movement had tried to invent a new architectural design which stands beyond the classical style architecture along progress of the industrial revolution. New technology provided new type of engineering system for construction and materials in particular, steel and reinforced concrete. Thus, they helped modernists to realise modern architecture. However, in incunabula of modern architectural movement, pioneers have sought new architecture by testing several measures. In particular, Otto Wagner created experiments of ornaments as expression of structure. Then, the Secession which is a new art movement in Vienna in 19th century is caused by artist in Vienna such as, Gustav Klimt, Egon Schiele, Joseph Maria Olbrich and Wagner. Architects in the Secession movement gave new ornaments which are invented by new technology to classical symmetrical building. Besides, the Art Nouveau in France and Belgium is the art movement which has curved, ornamental and sculpture like design in 19th century. In the case of Mackintosh's design, Arts and Craft movement which respects design by craft and is antithesis to manufacture influenced it considerably. In fact, cast-iron ornaments are set on throughout this building. Whilst, the important attempt of Glasgow School of Art is its asymmetrical façade and planning. Mackintosh didn't emphasize structural device on the building. Actually, the main structure is masonry wall and steel beam except the library which has suspended floor by steel. It is assumed that he contrived the composition of façade to give the building remarkable design. Colin Rowe indicates the composition had already been used as an architectural vocabulary in order to explain new style's design in this age. In addition, he mentions about the importance of asymmetry as a new type of geometry like the statement follow.

- and, that it was conceived as being peculiarly applicable to the new, free, asymmetrical organizations which could not be comprehended within the aesthetic categories of academic tradition.²

When people look at the façade of Glasgow School of Art, a peculiar

² C. Rowe, *The Mathematics of the Ideal Villa and Other Essays*, page 65 line 31-33

asymmetrical composition would be found. The proportion of west side to east side on the façade doesn't balance equally. Also, the number of windows is different obviously. However, it still looks well organised for some reason. The centre of building which has a entrance is a kind of attempt to give a balance to the façade though, it isn't located on the actual centre. Then, next section will describe some operations to compose the building by analysing plan drawings.

The outline of Glasgow School of Art was planned by Francis Newbery who is the art school's head master at that time. He hopes the building to be an ideal art school building. As a result, other famous art schools such as, Liverpool(1881), Birmingham(1884) and Manchester(1884) are refer from. The similarities has been indicated by Rowson in his essay (Rowson,G). Newbery decided the structure of building for instance, the width of corridor, the teaching space and location of staircase³. Mackintosh designed the building based on Newbery's plan because of competition which are organised by the institution of Glasgow School of Art. However, the plan drawing shows us some points which are decided by Mackintosh's geometrical principal. For most of architects, floor planning is the most important process and it is thought the beginning of building's design. In fact, it is frequent that geometry is used for planning. Glasgow School of Art is situated on a high dense area in Glasgow city centre, therefore, a cubage of the building had to be used effectively as an art school. This section will describe how the building is subdivided into several kinds of rooms from fixed volume on the plan. In addition, it also refers to the generating process of asymmetrical composition for Glasgow School of Art.

2. Process of Generating

The building of Glasgow School of Art has narrow and wide form on the plan. North and south side have wide surface whose length is about 256ft (77m). Though, west and east side only has about 95ft (29m). The ratio of two lengths is $5:13 = 1:2.6$. This proportion is exceeded the series of proportion which are defined by Palladio. It is too long to recognise the whole volume of the building without bringing up the example of Palladio's principle.

Therefore, it is necessary to divide into several volumes as not only design of façade but also planning. a position of the entrance gate and south east block of the building tell us the division points on west-east direction. There is a curvilinear form staircase in the front of entrance at the middle of 256ft. And over the stair case, entrance gate is set. Additionally, an ornamental lamp on the gate is set on the perfect centre where is 126ft from west edge of building, On the other hand, width of south east block which are used for special purpose such as, guest space, meeting room and

³ G. Rowson, Mac Journal 2, page 15, line 13

Mackintosh's room, is 36ft. The number is 1/7 of the building's total width, 256m, and it is important module for this building. Subdivision of south-north direction is quite simple. The volume is separated to three parts between north and south. The north part is the 15ft wide buffer space which is used for workshops on the basement floor and is glass roof as a top light to studio on the ground floor. The middle part is 40ft wide main studio and office space on each floor. The south part is 12m complex space for circulation and some important rooms. As from now, these parts will be named, 'north block', 'middle block', 'south block'.

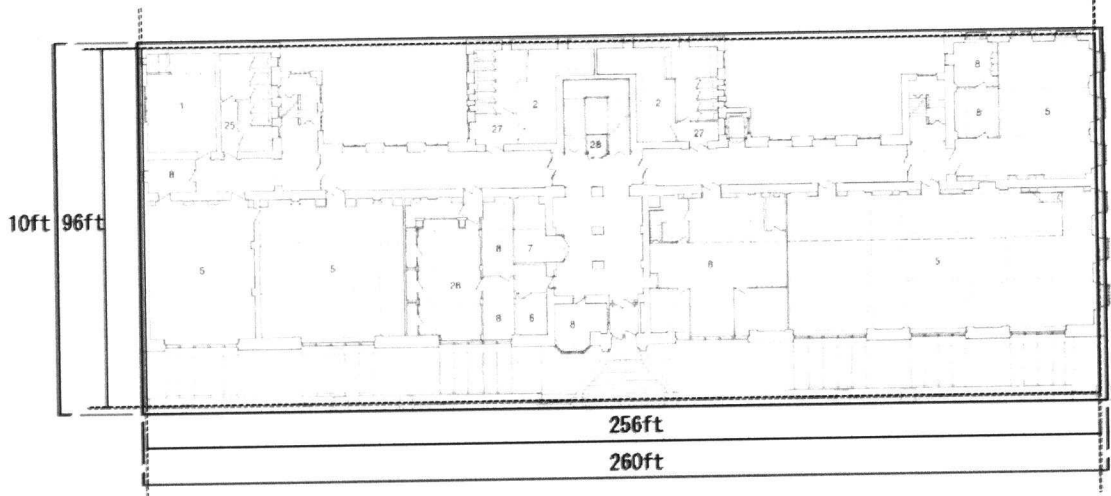


Fig06. Total Size of Building

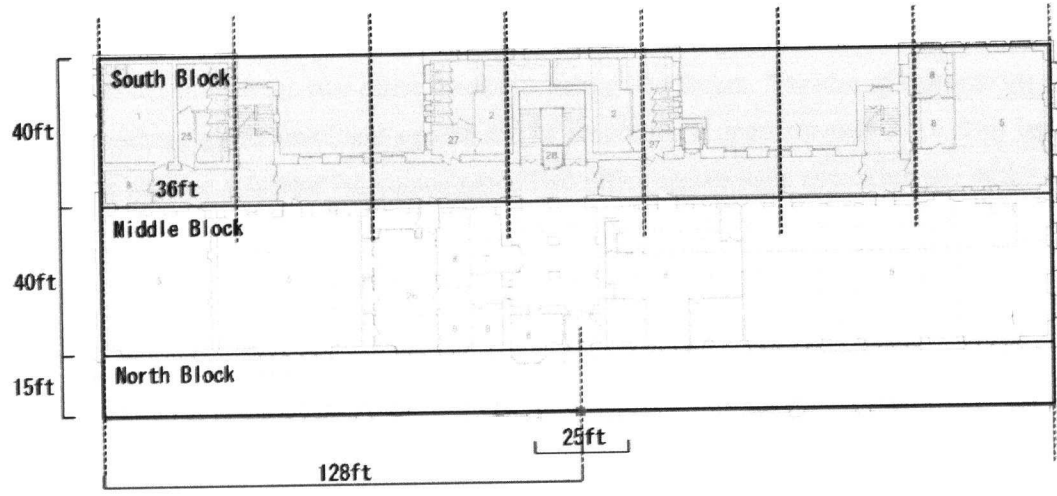


Fig07. Three Blocks and 1/7 Units

- Square
- 1:1.5 Rectangle
- 36ft Module

As description above, the entrance gate and stairs are located on the centre of the building. The fence which is structured by eight short stone columns, stone wall and steel fence surround outside of the north block. The composition of fence is almost bilateral symmetry. In other words, the north block is designed to aim symmetrical form. The span in between two columns is about 15ft in short part. It is expected that the span are decided by relationship to length of the side in the north block.

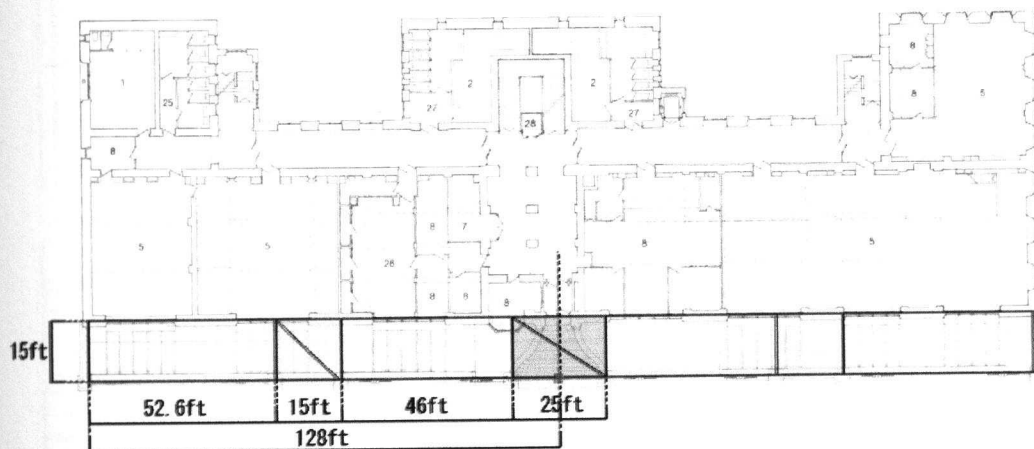


Fig08. The North Block

The middle block is main part of the building because of its use. In the 1st floor, the entrance foyer lies in between two office blocks including boardroom. The size of entrance block is 25ft by 40ft within a guard room, and a porch and its proportion is approximately 1:1.6. This ratio is well balanced because it is near the golden ratio. Two office spaces have approximately 40ft * 40ft square form. East space is divided into five rooms by partitioning walls to set boardroom, small offices and a shop. West space is use only for office and has a loft space as extended office space. Although there is a difference about partitioning, those two squares create symmetry. The other rooms are used for studio space.

The entrance block isn't located on the centre of the building exactly. The entrance porch which is on west side of north wall in the entrance foyer is set at the centre of building to link to entrance gate. It means entrance foyer is shifted from centre to east. This operation is the most important in the design process for this building. If two 40ft * 40ft squares are put the 36ft point from the east edge, the entrance foyer would come the center like the entrance gate in the north block.

