OBSERVATIONS ON DAYLIGHTING AS DEMONSTRATED BY THE WORK OF ALVAR AALTO (159 pp.)

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Daylight plays a dominant role in the works of Finnish architect Alvar Aalto. This thesis project investigates the role played by the natural light in his architectural works. One of the major concerns of this paper is to discover his intent behind the use of daylight, as well as to identify some of the techniques he devised to handle daylight. Literature research and physical model simulation studies have been incorporated as a method for the study.

Significant works of Aalto have been surveyed. It has been observed that the use of daylight has been one of the preoccupations of Aalto since the design of Viipuri Library and Paimio Sanatorium. It was also observed that skylights play a prominent role in Aalto’s architecture and that they are well developed and sophisticated devices. Some of the technical components and contributing factors of Aalto’s skylights have been identified.

Three case-studies were conducted through literature research and simulations. It was concluded that Aalto treats daylighting as one of the elements to embody sufficient psychological factors in man’s built environment. It was discovered that the selection and the detailing of the skylights in each case has been predominantly guided by the climate, function, personal relationships, and the visual task of the individual space. Physical model simulations proved to be extremely helpful in understanding the modeling of the daylight and the spatial quality.
Observations on Daylighting
as Demonstrated by the Work of Alvar Aalto.

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To my family ....
INTRODUCTION

Architecture is expression of human aspiration. Space is the vehicle. Light is the giver of life. Light is not something one adds to the building design, but it is implicit in every design process. Thus, it is obvious that the role played by light in architecture is dominant. Depending on the source, light can be broadly categorized into (1) natural light, (2) artificial light. This thesis project investigates the role played by the natural light in architectural design and the means to achieve it.

1.1 DAYLIGHTING

Natural light is sunlight that consists of ultra violet, visible, and infra-red radiation. Artificial light is man-made and does not have some of the spectral qualities that are unique to the natural light. Natural light, from now referred to as daylight, is considered suitable for the human built environment for the following reasons:

- **Health:** Biological needs, Plant growth etc.
- **Task:** Psychological and Perceptual needs.
- **Emotion:** Spiritual needs
In addition, the following are the reasons for my personal preference for daylight:

- Firstly, it may be due to my cultural background. In India, where I grew up, daylight is considered very important in human built environment. Artificial light is considered inferior in quality and is used only when there is no choice. People there, do not accept artificial light as a substitute for daylight (or for that matter artificial ventilation for natural ventilation). In my considered opinion this attitude is not just due to high cost of electricity and the state of the technology, but because people think daylight is essential for the survival of man (health as well as spiritual reasons). By contrast, in the United States daylight is mostly ignored in conventional architectural practice.

- Secondly, I strongly feel that the effect created by daylight can not be duplicated by electrical lighting.

One of the unfortunate outcomes of orthodox modernism was a shift from using daylighting to that of using artificial lighting. Perhaps, this was because of some kind of belief that there is an "easier" control over the artificial lighting to maintain steady lighting conditions. Also, daylighting design is not easy. It cannot be done as an afterthought but has to be developed as an integral part of the design. It is difficult to achieve control over daylight. Prof. Richard C Peters of University of California, Berkeley suggests that masters of architecture are also masters of light. Alvar Aalto, Frank Lloyd Wright, Le Corbusier, and Louis Kahn are few examples of the greatest architects of the century who demonstrate this point eloquently through their architectural works.
1.2 AALVAR AALTO

Alvar Aalto is recognized as one of the masters to have extracted the utmost of the three essentials of architecture: Space, Light, and Materials\(^1\). The works of the Finnish master make good examples to study and understand the role of daylighting the buildings. Aalto used daylight in nearly all of his buildings following Viipuri library building. In my personal view, no other architect has demonstrated the architectural value of daylighting more eloquently than Alvar Aalto. My admiration for Aalto derives from the following reasons:

- **Aalto's architecture is time tested.** Aalto's buildings, even buildings designed in as early as 1930's, such as Paimio Sanitarium, Villa Maria are still being used and are considered master pieces.

- **Daylighting design in Aalto's work is acknowledged** as one of the best by renowned architectural lighting designers like Fuller Moore, and William Lam, architects like Reima Peitila and Gunnar Bikkerts, and architectural scholars like Malcom Quantrill and William C Miller.