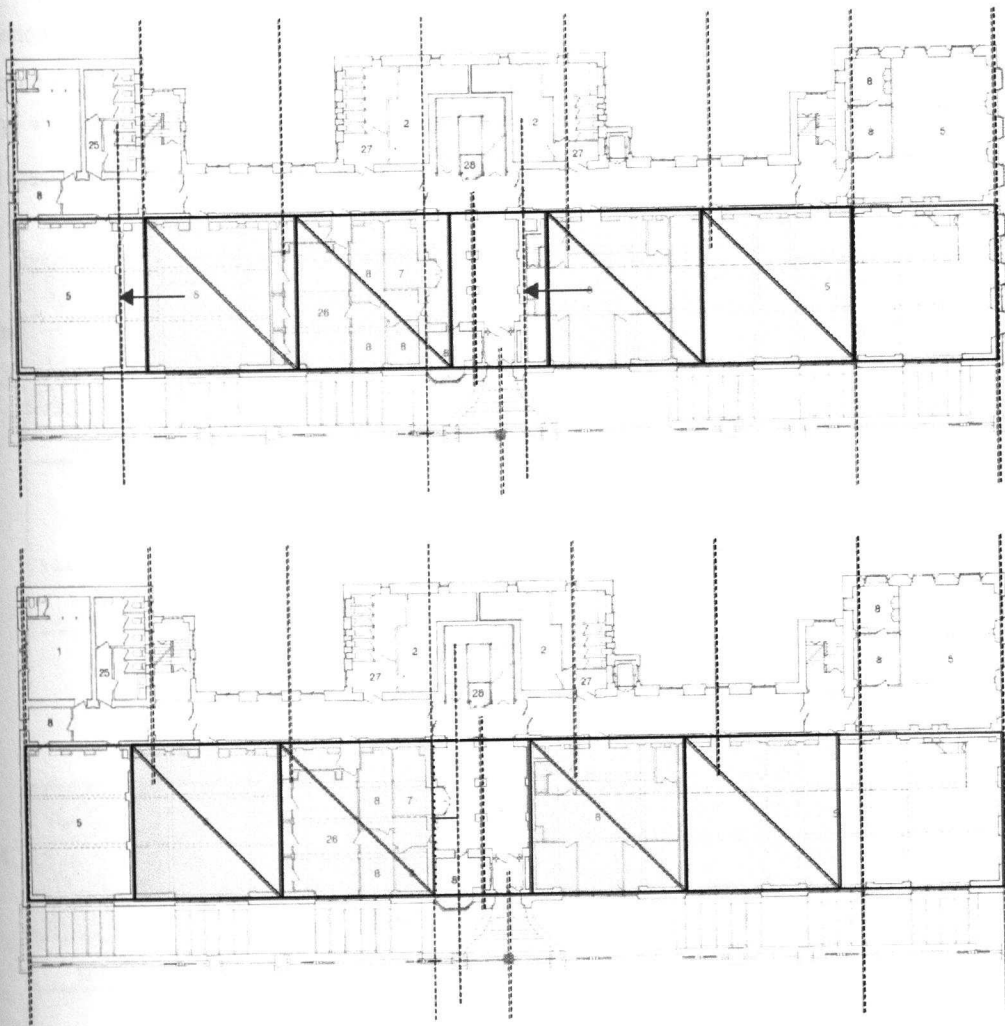


Fig09-10. Shifting Square Units

In the south block, three volumes are set on east side, west side and centre. And, a corridor connects three volumes. The east side volume has 36ft wide keeping the module of this building. The west side volume has 40ft wide square shape which is same proportion and size with the square in the middle block. This volume is used for special program such as, main lecture theatre in basement floor and a carefully designed library on 1st floor, therefore, the characteristic geometry and the size which are bigger than 36ft module are chosen. The volume at the middle has 20m width block and is used for vertical circulation, services, offices in basement and ground floor and the gallery space in 1st floor. The proportion of this block including corridor is what has never appeared in the planning. Thus, the way to decide the size and proportion has to be explained. First, this block is subdivided into vertical circulation in the centre and two parts on both sides of the central part. The vertical circulation is equal to the entrance foyer in proportion though its size differs from it. In other words, these two figures which are 40ft * 25ft rectangle and 32ft * 20ft are similar. An

information desk on the centre of the main staircase is an important factor composing the geometry of the central volume. The 6ft wide information desk is located on the centre in between staircases. If two 40ft * 36ft rectangles are lapped over each other for 6ft, the information desk appears on the lapped space. Then, the central volume becomes 40ft * 66ft rectangle shape.

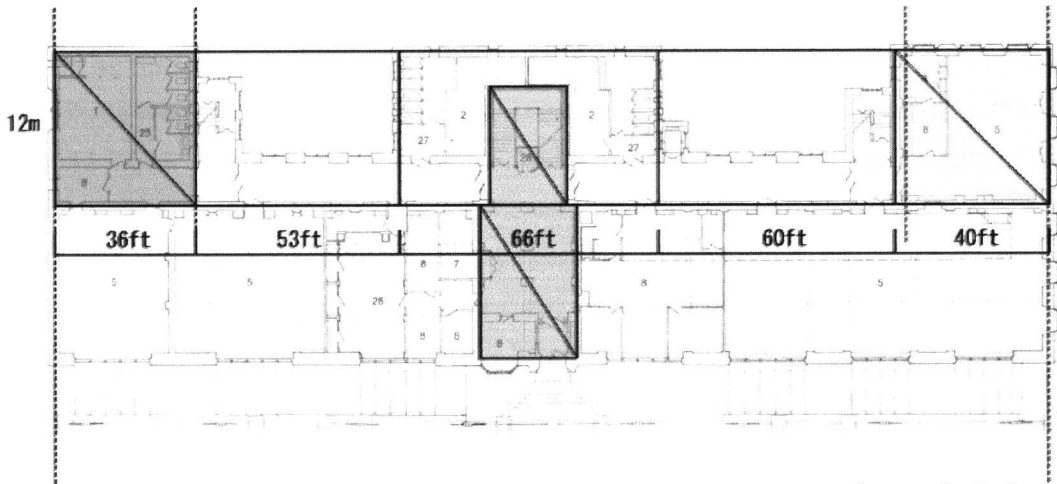


Fig11. The South Block

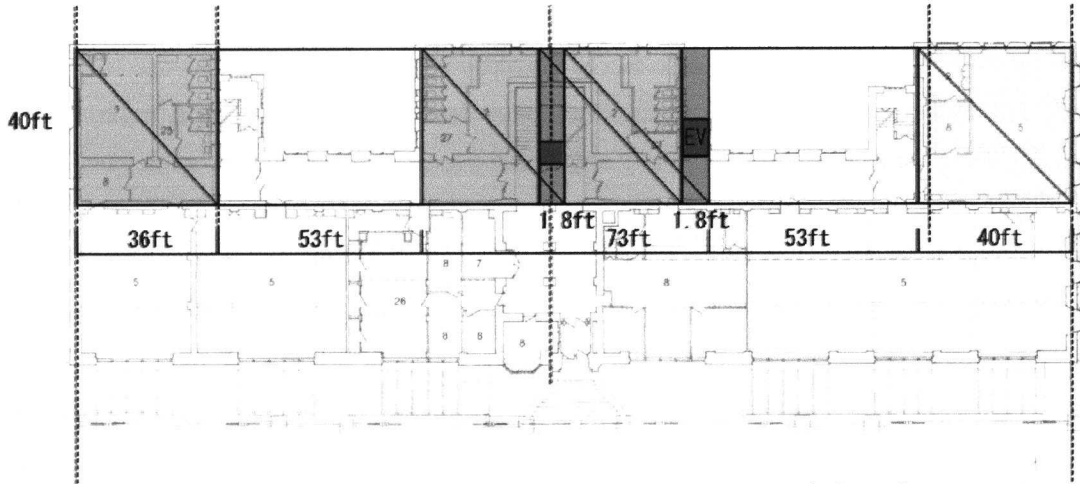
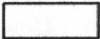

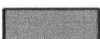


Fig12. Shifting the Proportion

-  Square
-  1:1.5 Rectangle
-  36ft Module

3. Analysis

Lined masses and voids create rhythm in the south block. However, it seems that the widths of three masses and two voids are irregular proportion. The widths excluding mass of staircases and lift are 36ft, 53ft, 66ft, 60ft and 40ft from east to west. In brief, the proportion is not symmetry. As the above examination, west volume has square shape for the special order. The central volume has 72ft which is double width of 36ft module and 60ft void decrease to 53ft if it includes lift which had been planned when Mackintosh designed 1st phase. So, the proportion is changed to well balance one, 36ft, 53ft, 72ft, 53ft, and 40ft.

According to the description above, the generating process of asymmetry composition on the plan are revealed. Mackintosh used the way that he shifts the main volume to east in order to break symmetrical facade. The module which is based on the total length of building is quit simple. Subdividing the total length to seven parts creates one important module, 36ft. Moreover, 25ft which is approximately one tenths of total width of the building is another important module. In this section, Mackintosh's thought will be reasoned. Also, the meaning of the operation, shifting, will be deliberated.

Glasgow School of Art was anticipated to be one of the most beautiful art school buildings in UK. Besides, it also should have enough quality of function. The composition which was planned by Newberry reflected classical art school's building in this generation. In fact, Glasgow School of Art had a quite similar plan to Manchester School of Art (1881) which is one of the reference case studies. Some requests for function have been satisfied based on the plan which is referred from the examples. It is expected easily that Mackintosh was seeking the epoch-making way to make the building be superior to others. Then, he conceived a bright idea, shifting volume, as an approach to beauty and originality. Instead, the new art school in Glasgow needed to have classical beauty as well as cutting edge beauty. Therefore, Mackintosh cleverly controlled the façade design between symmetry and asymmetry.

A fence which is made of stone and cast-iron on the north part of building surrounds the top-light which is created by setting back the main volume of building. Although main volume of the building breaks symmetrical form, this characteristic fence including entrance gate and stair has symmetrical composition completely. It means that Mackintosh didn't discard the symmetry for this building. He knew that the centripetal force by symmetry is necessary for this building. Therefore, it is considered that the approach should be set on the centre and the fence and design of entrance must be symmetry. The middle block on main volume is shifted from centre to east. However, on the plan drawing, simple and conspicuous square units are located each side of the entrance foyer. As a result, it is regarded that the composition on plan is close to symmetry. The distance of move is small, approximately 6ft, just to line on the basic grid, 36ft. It is a little operation if 6ft compared with total

length, 256ft. This modest way succeeded to keep good balance between symmetry and asymmetry. On the south block, shifting is found. The central part which is formed by main vertical circulation and two rooms around it are located on same grid with the middle block. It means that this block is shifted 6ft as well as the middle block. There is a rhythm of lined mass and void. The composition is two voids are inserted between three volumes and the largest volume is placed on the centre. Therefore, it is thought that Mackintosh might make the composition of the south block be symmetry. Dividing south-east block on the ground floor into two rooms which have different programs also tells us what he wanted to create the composition.

Conversely, 40ft square room appears on the south-west block which has a lecture theatre on the basement floor and a library on the 1st floor. This unit is same with one on the middle block. The size of this room destroys the proportion of the south block. Two reasons are guessed to this incident. Firstly, the reason is based on its program. The library was the most important room in this building for Mackintosh. Actually, the essence of his design is condensed into this room. Even structural device which he rarely used is realised in this room and upper floor. So, this mass including the precious room needs to have characteristic shape. A square shape is not only prominent geometry, but also basic unit of the building. Mackintosh aims to adapt the special block to the geometry of this building by choosing the square shape. As another reason, it is brought that the west part of the building is stretched because the main volume including the middle and south blocks are shifted to east. In other words, it is necessary to increase the width of the south-west block in order to proportionate whole the south block. This proportion is relevant to south elevation of the building.

Chapter 3: the Composition of the Main Façade

1. Introduction

The façade is composed by five parts which are fence, the central part, the west wing, the east wing and penthouse. The fence covered the top-light of the basement floor as the last chapter explained. The central part is the significant part for the façade of this building because several design elements are assembled there. It is necessary to analyse the geometrical regulation of composition including these spread elements. The east wing and west wing is composed by stone wall and large size of windows collects natural light to studio space. Therefore, these windows have important mean on the composition of the façade. The 2nd floor has glazing skin on the front wall. This square grid sash emphasizes transparency of volume of penthouse. This chapter aims to consider the composition of façade drawing by analysis of separated the five parts.



The Main Façade of Glasgow School of Art

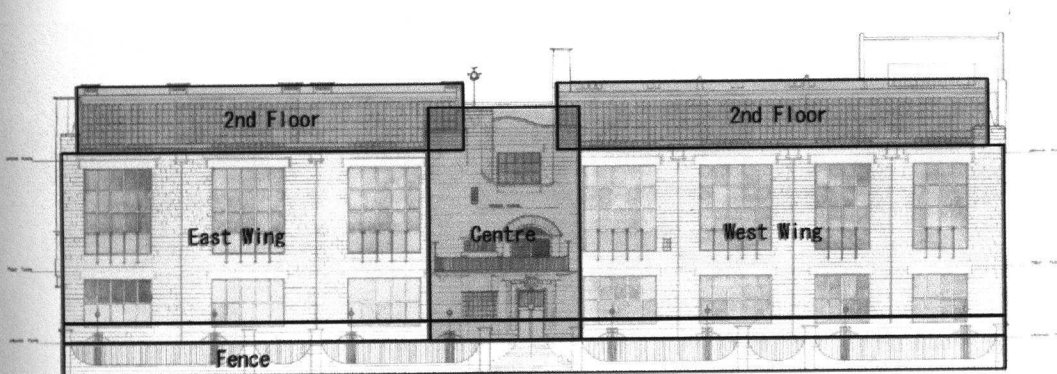


Fig13. Five parts of Façade

2. the Fence and the Gate

The fence is constructed by stone and cast-iron poles. Stone columns are settled and low wall which are shaved off to curve form are in between columns. Then, cast-iron poles which are workmanship design stand on the stone wall. As the description of the last chapter, the fence has symmetrical composition. Generating process starts from the entrance gate at the centre. Then, the position of stone column which is third one from east end is aligned with the edge of office room next to entrance foyer. This axis is appeared by shifting the volumes. A span between this column and next column which is second one from east end is approximately 17.5ft (5m). The length is same with depth of the north block. So, the position of stone columns has been defined already though the position of some ornamental iron-cast poles needs to explain about. The iron fences which are constructed by two noticeable cast-iron poles and low steal fence are set on wide space between stone columns. These ornamental poles have a pointed form on top the edge and a circle sculpture below. The position of the poles is relied on the distance in between stone columns. An iron-cast pole is located on the position of 1.5 times of this length from the second stone column. Next pole also stand 26.5ft away from the first pole. A rectangle which is made by the length and the height of the pole, 17.5ft has the 1: 1.5ratio. So, the length, 9.1ft (2.8m), between the stone column and the cast-iron pole is basic span in between them.

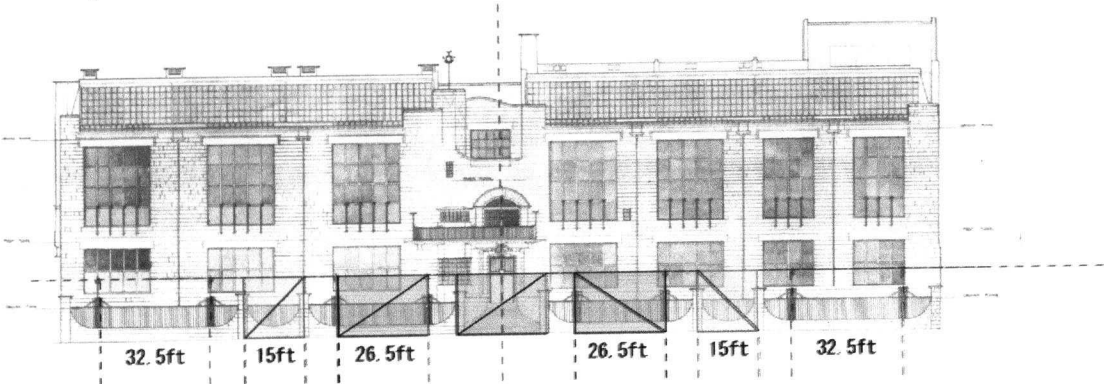
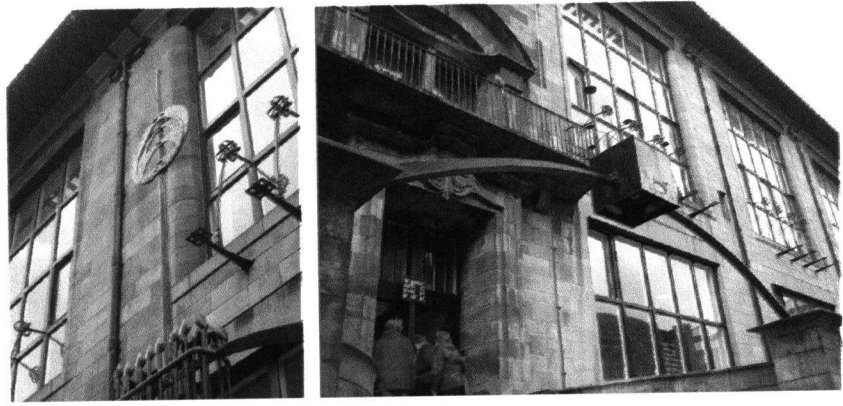


Fig14. Composition of the Fence and Gate



the cast-iron ornament & the Lamp on the Gate

3. the Central Part

This part has quite important mean for façade design because of the characteristic composition. It divides the façade to east part and west part. Then, the entrance door which is approached through entrance gate and stair is located on the part. The deep ornament is carved around the door in order to emphasize Mackintosh's originality. In addition, the door is located the centre as well as the entrance gate exactly. If a square are made of the length of entrance gate, the figure covers all elements of approach which are composed by the entrance gate, the entrance stair and the entrance door. Above the entrance door, there is a large window which is combined a square and an arch form. The window is for the director's room. As a room for the high-ranking person, the exterior is designed carefully. The position of the window is on the central line as well as entrance door. It means that the director should be stand center of the building because she or he is the man of Glasgow School of Art. The plan and section drawing explain the represented sequence to the room. The height of top edge of the window is 1.5 times by the height of top edge of the entrance door. In other words, the rectangle which connotes the window of director's room and all entrance elements has a 1:1.5 proportion.

The most popular module is also square in the central part. Square forms are found not only in entrance gate, but also composition of the central part. The rectangle which is made by connecting the edge of windows on east-wing and west-wing is 43.5ft * 43.5ft (13m * 13m) square form. In that case, width of the central part is equal to height of the windows on both wings. In addition, the height from the ground level to the window on the director's room is 43.5ft as well. Therefore, the square appears on the ground level. Then, there is one more 43.5ft square in the composition here. The length from the top edge of small window on both wings to the top of the central part including parapet is 43.5ft. Although the roof line is formed curve, the roof top is covered by the square clearly.

The detail of façade on the central part also has the geometry, square. The bay window of the director's room including a sticking out wall has a shape of square. This small bay window leads natural light into the bath room for a director. Similarly, the studio for a director on the 2nd floor has square shape window and balcony which has handrail. A figure of wall which is shaved by the handrail is square as well. Besides, the highest wall on the façade at the central part can be explained 1:1 proportion.



Main Entrance on the central part

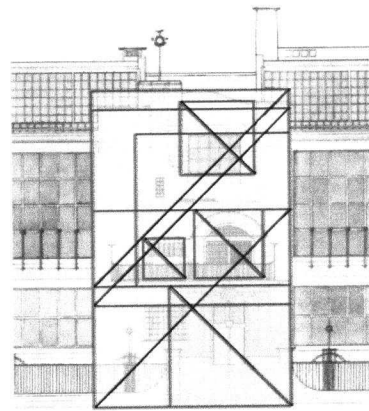


Fig15. Composition of the Central part

4. the East Wing and the West Wing

The east-wing and west-wing will be analysed together because they are based on a same theory. Before we look at the elevation drawing for analysis, the position of windows on the plan is described about. The ground floor and 1st floor have seven large windows each. They are set on studio or office spaces to get modest natural light from north. To decide the position of windows, the modules, 36ft and 25ft, which are found before are used. East side of north façade from centre has three windows on each floor and the first window nearby entrance foyer is located on the place which is 11m from the west wall on entrance foyer. Then, next window and last window are also set on 11m from the first window and the next window. West side of north façade from centre has four windows on each floor. The first one is on same line of west column on entrance gate. Somehow, the second one is placed 11m from the west wall on entrance foyer. Therefore, the span between first window and second window on west side of north façade are shorter than it on east side of north facade. Third window and fourth window use the module of entrance gate, 25ft. From west end of building, two windows line on 7.5m pitch. Thus, the spans between windows are integrated to same length.

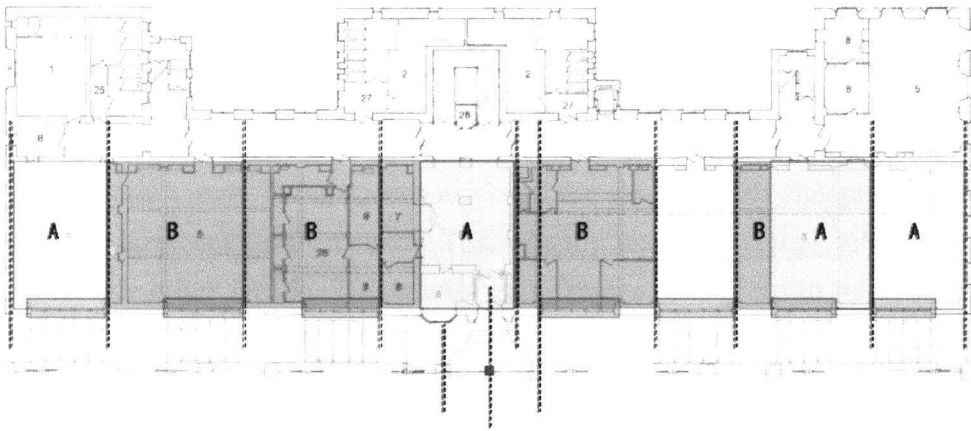


Fig16. Position of the windows on plan

Then, the windows' shape, proportion and positioning on the elevation will be explained. Seven pairs of large windows are lined on the north elevation as a description of above. There are two kinds of size and proportion in seven pairs. Five pairs are composed by 1.3ft * 2ft (4m * 6m) and 2.3ft * 2ft (7m * 6m) windows. Small window, 1.3ft * 2ft (4m * 6m), is 1:1.5 proportion which is the popular ration in the design of this building. The height from the top edge of small window to large window's top is 9m. So, the figure has 1:1.5 ratios as well. Besides, the height in between the bottom edge of two windows is 2ft, therefore, the figure is square.

The other two pairs have narrower proportion than five pairs whose generating process is illuminated above. The Four pairs of windows including wide pairs and narrow pairs are distributed onto east side of façade equally. The range in between pairs of windows is about 11ft (3.3m) for all. There are waterspouts at the centre of the space between windows and it divides half of the space. The narrow pairs are relied on the line of waterspouts. There is the 1: 1.5 rectangle around smaller windows bellow if it is measured that from the waterspout's line to west-edge of window. Besides, larger windows are based on this geometrical system as well. All pairs of windows are set on the same height, 13.3ft (4m), with the window's own height. Consequently, the 1:1.5 rectangle appears under the window again.

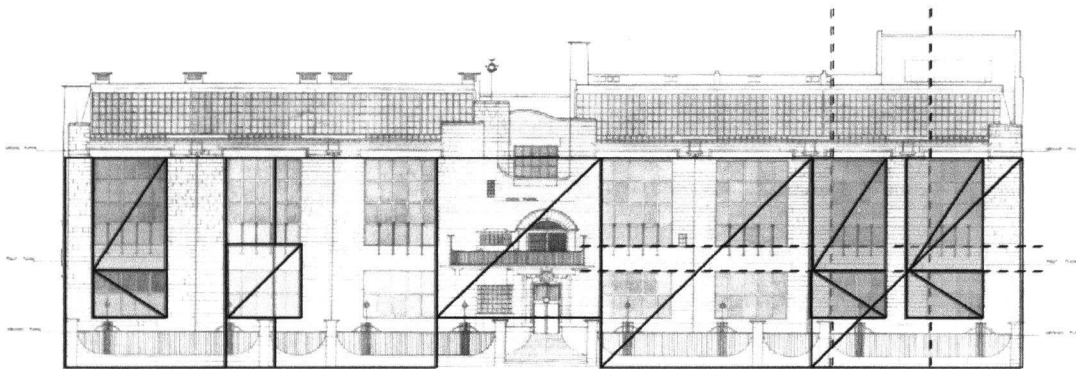


Fig17. the size and proportion of windows

5. the 2nd Floor

There are two transparent volumes on the main building which are consisted by the central part and both wings. These spaces are used for studio which can get a natural light through the large transparent skin. This glazing skin has completely different taste of design from other façade. The square grid frames hold glass in position. The span, of grid, 1.8ft * 1.8ft (540mm * 540mm), is much smaller than other window frames such as, the large window on the ground floor and the 1st first floor, 3.8ft * 5.9ft (1.1m * 1.7m). This module is calculated from the width of volumes which are created by planning on 1st floor. Each cell has uniform size to express the equality.