- **Aalto’s solutions are poetic, formally appealing.** To me, most “lighting designers” solutions appear diagrammatic. Whereas, Aalto's lighting solutions are formally appealing, contextual and make the spaces exciting.

Therefore, I have chosen to study the example set up by the grand master through his architectural works, to discover his intent and some principles of daylighting.

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1.3 RESEARCH METHODOLOGY

Premise:

(1) Introduction of daylight into the interior spaces was one of the preoccupations in the achievement of interior environmental quality in Aalto's architecture.

(2) Daylighting devices were one of the most developed and consciously used elements in Aalto's architecture.

Concern:

(1) To discover Aalto's intent in using daylight in his buildings.

(2) To discover the daylighting principle Aalto incorporates.

1.3.1 SCOPE OF THE STUDY

This is not a study on Aalto's architectural theory or ideologies. Aalto's lighting design is inseparable from architectural design. Lighting is one facet of Aalto's design methodology. This study will focus on how Aalto handled lighting and the process that he used to achieve the lighting solutions.

As we have identified in the beginning of this chapter lighting design involves fulfillment of task, health, emotional, and various other human needs. This study aims at understanding how Aalto handled daylight to fulfill the emotional needs of man and ritual and the function of the place. Our study will examine Aalto's architectural design methodology as it pertains to the lighting design. We are not interested in measuring the lighting levels in foot candles.
in these spaces, but we are looking forward to observing the sensorial experiences these spaces provide.
1.3.2 Procedure

(1) Literature Research

There are several writings by architectural scholars and critics on Aalto’s architectural works as listed in the bibliography. In some of his early pronouncements (published as *Alvar Aalto: Sketches*), Aalto critically talks about the criteria for architectural design. This makes a rich resource in understanding Aalto’s intentions in general. The following are the objectives of the literature research:

- To survey major works of Aalto in order to get familiar with his works, and to identify the daylighting systems he adopted and to observe if there are any patterns.

- To select specific case-studies which suit the intent of this effort.

(2) Simulation Studies:

Speculation on the performance of the daylighting design and the effect created could be complex. Since light has no scaling factor, physical models are appropriate to model the light in a space. This helps to get a better feel for the light in the space.

(1) “Skylight Model Simulations”: In order to understand the working mechanism of the skylight devices, and the ceiling modulation.

(2) “Space Model Simulations”: To get a feel for the light in the space, to understand the character of light in space, and the spatial character.

This study will culminate in making conclusions about Aalto’s intent behind using daylight, the techniques he adopted, and his solutions.
"...From the very beginning Alvar Aalto's work took a decisively softer, more personal and humane, more regionalistic and more irrational course. Throughout the Modern Movement Alvar Aalto has been the lonely individual and even after his recent death, he remains the Pioneer of Humanism."

- Juhani Pellasmäa
Aalto's design methodology is complex and has many facets. One should recognize that his architectural solutions are simultaneous solutions achieving a harmony between innumerable aspects, of which daylighting is just one aspect. While we want to focus on the aspect of daylighting, it is important to be aware of the other aspects, which often play influencing role in the decision making process. I have pointed out some aspects of Aalto's architecture and thinking that need to be examined and understood, to develop an understanding about the motivations and the leading influences for Aalto's sensitivity to human needs, value of light and the humane creation of the space and place.

1.1 Sensitivity to Nature: Finnish Context

Finland is a land of forests and lakes, over 80,000 lakes. Though it is the fifth largest in Europe in terms of area, its population is only 5 million. The demographic distribution is rather sparse. A typical Finnish town has a population of about 30,000 people. Finnish people have always been able to maintain their close contact with nature. Alvar Aalto was a nature loving person himself. He spent a lot of his time close to nature in his childhood helping his surveyor-father with surveying and drawing the land forms, and contour maps. The influence of Finnish landscape can be seen in his architectural forms.
Aalto’s interest in nature can also be observed in his expressive use of natural materials such as wood, brick, and natural stone.

“...Finland has tremendous juxtaposition of horizontality and verticality and natural organic form. The lakes give a constant reference to the horizontal line and the dark pines and light birch trees are pure verticality. The contours of Aalto recalled theses in his savoy vase, not to mention his buildings”

- Gunnar Bikkerts

1.2 HUMANISM

Central to Aalto’s design was “Man”. Aalto perceived functionalism as something that covers psychological issues beyond the technical issues. Aalto demonstrated technology can be touched with pleasure and warmth. He viewed architecture as a great synthetic process of combining thousands of definite human functions with a purpose of bringing the material world into harmony with human life. Aalto’s paper on “Humanizing of Technology” is recommended to those interested in this topic.