Next, the volume control will be explained about. The mass of the rooms are set back to north for 10ft (3m). Therefore, a wall of the central part doesn't reach the glazing wall of the 2nd floor. The spaces which are created by setting back would be terraces with top-lights for rooms in 1st floor. In addition, wooden eaves protrude from the terrace on 2nd floor. The depth of eaves is 5ft (1.5m). So, the edge of eaves comes out of the central part forward. If the terrace and eaves are put together, the depth of it will be 16.5ft (5m) which is as long as the depth of the north block on the ground floor. Besides, the position of top-lights is relied on the large window on ground floor and 1st floor. In brief, the modules are unified with the other part of the building.

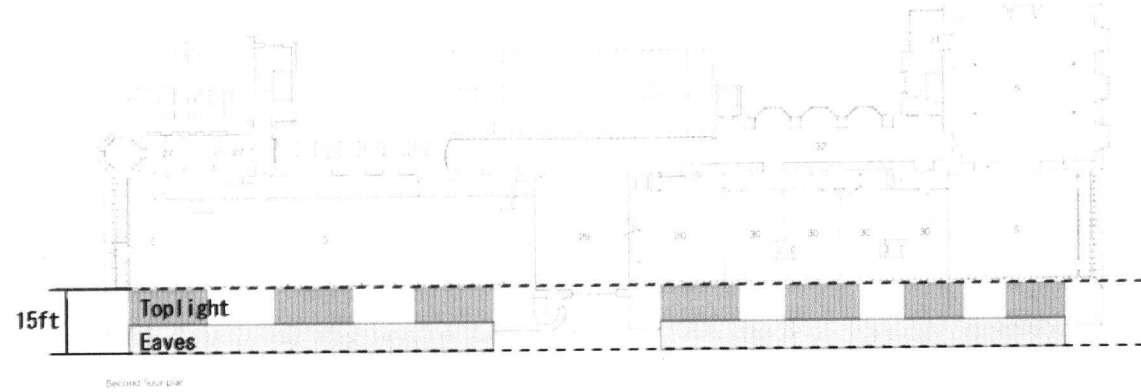


Fig18. Eaves and Terrace on the 2nd floor

6. Analysis

6. Analysis

Before "the domino system" was defined by Le Corbusier, façade had been designed for superficial ornament mainly. Skin could be separated from structure because of the development of technology. Conversely, the classical masonry structure of this building restricts the freeness of façade design. Hence, the open elements in particular, windows and doors, have to come the place where is not on the structural grid. The generation of Mackintosh had already had the modern building technology such as, reinforced concrete structure and steel frame structure at that time. Yet, the façade of Glasgow School of Art is still dominated by structural restriction. In fact, Mackintosh tried to create composition of the façade without using any structural methods. Seeking the composition of façade is a part of thinking for modernist. Actually, Colin Rowe mentioned that a façade is not only the elevation, but also shows a character of buildings. Then he preached the importance of composition related to character.

A truly significant building for these theorists is not an organization derived from functional and structural disciplines-although these may have contributed to it. But a truly significant building is preeminently a structure, organized according to the principles of architectural composition and infused with a symbolic content which is usually described as character.⁴

This consideration aims to reveal the mean of façade of Glasgow School of Art and assume the thinking of Mackintosh about façade design.

Mackintosh avoided making façade of the building fall into an old fashion design because he had been tried cutting-edge experiment for his architectural design.

He contrived to break symmetrical façade by using several ways for instance, shifting units on the plan, control the size of windows on the main volume and the well elaborated details on the centre part of façade. As the last chapter described, the manipulation of making asymmetry is the most important fact in this design of building. It is not only breaking the symmetrical façade, but also to reconcile symmetry with asymmetry. Because, when the building communicates to city and people as a significant art school building in Glasgow, symmetry is effective geometry. So, Mackintosh made the symmetrical fence with the entrance gate instead of the

⁴ C. Rowe, The mathematics of the Ideal villa and Other Essays, Character and Composition, page 62 line 1-6

asymmetrical composition on the main volume. In addition, some of modules which are used for fence design are similar with on the plan. The spans in between stone columns are decided by the 1:1 square module which is found on the plan analysis often. In the same way, the extraordinary cast-iron poles on the fence are placed being based on the 1:1.5 ratio which is also popular units for this building. This kind of cast-iron ornaments are spread out façade. In the case of the fence, the poles which are described as a starting point for finding 1:1.5 ratio has a circle shape decoration on the top. Furthermore, the entrance gate consists of stone columns, a steal frame and an ornamental ramp made of steal plate. The light bulb are covered cubical box which has pattern of oval shape is designed very well and represents character of Mackintosh's design. Then, the position of the ramp is exact centre in order to emphasize the symmetry. Moreover, Mackintosh chose the elementary geometry, a square, for the ramp again. Having chosen a cube which consists of squares prove what his geometrical principle is mainly square (1:1) for this building.

The central part of building shows the city a complex face in comparison with the other part of façade such as, the fence, the penthouse and both wings. This complexity is made of lots of elements which are quotation or imitation of other European architecture. The similarity of the elements has been already referred to by researchers in particularly, Dr. Howarth, R. MacLeod, D. Walker. Actually, H. Kimura indicated that Glasgow school of Art resemble the house at Place Court, London in 1892⁵ by J. MacLaren in the balcony with bay window and arch window for the director's room. Besides, he mentions about the similarity of the stone entrance and form of the fence of Glasgow school of Art to Mary Ward's House by D. Smith & C. Brewer in 1895.⁶ So, this consideration will guess the reason and intention that Mackintosh used the kinds of design for his building as a reference.

Actually, the composition of balcony design for the director's room in Mackintosh's design imitates the house at Place Court. In the case of the house at Place Court, the window with arch is located on the centre of the house. This window is namely set above the entrance door. Besides, the position of bay window is moved from centre to the left from a front view in order to align of the window on the ground floor. Thus, the balcony only connects the centre window and left side bay window without any elements on the right side. Glasgow School of Art has a same structure of the balcony to the house at Place Court. It is possible to hypothesise that the composition of

⁵ A. Kimura, *Process Architecture* 50th : Charles Renew Mackintosh, page 95

⁶ A. Kimura, *Process Architecture* 50th : Charles Renew Mackintosh, page 95

the façade is suitable for Mackintosh's plan. The window with arch is for the important director's room, therefore, it must come the centre of the building. However, Mackintosh avoided making the central part become dominant or high-pressure existence. The balcony design of the house at Place Court is effective for not only breaking the symmetry, but also organising the façade design. Hence, the factor participates in the design of Glasgow School of Art.

On the other hand, the vertical line on bay-windows at the left from a front view shows us importance. There are a small window for a staircase inside of the director's room, a stone tower on façade and an ornamental pole on this line without two bay-windows. These elements express the diversity of Mackintosh design. Though, his design doesn't lose the integrity. The all elements which are arranged on a line are inserted to the central part. If the central part is observed without these elements, the façade consists of simple parts of design. The volume of the director's studio is set back and a terrace is created above the window with arch for the director's room. This control of volume reduces the massive feeling of building and gives diversity for façade. Still, the central part has simple face with a flat and massive wall on the left side of the entrance door from a front view. The inserted elements, bay-windows, a tower and a pole, don't destroy the harmony of façade design, but succeed to gain the balance. Some buildings are likely to lose the integrity instead of the variety on the façade design. In other words, they lose the composition instead of obtaining character. Colin

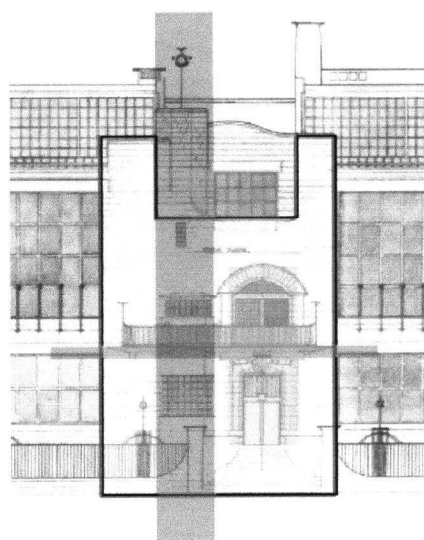


Fig19. composition of the central part

Rowe indicated that the architecture with character could have beauty in the generation after classical style architecture.⁷ Because, he prove that composition and character as architectural vocabulary influenced academism in the age. Mackintosh solved this problem by imitating the successful idea and by arranging relied on the geometrical principle.

The 2nd floor makes an impression for people who look up the façade. The 2nd floor is put on the main volume with setting back for 10ft (3m). Besides, eaves above the

⁷ C. Rowe, The mathematics of the Ideal Villa and Other Essays, Character and Composition, page 65 line 29

main volume divide main volume and the 2nd floor. Therefore, the volume of 2nd floor looks like a penthouse. This volume has the unusual design by glazing skin in this building. Although the other spaces consist of stone wall and windows, the façade of the 2nd floor is covered by transparent material eminently. In other words, this "penthouse" has essence of the modern architecture because of a large transparent skin in comparison with the other parts. Besides, the curious method of setting frame is found. The glazing wall is on 2nd floor held the square grid frame. The geometry is square for the frame in spite of the fact that the large window is held by rectangular frame. The rectangular frame for the large windows on the main volume gives a sense of vertical direction for people. Square which is a principal geometry to Mackintosh's design exclude the sense of direction instead of getting centripetal force. Mackintosh thought the 2nd floor ought to have flat and primitive facade as an additional volume. Hence, square grid is used for the façade of the 2nd floor. In the same way, eaves on the main volume and a roof on the transparent volume which can be seen from the front of the building express the flatness and simpleness of the modern architecture. Although the other rooms in particular, the director's studio, the gallery on the 1st floor and the library in the south-west part have pitched roofs, the visible eaves and roof on the façade are almost flat.

Chapter 4: The Similarity with Scottish Castle

1. Introduction

The south elevation of Glasgow School of Art shows traces of a long deliberation about massing. The sand coat skin which is a usual material for Mackintosh covers whole the south elevation. In comparison with rich materials, cast-iron and lime stone, on north façade of the building, the plaster work by sand coat on south elevation gives us modest impression. In fact, this face is invisible to city due to obstruction by the other buildings which stand along a next street. Therefore, it is no wonder that an inexpensive material is used for the exterior. However, Mackintosh tried to secure the quality of elevation design by operation of volume. He controlled the proportion of masses and voids by shifting the units as stated the 2nd chapter. In addition, a design of the Fyvie Castle is quoted in order to arrange the elevation. The similarity with the Fyvie Castle, Aberdeenshire is indicated by researchers and critics. Frank Arneil Walker who is one of the researchers explains about the similarity 'Mackintosh's drawing shows a similar solid: void relationship and aggregation of symmetries to those evident at Fyvie'.⁸ He also emphasize that the Fyvie Castle is one of the representative Scottish architecture. However, the composition of the south elevation is not symmetry actually. It is necessary to compare the proportion between Glasgow School of Art and the Fyvie Castle. In this chapter, the similarity of proportion between one of the typical Scottish castle architecture, the Fyvie Castle, and Glasgow School of Art will be discussed mainly. Besides, the south elevation of the building will analysed grounding on the geometrical point of view.

First, this section will consider about the operation of shifting units. The middle block where was defined on Chapter 2 is shifted to east for 6.4ft (1.9m) in order to break symmetrical façade on the north side. The south block is led by movement of the middle block. As stated the Chapter 2, the proportion of masses and voids on the plan drawing are arranged to the symmetry by putting a lift volume aside of the central part. Alternatively, if the central part in the south block is replaced on the centre, it will be observed that a primitive composition of the design. The ratio before being shifted is 0.15: 0.22: 0.26: 0.22: 0.15 if total length is defied to 1. Then, the ratio of sifted volumes is 0.16: 0.23: 0.26: 0.20: 0.15 against total length as well. It means that the proportion of the central part and the south-west volume has not change from before sifting. In other words, the difference is only the position of the central part without the size of the

⁸ F.A. Walker, Charles Rennie Mackintosh The Architectural Papers, page 34

south-west part. The south-west part consists of three important programs, the largest lecture theatre in this building, the hanged gallery and the library. Therefore, this part was given a larger volume than the south-east part.

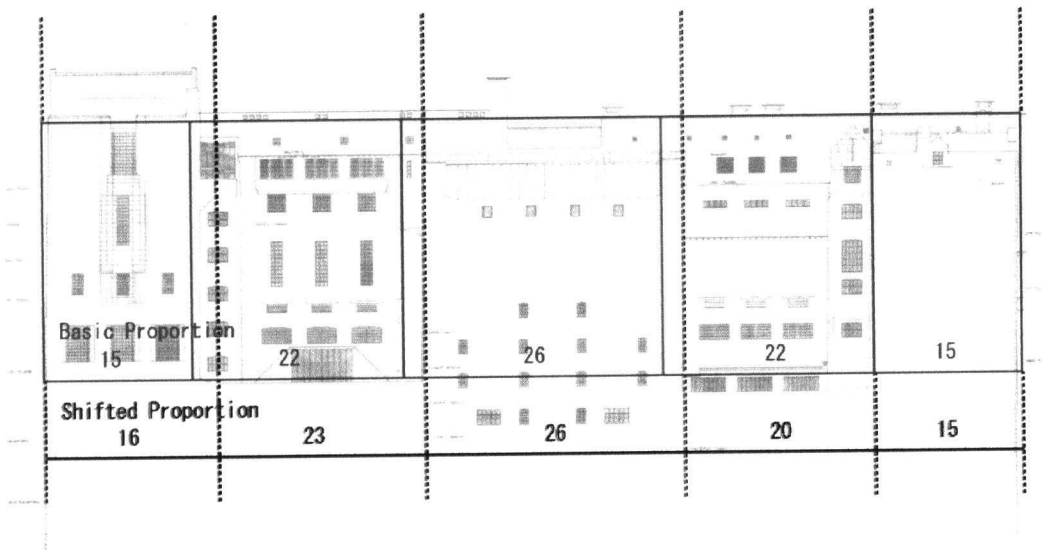


Fig20. comparison of proportions

Secondly, the design of the southern elevation will be compared with a traditional Scottish architecture, Fyvie Castle. For this analysis, a famous essay, "The Mathematics of the Ideal Villa", by Colin Rowe is important reference. He indicated the similarity of proportion on the structural grid between Villa Capra-Rotonda, Vicenza by Andrea Palladio and Villa Stein, Garches by Le Corbusier.

Then, further to this, there is a comparable bay structure to be observed. Each house exhibits (and conceals) an alternating rhythm of double and single spatial intervals; each house, read from front to back, displays a comparable tripartite distribution of lines of support.⁹

He mentioned about not only the rhythm of proportion from left to right, but also the way of subdivision from front to back. In the case of comparison between GSA and the Fyvie Castle, the proportion of elevation will be analysed.

⁹ C. Rowe, The Mathematics of the Ideal Villa and Other Essays, page 4 line 1-5

2. Analysis - Comparison between the Fvyie and Glasgow School of Art

This Fvyie castle's façade consists of 5 parts, three protruded volumes and two stood back volume. In other words, three masses and two voids are abstracted from the composition of the façade. It means that the composition is similar with Glasgow School of Art. The ratio of these volumes' width is $0.17 : 0.21 : 0.28 : 0.18 : 0.16$ from west to east if total length is defied to 1. When the ratio of south elevation of Glasgow School of Art, $0.16 : 0.23 : 0.26 : 0.20 : 0.15$, are compared with the ratio of the Fvyie Castle, curious similarities would be found. At first, both proportion is asymmetry as the ratio shows. Besides, a volume and a void on west side are wider than on east sides. In fact, the ratio of the east mass and void also resembles the west mass void of each elevation obviously. In brief, they have same rhythm of proportion. In addition, asymmetrical composition had been used for a traditional Scottish architecture in early seventeen century.

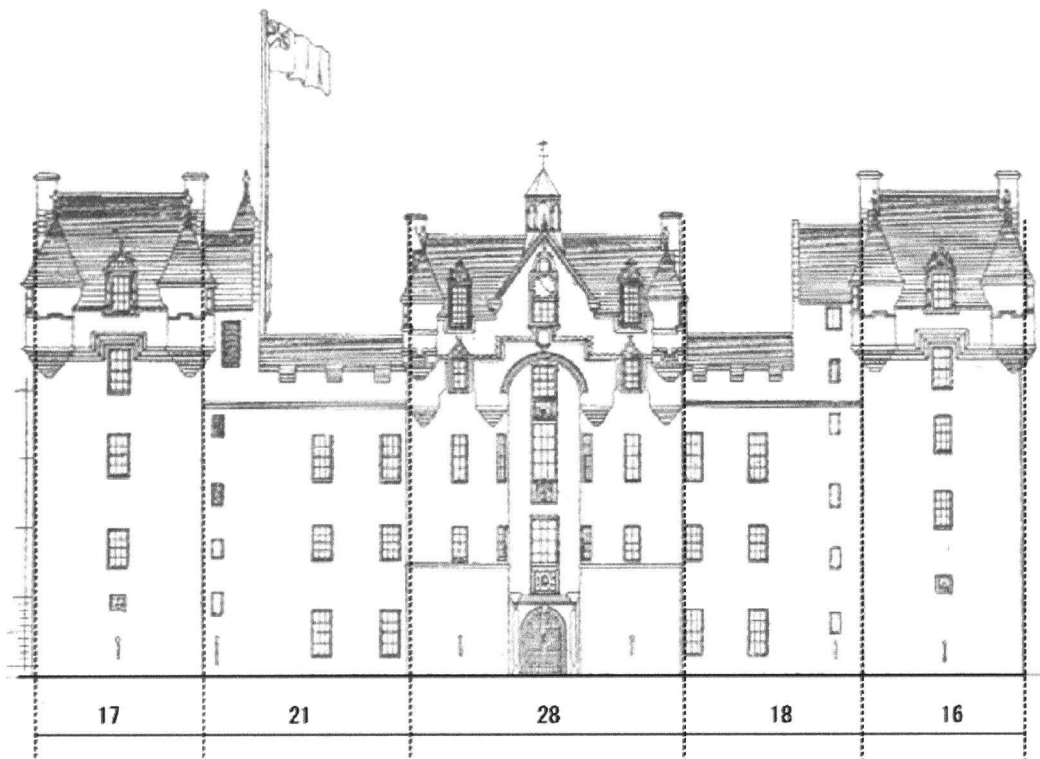


Fig21. proportion of the Fvyie Castle

This curious similarity gives a truth about Mackintosh's design. As a description above, the similarity of composition has been talked already. Actually, people must mention the likeness between two elevations at sight. Instead, this composition might be regarded as symmetry substantially because of its little difference

of ratio. Mackintosh was influenced the composition considerably due to the fact that ambiguous asymmetrical forms are found on both elevation. It is not exaggeration that this elevation design is mimicry. However, the east part and west part of Fyvie Castle have almost same design of windows and ornaments on wall though Glasgow School of Art has distinction between the south-east part and south-west part. Although the wall on the south-east part is blank, the south-west part has ornamental windows on its south wall. It is clear that Mackintosh tried to make asymmetry by the ornament which is his strength. Likewise, the differences with the Fyvie Castle are made by this operation.

3. Analysis - Process of Generating Façade.

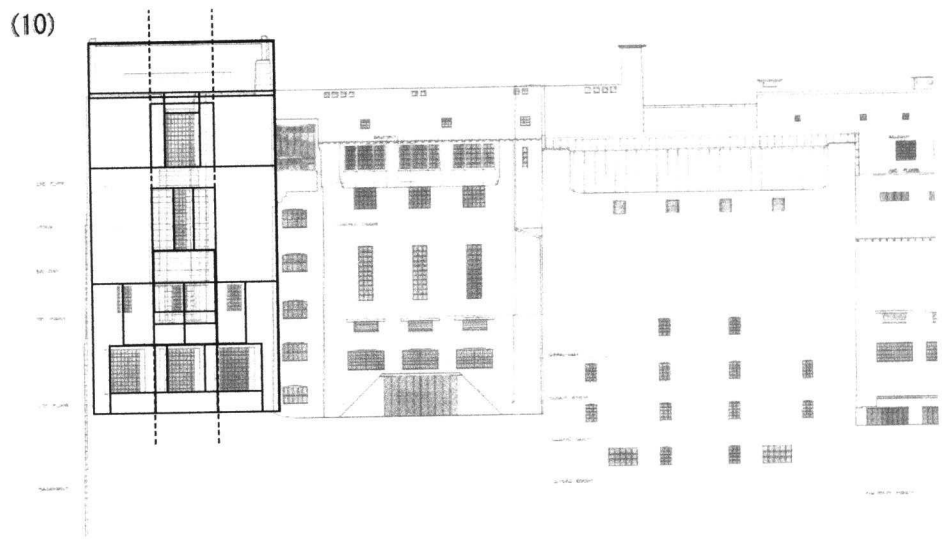
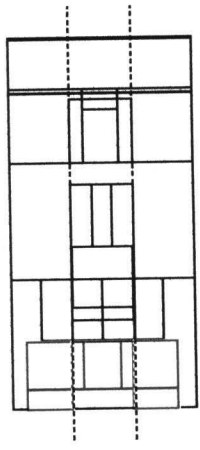
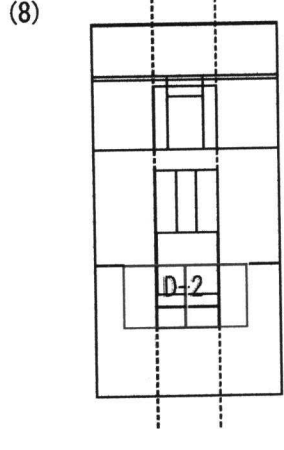
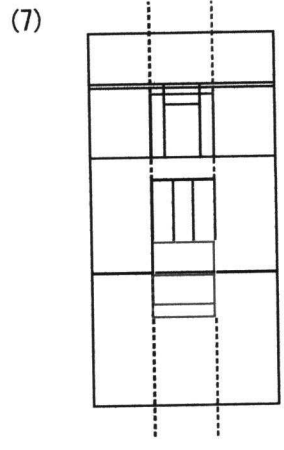
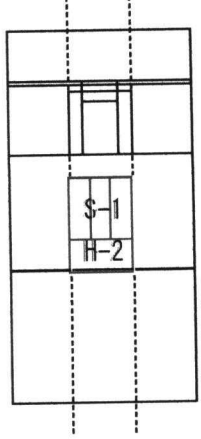
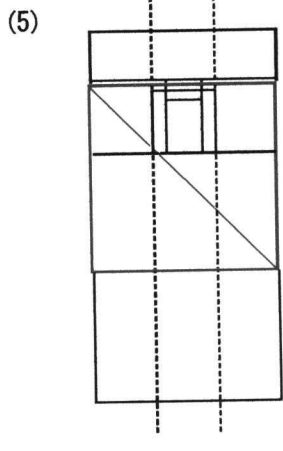
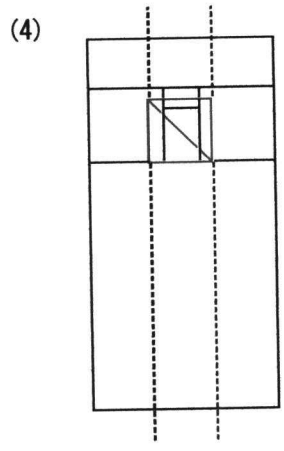
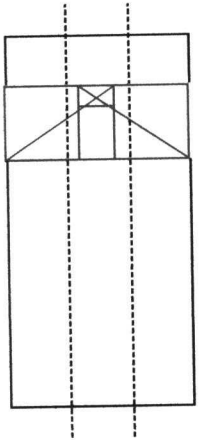
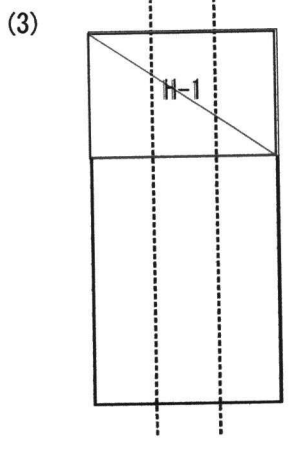
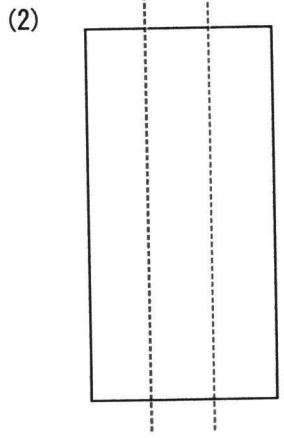
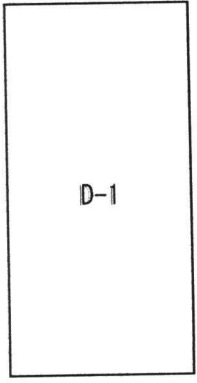
Next, the composition of the southern elevation of the south-east part will be analysed. This elevation is needed to be designed carefully because of the importance of the programs. Hence, the location of windows and ornaments around them are considered as well as the façade. In fact, the exterior material around windows is lime stones which are same with façade though the other walls are covered by sand coat. The basis of the windows' position is obviously the centre of the part. Thus, the face shows people an exact symmetrical composition. The generating process of the composition is described the follow.