1.3 DEMOCRATIC IDEALS

Finland was under Russian Communist rule for a long time, until the 1917 Russian revolution when Finland became independent republic. Aalto began his professional career approximately at the same time as Finland became independent. He was firmly committed to the democratic ideals of his own which put “little man” at the center of the problem.

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Schildt's *Alvar Aalto: The Early Years* and Salokopis' "Currents and Undercurrents of in Finnish Architecture" are recommended to those interested in this topic. Aalto's buildings consisted of a central "civic core" around which the other spaces are organized.

1.4 Elastic Standardization

Aalto made the idiom of functionalism more individual and more local. It is to be noted that this is in direct opposition to the proponents of the "international style" and their attempts to universalize space and form. Aalto's philosophy of mass production was to reach different ends with one and the same standard unit which elastically adopts itself to its task. His buildings adopt to the natural variations of the surroundings and do not deprive people of their individuality. Gunnar Birkerts paper on "Aalto's Design Methodology", is recommended to those interested in this topic.

1.5 Organic Characteristics

"...The process which his (Aalto's) design motif, one given a lease of life, undergoes from the point of birth via gradual refinement to perfection is an unfailingly solid one, comparable to say the process of growth of a plant or of an animal. By contrast, Wright's works all feature an uncompromisingly consistent thought throughout as a salient leitmotif and as a secret of their verve, while Le Corbusier's is a seductive world of gaiety and elegance inspired by an untrammeled creative esprit. If Le Corbusier's is again, the world of a fanciful hunter chasing one variety after another of game, Aalto's is the steady world of a farmer who carefully sows his seed and watches them sprout and grow.

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6 Ibid 2.
Herein seems to lie the personality trait of Aalto as a creator.  
- Akira Mutoh.

Aalto never used any kind of geometric or mathematical principles of order to derive his form such as one find in the works of Frank Lloyd Wright or Le Corbusier. His architectural motifs recur and unfold singly or in combination without any process of logical order, comparable to the growth process of organic life. When ever he faces a new problem, he cross examined them in the light of ecological order.

1.6 Range of Expression

Aalto's range of expression can found not only in buildings and town planning but also paintings, boats, and mass-produced furniture, glassware, tiles, and textiles. The first bent wood furniture, developed together with his wife, Aino Aalto, goes back to the construction of Paimio sanatorium. The types of furniture were expanded further developed in the following years. In addition, through “Artek” furniture company, other household objects such as lamps, glasses, textiles, etc. were developed.

1.7 Gifted Senses

Aalto was gifted with sensitive eyes and great sense of perception which allows him to perceive various problems which usually escape the attention of ordinary observers. He also possessed a creative ability with which he could give an extremely delicate formal interpretation of what he perceived.

"...Man to Aalto meant a walking man equipped with sensitive eyes and sensitive ears. The man present in his architectural thought was a man defined in terms of man's primary functions: How would the primary functions of man respond to the environment surrounding him? The questions of biological, or ecological, nature constituted Aalto's starting point in architecture."

- Akira Mutoh.

### 1.8 Emotional Value in Aalto's Solutions

Though he took a path of functionalism, he went his own way to toward the emotional value of architecture and its humanization. Aalto's paper on "Rationalism and Man" is recommended to those interested in the topic where, as an example, he describes how feelings like "coziness" can be understood in scientific terms.

"...The main criticism against the metal chairs has been that they are not what one would call "cozy". This has in most cases been true, but when one uses the concept of "coziness" to mean something totally, undefinably human and claims that only traditional formalism could create it then one is on the wrong path. The criticisms, too noisy, too light-reflective, and too good a heat conductor, are in reality scientific terms for things that when put together form the mystical concept of "cozy"." 

- Alvar Aalto.

Aalto was a master at capturing and reflecting the emotional content of works of past. Aalto was fascinated by Italian hilltowns during his study tour of Italy in 1924 and his architecture shows a transformation of some the architectural features typical of the Mediterranean region modified by Finnish culture.