- (1) The figure including the plane from bottom to top of roof is set to 1: 2 rectangle. This figure will be called "D-1" from now on.
- (2) D-1 is subdivided into three parts on the vertical direction. These three parts will be called "the strip" from now on.
- (3) To set 1: 1.5 rectangle putting its longer side together the top side of D1 in order to decide the bottom edge of the window on the 2nd floor. This 1: 1.5 rectangle will be called "H-1" from now on.
- (4) The long side of H-1 is subdivided 1: 1.5. The lines which are decided by the subdivision of 1: 1.5 become the basis of the window's width on the 2nd floor. Besides, the size of the window is defined by the 1: 1.5 ratio.
- (5) The height of the wall on the both side of the window is decided by the squares which are created being based on the subdivided lines.
- (6) Setting a square putting its top side together the top side of the walls makes a base line of three windows for the library.
- (7) 1: 1.5 rectangle (H-2) which has width of the strip is located on centre of the base line. H-2 connotes a square (S-1) inside. Besides, other two 1: 1.5

rectangles which have same height with S-1 are lapped over each other. Consequently, a window for mezzanine has been formed.

- (8) Another square whose size is same with S-1 is placed at the centre of the base line. As a result, the height of bottom side of three windows for library is decided. The width of these windows is same with the window for mezzanine. Furthermore, ornaments around the centre window of three is placed lower position which are defined by 1 : 1.5 rectangle.
- (9) 1 : 2 rectangle (D-2) whose short side is same with height of S-1 is set under the base line for three windows. The centre of D-2 is fitted on centre of the base line. Both edge of this rectangle defines the position of two windows for library.
- (10) The height has been defined by reducing the length which is same with S-1 from the height from bottom of H-1 to the base line for three windows. Then, the two 1 : 1.5 rectangles which have this height are placed at the side of the strips. From the corner of these rectangles, 1 : 2 rectangles are appeared and lapped over each other. So, a figure is created on lapped plain as a window's form. The other two window for studio space on the ground floor has completely same form and are set at the corner of the 1 : 2 rectangle and 1 : 1.5 rectangle.

The main proportions of façade design on the south-east part are 1 : 1 and 1 : 1.5 as well as the proportions which are found on plan and façade. In addition, 1 : 2 proportion has been used sometimes as a derivation from 1 : 1 proportion. In this case, the design seemed to be composed on the basis of uncomplicated system because of its symmetrical elevation. In fact, the figures which are found on the analysis are made of only simple geometry such as, square, 1 : 1.5 and 1 : 2 rectangle. Basically, these geometries are used for decision, but, there are two more important operations. Subdivision the plain into three parts and lapping over two figures are significant operation to give diversity on the design of the elevation. The composition of elevation is symmetry as main elements, windows and ornaments, lines on the centre. The stripes which are created by subdivision defined the width of central elements. Besides, the position of windows for the library and the studio is also based on the vertical line which divided three parts. Lapping over two figures can make a new figure on the centre. The windows for mezzanine of the library and studio are formed by this operation. In conclusion, these two operations and three proportions create the composition of the elevation. Also, they are definitely in the geometrical principle throughout the design of Glasgow School of Art.



Chapter 5: the Transition of Design on the East and the West Facade

1. Introduction

Glasgow School of Art shows the different aspect between the façade of east and west. These two façade have almost same size of plane because the volume of the building has a hexahedron shape basically. However, they look that two façade are designed by the distinct way. The proportion of surface area of walls to windows is one of the distinctions between east and west. The towering wall with some small windows in comparison on the east side impresses people as a solemn building with feeling of pressure. On the other hand, the west façade gives a graceful impression and a feeling of lightness in spite of the fact that it has massive wall. Two reasons are assumed that Mackintosh designed the different character on each façade. One is difference of programs behind the walls and the other one is transition of design style depends on ages. Programs on the eastside were not important for Mackintosh. In fact, it has only one significant room which is Mackintosh's room (nowadays, it is used for meeting room). On the other hand, the west part of building connotes three important spaces for instance, the largest lecture theatre, a gallery on the top floor and the library. Therefore, the west façade has a lot of well-designed windows and ornaments. As a result of two phase construction, the taste of design was changing from the east part to west part while two terms. The ornaments around windows on the east façade are modest and even surface. Then again, uneven frames of windows and bay windows appear on the west façade. In this chapter, the composition of the façade on east and west are analysed on the geometrical point of view. Besides, the intension of design by Mackintosh will be read.

2. the East Facade

Firstly, the composition of the east façade will be analysed on the geometrical point of view. This solid volume can be resolved into three parts, the north part, the middle part and the south part without the area covered by fences. These three parts are subdivided on the both side of windows on the central part.

The north part consists of a solid stone wall and only two windows because the room is used for a studio space which does not need shiny light from east. The 1:2 proportion rectangle which is the derivation from square is found on the wall. This rectangle is set from the bottom of building on the south edge. Both windows are located

below for the art shop on the basement floor. Without the basement floor, this part only has studio space behind of the wall on each floor. Northern window of two does not exist on the original drawing. It is probably on the shop drawing, and the existing building has the window. The position of southern window which is smaller than northern one is relied on the 1:1.5 proportion. If a 1:1.5 rectangle is put on the top of wall as a short side, the bottom side of the rectangle will be on the top side of the small window. Besides, the proportion of the small window is approximately 1:1.5. Then, the northern window is located on the same height with the southern window. In addition, a black-painted steel waterspout is settled on the wall as another impressive element on the solid façade. This long waterspout from the top of 1st floor to the ground is located on the place where is relied on the height from the ground floor level to the top of wall. One more 1:2 rectangle is found inside of the 1:2 rectangle which defined at first. The waterspout is on the line of south side of rectangle. In fact, this waterspout is cranked on the high position with setting a gutter because of a drainage reason. The cranked point is defined by 1 : 2 ratio which is created from the top left corner of the north part. Finally, a small pediment is set on the centre of 1:2 rectangle which is used for deciding the position of the waterspout. Its proportion is also 1:2. In brief, 1:2 proportion is dominant in this part as well as design of the south elevation.

The south part on the east façade is also composed by using the proportions which are appeared on the building. However, it is a little more complicated than the north part which is analysed above. In fact, the number of windows, eight, is much larger than these in the north part. Especially, an arch form window for a flat for guests and two long windows for Mackintosh's room (a meeting room) are significant because of means of the programs. The generating process will be explained on the follow as well as the case of south elevation in the last chapter.

- (1) Two square and one 1:1.5 rectangle covers the wall of the south part.
- (2) The wall is subdivided into three parts on the vertical direction.
- (3) In above square (S-1), a 1:1.5 rectangle based on the subdivided length is set on the centre in order to decide the size of window. Besides, the square which has same width defined the height of the arch. The arch is formed by another 1:1.5 rectangle (H-1).
- (4) S-1 is subdivided into two parts by 1:1.5 ratio. This section line becomes the basis of the two long windows for Mackintosh's room (the meeting room). The horizontal position of long windows is defined by 1:1.5 rectangle on both

edges of the south part. The form of two windows is 1:2.5 which ratio is combination 1:1 square and 1:1.5 rectangle.

- (5) The base line (BL-1) is set on below square being relied on 1:1.5 ration on horizontal direction. In, addition, another base line (BL-2) comes to the centre. Both base lines decide the position of four windows.
- (6) An extended line from the right side of H-1 meets BL-1 on the corner of a window. A 1:1.5 rectangle is set there as subdivision line is the centre. Similarly, a small window below make square on the corner of the extended line from H-1 and BL-2. Then, the other two windows which have square and 1:1.5 rectangle form are located on the position which are decided by a large square.

In addition, a large pediment stands on the wall of the south part. Although the pediment isn't on the geometrical figure which is defined, the height of top edge relied on the 1:1.5 proportion on the central part of subdivided strip. As the process of generation above, the dominant geometry in the south part is the square and 1:1.5 rectangle.

The central part which looks narrow and high tower is inserted in between two walls. This volume has octagon plan and three surfaces of eight walls appear on the façade. However, two surfaces on both sides of the center hide behind of two walls and tip of tower protrude above the top of two walls. All elements, doors, windows and ornaments, are set on the centre line. The entrance door is not only sub-entrance of the building, but also the direct entrance to the art shop. It is located on the middle of a hill, therefore, a pavement on the front of the door is made flat and covered by a stone handrail. These elements of façade around sub-entrance are composed according to 1:1 and 1:1.5 proportion which is Mackintosh's geometrical principle as well as the other parts. The height of door is defied by the base lines which are created in the north part. The door whose proportion is 1:1.5 is set on the basement floor level. Then, the top edge of the door is on same height with the small window for the art shop on the north part. When a square is put on the basement floor level with a double width from the central line to the waterspout, the position of a 1:2 proportion window will be fixed. Besides, the stone handrail whose proportion is also 1:2 has same width with the square. In addition, its height is decided by the 1:1.5 rectangle on the north part.

A window on the ground floor is placed on same height with the arch window on the south part of the east façade. Then, the top of the window is on the top side of 1:1.5

rectangle on the square. In other words, the geometry which covers the sub-entrance door and the window on the ground floor is 1:1.66 rectangle, the combination between 1:1 square and 1:1.5 rectangle. The window on the ground floor have a same proportion, 1:1.66, therefore, they are similar. Next, the composition of upper volume which protrudes toward east will be explained. A window on the 1st floor has a sculptural ornament around itself. The height of this window relied on the baseline of the south part. The size and proportion of the window is almost same with the other window below, 1:1.66 rectangle. Around the window, a sculptural ornament is designed like a bay-window. When a square put on the figure of window like it is divided into 1 : 1.5 ratio on the base line from the bottom, the ornaments are framed by the square. Then, another window is located above with a space between upper window and lower window on the 1st floor. The space is formed by a 3:4 scale rectangle whose longer side has same length with width of the central part. Finally, the total height of the central volume will be analysed. It is relied on the geometry of the south part as well as the windows on the 1st floor and the 2nd floor. When three squares is on the south part, the top of the 1:3 rectangle will meet the top of the central part. In, addition the very small window which has 1:1.66 proportion is set based on the top of the volume. The position of the window is defied by a square which has width of the central part on the top.

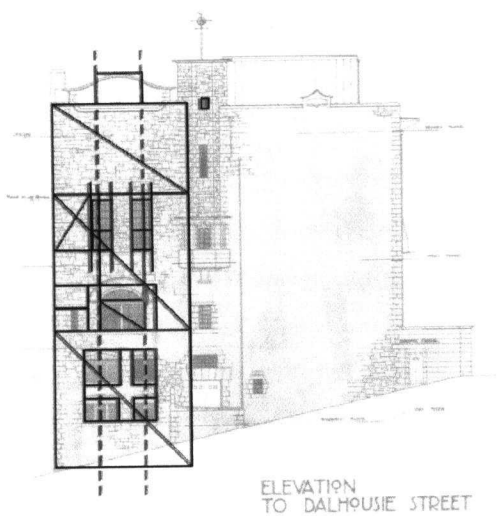


Fig23. the North Side Composition

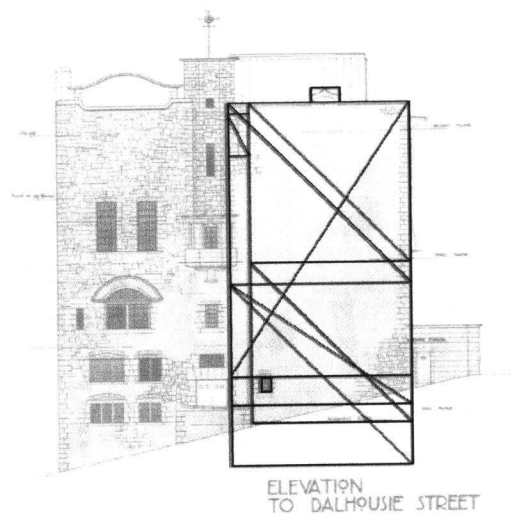


Fig24. the South Side Composition



The East Facade

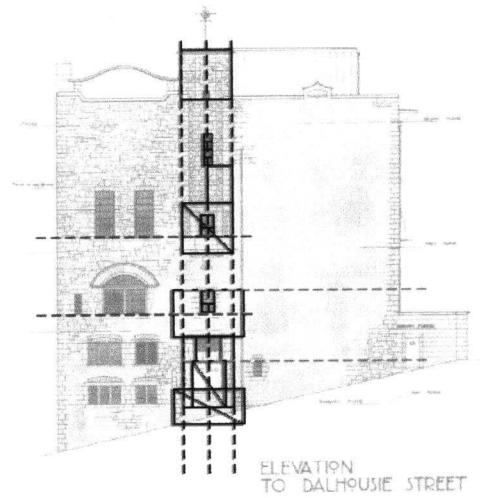
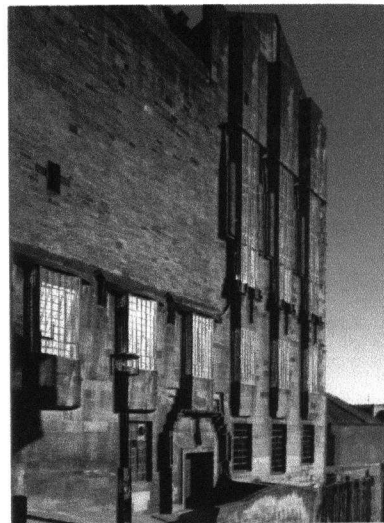


Fig25. The middle part

In summary, it is revealed that a tower is inserted between a solid wall and a wall with some designed windows. Moreover, in order to decide the position of elements on the central part, the baselines which are made on each side of parts are quoted. In particular, the height of the entrance door is related to a window on the north part and the handrail and windows above is formed by derivate geometries. On the other hand, for some windows on the upper floor, the south part is basis of the proportion. It is curious that the both of baselines from the south part and the north part are refer in order to decide the position and size of a window on the 1st floor. To put it simply, two large walls are integrated on this point.

3. the West Facade

Then, the west façade will be analysed by the geometrical point of view. This façade has a more elegant face than the east one because of its composition of façade elements. Actually, the wall of west façade mainly consists of honed finish stones instead of rubbed finish stones wall on the east façade. In addition, the most of wall is constructed by coursed ashlar masonry. Therefore, it is apparent that the west façade has different from the east one with the composition. The west is separated to two parts on the vertical direction despite of the three parts on the east façade. Besides, the south part of the west façade



The West Facade

continues to north edge of the façade, therefore, it creates L-shape. This part will be called the L part from now on. The other part which consists of solid wall located on the corner of top side and the northern side. It will be called the solid part in this section from now.

First, the composition of the L part will be resolved and analysed. The process of generation is influenced by geometrical principle such as, 1:1 ratio and 1:1.5 ratio as well as the other compositions of facade. However, it is important that dividing the wall on vertical direction is main operation. So, the generation process on the L part will be shown on the follow.

- (1) The south part of the L part can be divided into 7 narrow stripes on vertical direction equally.
- (2) One 1:1.5 (H-2) rectangle and two squares are stack on the bottom to connote the total height of wall including a pitched roof. Then, another 1:1.5 rectangle (H-3) is put on bottom side of the upper square (S-2) in order to decide the height of wall excluding the roof.
- (3) Another 1:1.5 rectangle which is same size with H-3 is set being on the top of the wall. The bottom of this rectangle becomes a baseline to decide the position of three windows for gallery space on the 2nd floor. The proportion of windows is 1:2.5, and, they are put at one interval of seven stripes.
- (4) The position of three long narrow bay-windows which is for the library is based on a line of S-1 and the 2nd floor level. The 1:1.5 rectangle which height is the length in between these baselines is found. When the top of windows is set on the 2nd floor level, 1:4.5 rectangle which consists of three 1:1.5 rectangle. Besides, the positions of ornaments below the windows are relied on the height of a square which is created by the width of five stripes.
- (5) Six bay-windows on the ground floor have same scale and proportion. The width of windows is based on the stripes. Then, space between the window and the ground floor has same distance with width of the stripes.
- (6) A sub-entrance which has 1:1.5 ratio is located on the basement floor level. Furthermore, its ornamental frame has similar form. There are four windows on the basement floor based along the subdivided lines. Three of them have a same form with the ground level's one. One longer window has 1:1.66 proportion.
- (7) Shapes of a handrail and fences are defined by 1 : 1.5 rectangles from the bottom of the building.

Actually, the geometrical principle for the L part is square and 1:1.5 rectangle as well as others. Dividing process is more apparent than the east façade. The façade of west has clear composition because of the operation.

Next, the solid part will be analysed as well as the other part. This part has quite simple composition because of the square form. The design of this solid wall is composed of two different scale squares. Top of the part has been defined by the plan in the 1st phase. Besides, the position of bottom of wall is decided by 1 : 1.5 rectangle on the ground level. A square whose width is distance between north edge of the building and border to the L part is set on the bottom of the wall. A small window on the solid wall is placed at the intersection of two lines which are a diagonal line of the square and a centre line of the window below. However, this square can not cover all surface of the solid part. A large square which has same height with the solid part is put on the bottom of the wall. Consequently, the large square lapped over the L part and its right edge reached an ornamental frame of long window for library. A simple frieze is settled on the top side of the smaller square in order to emphasize that primitive geometrical figure.

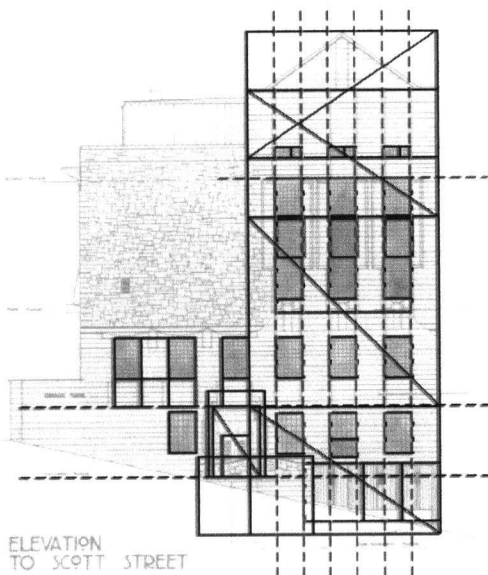


Fig26. the Composition of the L part

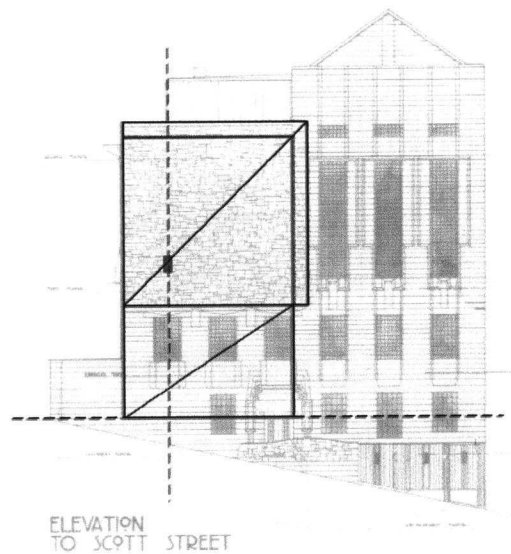
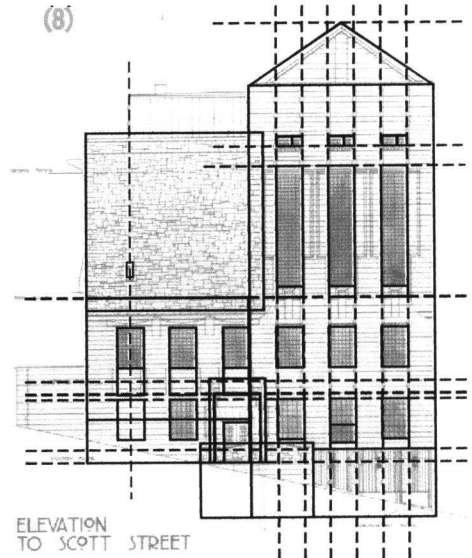
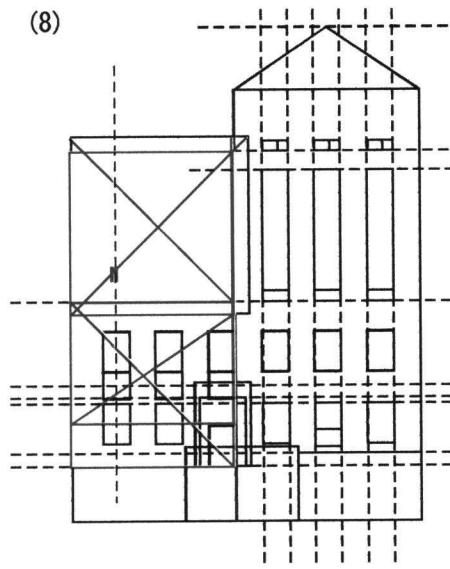
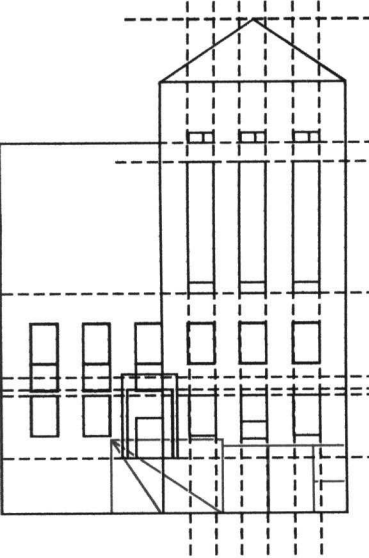
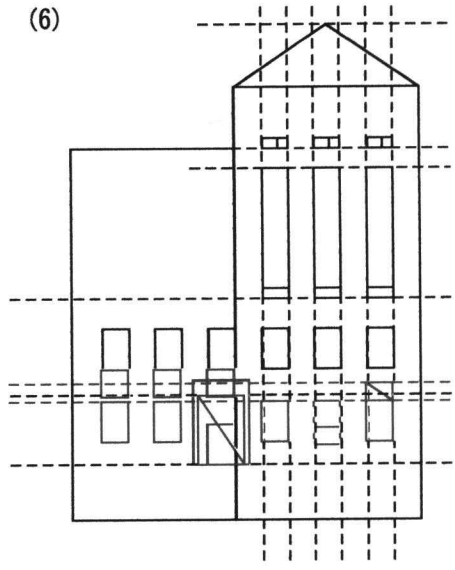
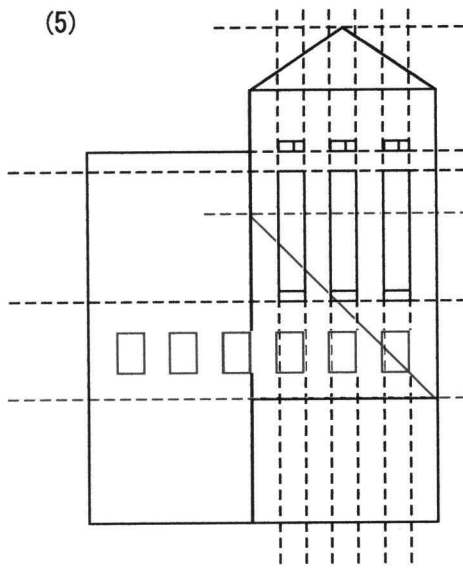
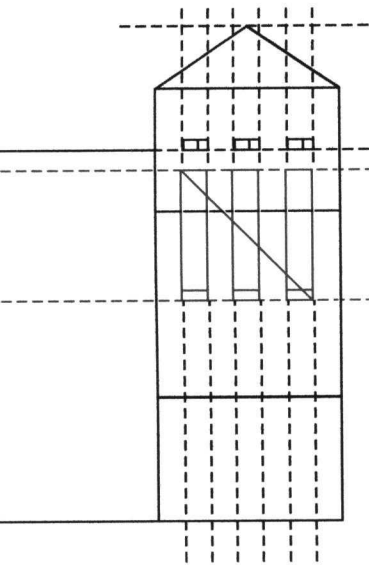
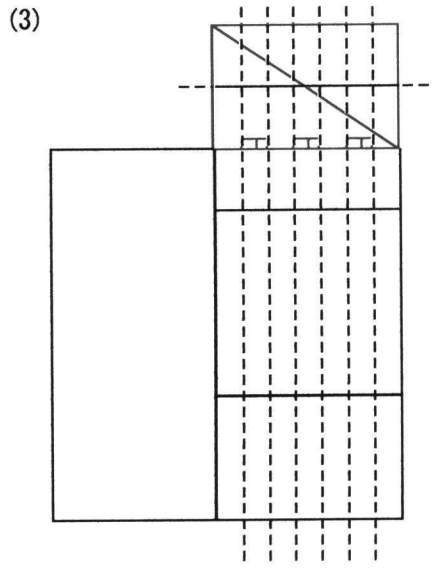
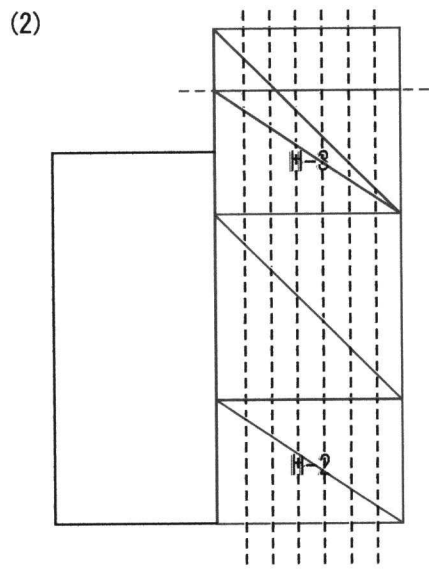
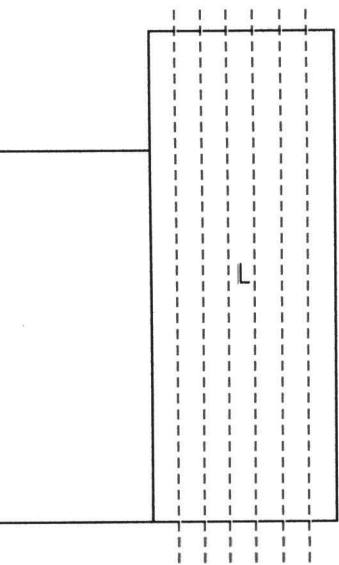


Fig27. the Composition of the Solid part

In conclusion, the façade of the L part is composed the elements which are defined by the divided module. Arrangement of windows emphasizes the vertical direction and the structural rationality. These narrow and long windows are framed by the sculptural ornaments in order to add elegance. Although the ornament is based on rigid geometrical principle such as square, it does not lose its value because of uneven and roundish details. The solid part does not show a boring face, but it shows people well organised impression because of its square form.



ELEVATION
TO SCOTT STREET

4. Analysis - Comparison between East and West

The comparison between the east façade and the west façade will give us curious facts. It passed for eight years from the completion of 1st phase to beginning of 2nd phase. While a blank year, Mackintosh developed his thinking about design. Especially, the intension of the solid wall should be considerable. Colin Rowe has described about such kind of massive wall on La Tourette by Le Corbusier. He assumed the thinking and feeling of visitor against the oppressive wall like the follow.

But the visitor also knows it to be part of a building; and he believes himself to be approaching, not this building's front, but its flank. The information which he is being offered, he therefore feels, must be less crucial than simply interesting. The architect is displaying a profile rather than a full face. And, accordingly, since he assumes that the expressive countenance of the building must be around the corner, rather as though the church were the subject of a portrait en profil perdu, the visitor now sets out to cross an imaginary picture plane in order to grasp the object in its true frontality.¹⁰

In brief, the unattractive north wall on La Tourette can possibly make people be interested in what is beyond the wall. So, the mean of two walls on Glasgow School of Art will be considered. Mackintosh chose effective way to divide the west façade instead of the division on vertical direction on the east façade. The L part is set like surrounding a perfect square. In addition, this part is constructed by coursed ashlar masonry of honed finish stones. Therefore, people who walk on the street can see an elegant façade on their eye level. Besides, the solid part shows a quiet appearance in spite of massive and rubbed finish stones wall. On the other hand, the north part of east façade gives a little pressure to people who come from under the hill. This difference proves the development of Mackintosh's design. Furthermore, texture of the wall shows a difference between west and east. The most part of the west wall consists of honed finish stones though the all part of east wall is filled by rubbed finish stones. Besides, this part of west wall is constructed by coursed ashlar masonry. It means that the construction method was changed from west to east. This change is an effective attempt to make a wall be more communicative with people.

¹⁰ C. Rowe, *The Mathematics of the Ideal Villa and Other Essays*, La Tourette, page 187 line 30-37

Conclusion

This essay aimed to find Mackintosh's geometrical principle throughout the analysis of Glasgow School of Art. Besides, the purpose of the study is not only finding some geometry in the composition of façade and plan, but also disclosing a hidden intention beyond the geometry.

Before the analysis of Mackintosh's building was done, case studies had been examined in order to obtain the method for analysis. As a result, the popular modules were 1:1, $1:\sqrt{2}$, 3:4, 2:3, 3:5, 1:2 and the golden ratio despite of the tendency of each architects and critics. Andrea Palladio defined his ideal proportions clearly, and, Le Corbusier invented "Modulor" by focusing on the golden proportion. These ideal modules became the guideline for the geometrical analysis of Glasgow School of Art. In addition, the analysis referred to generating process of projects by Frank Lloyd Wright or Louis I.Kahn. For instance, shifting figure to create a new geometry, derivation of figure from the baselines and subdivision into small part were found as methods.

In the analysis of Glasgow School of Art, the plan drawing was decomposed at first. The generating process of the significant character, asymmetrical composition, was revealed by the analysis of the plan drawing. Shifting main body of the building effects the impression of the building. Each room which is created by the division of total volume has simple proportion. Thus, they organize the unity of this irregular composition on the planning. Furthermore, an operation which makes perfect symmetry on the fence and entrance gate succeeded to communicate with the city from the point of façade design. Also, the north façade showed us Mackintosh's ingenious attempt to integrate the composition. The form of large windows which have 1:1.5 (2:3) proportion on the façade is kept in order to soften the unbalance of the façade. Conversely, the central part of the north façade has complicated composition. The position and size of elements which are a bay-window, a balcony, an arch window and a tower refer to the some buildings by British architects in same age in particular, J. MacLaren. The main entrance door and a window for director are located on the exact centre and have a symmetrical form. It means that they are designed for the most important space on the north side. It is known that shifting which is a significant operation came from the composition of the south elevation. The composition of south elevation is obviously referred to the Fyvie Castle in Aberdeen even the asymmetrical composition. In fact, the ratio between masses and voids are quite similar. It is certain that the proportion of asymmetry is defined by referring the Fyvie Castle's one. Therefore, Mackintosh used the operation, shifting, for making the ideal composition. The south west block which

has the library is designed by using ingenious measure to define difference from an imitation. The façade is divided on vertical direction to decide the position of windows and ornaments. The emphasis of vertical direction express like the modernism architecture because of its clearness of the form. In addition, it is another reason that the wall seems to be not restricted by structure. When the east façade was compared with the west façade, differences in between two phases would be found. The north side of the east facade has massive wall which is made of rubbed finish stone despite of honed finish stones on the west. Although the composition is well-designed, the façade still gives pressure for people. The composition of the west façade can lead people to come up from the bottom of hill. Though the analysis, it is revealed that Mackintosh's geometrical module is quite simple such as 1:1, 1:1.5 and 1:2. In other words, a unit of proportion is at 0.5 intervals.

To sum up, Mackintosh referred many kinds of examples which are not only in the classical architecture, but also buildings in same age. However, he arranged the design based on his geometrical principle in order to avoid that Glasgow School of Art would be a commonplace imitation. Therefore, Mackintosh intended that the asymmetrical composition with a little symmetry could effects the façade design. Actually, the proportion of volume are referred to the Fyvie Castle, instead, the shifting operation is recognized as a proper way in order to make this composition. During dramatic worldwide change of architectural style, Mackintosh showed incomparable creativities for design based on the geometrical principle. It is not only for details, but also composition on the wide point of view. As a result, Glasgow School of Art is regarded as a masterpiece of architecture in 20th century.

References

Fig01: The Four Books of Architecture, 1965

Fig02: Frank Lloyd Wright between principle and form

Fig03: Louis I. Kahn Ideal of Order, 2001

Fig04: The Mathematics of the Ideal Villa and Other Essays

Fig05: The Mathematics of the Ideal Villa and Other Essays

Two photographs of the east façade and the west façade are from “Charles Rennie Mackintosh, TASCHEN”.

And, all drawings are from “Architecture in Detail · Glasgow School of Art, PHAIDON”

Bibliography

- Eisenman, P. (2003) Giuseppe Terragni Transformations Decompositions Critiques, New York: The Monacelli Press
- Eisenman, P. (2006) Feints, Italy, Skira
- Elam, K. (2001) Geometry of Design, New York: Princeton Architectural Press
- Fiell, C and Fiell, P. (1995) Charles Rennie Mackintosh, London: TASCHEN GmbH
- Gast, K. (2001) Louis I. Kahn The Idea of Order, Berlin: Birkhauser
- George Rawson (1995) Francis Nwebery and the Building of Glasgow School of Art, Mac journal 2, Glasgow: Glasgow School of Art.
- Kimura, H. (1984) Process: Architecture 50th , Tokyo: Process architecture Publishing Co
- Macaulay, J. (1993) Glasgow School of Art, London: Phaidon Press
- Macaulay, J. Hermansen, C (1995) Mac journal 2, Mackintosh School of Architecture
- Palladio, A. (1997) The Four books of Architecture, Cambridge, Mass, London: MIT
- Robertson, P (1990) Charles Rennie Mackintosh The Architectural Papers, Glasgow: The University of Glasgow
- Rowe, C. (1976) The Mathematics of the Ideal Villa and Other Essays, London: The MIT Press
- Wagner, O. (2002) Otto Wagner, Barcelona: LOFT Publications