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11 Ibid 10.
1.9 Empirical Design Criterion

Aalto advanced along his path of trial and error, step by step, concretizing his prime vision until it became tangible form, true, empiric. Reima Peitila states that Aalto was not an abstract designer but an empiric designer\(^\text{12}\). In the Greek this term “empirikos”, was originally applied to certain doctors who were skeptical about theory and principles and relied entirely upon practical experiment and experience.

The “Book of Inventions” passed onto Aalto by his inventor grand father, considers that architecture is one of the fields making constant progress owing to new discoveries. The influence of this book on Aalto is noticeable.

According to Schliedt, empirical criterion, the principle that all inventions should be tested in practice and improve gradually by experiment, was a basic rule of architecture for Aalto. Aalto took this playful experimentation with deepest seriousness. Aalto's paper on “Experimental House, Muuratsalo”\(^\text{13}\) is recommended to those interested in this topic.

“...The building complex at Muuratsalo is meant to become a kind of synthesis between a protected architectural studio and an experimental center where one can expect to try experiments that are ready to be tried elsewhere, and where the proximity to nature can give fresh inspiration possible there to find the specific character of architectural detail that our northern climate requires.”\(^\text{14}\) - Alvar Aalto,


\(^{14}\) Ibid 13.
However, Schildt also mentions that Aalto rejected the artist's principle, according to which every work of art is final, a definitive result of creative impulses to the hand. For him the buildings were temporary in a sense, they could always be improved or varied until they approached ideal.

1.10 Foundations

Aalto's career was long and spans over half a century. He produced over 100 buildings ranging in size from a weekend house to giant industrial complexes. With the exception of Le Corbusier and Frank Lloyd Wright, few architects in the twentieth century have produced as many buildings and projects as Aalto. David Pearson, an architectural scholar, in his book *Alvar Aalto: International Architect* points that Aalto is still being characterized by those buildings from the thirties that earned him respect as a “truly modern architect”. Paimio Sanatorium and Viipuri Library are major projects during that time for which he is remembered. Pearson also states that these buildings alone have caused his name to be passed down to succeeding generations of architectural enthusiasts and students as “a key developer of thought and form” in building of this century. In this chapter we have gained acquaintance with Aalto's architectural thought and some of his attitudes. In the next chapter we will examine these two crucial buildings to observe Aalto's design convictions as they pertain to the use of daylight and the development of daylighting systems.
CHAPTER II

DAYLIGHTING IN THE WORK OF AALTO

2.1 BACKGROUND

Many of Aalto's design motifs were conceived in the early 1930's. Viipuri Library and Paimio Sanatorium designs are the first major works that made Aalto's presence as an architect known all over the world. The design phase of Viipuri Library and Paimio Sanatorium projects can be described as the formative period for Aalto, where he searched, studied extensively and made certain design convictions which remained to be reflected in his later works as a method.

"...Most of Aalto's designs during the 1930's derived from the interior space and its problems. This established a method for later works, where the design of the interior space largely dictates the exterior architecture for example The Town Hall in Sanyatsalo, "The House of Culture", The church in Vuoksenniska, The Rautalao Office and Commercial Building(“Iron House”). The works in the 1920's and 1930's by Aalto can be said to signify a time of searching and maturing."

- Pekka Suhonen

It is beyond the scope of this thesis project to discuss details of the transformations of Aalto's design ideologies during this crucial stage. Goran Schildt’s classic books, Alvar Aalto: The Early Years and Alvar Aalto: The Decisive Years are recommended to those interested in this topic. We will look into the leading influences in the design of these two buildings in order to observe Aalto's motivations and conviction to use day lighting.

2.1.1 Viipurin kirjastola (1927-35)

The design of Viipurin Kirjastola began in 1927 as a prize winning competition entry and underwent a lengthy process of design establishing many of the themes which are reflected in almost all of Aalto’s later works. Fig A.1 shows the interior views of this building. As Gunnar Birkets points out Aalto established a unique methodical approach here. Aalto did extensive searching and experimenting during this period which included the studies on lighting, acoustics, structures, spatial organization, material selection, and site planning.

![Fig 2.1 Viipurin Kirjastola preliminary design sketches by Alvar Aalto.](image)

In Viipurin, Aalto treated lighting design as a primary consideration. Aalto was striving to provide ideal lighting for reading. Appendix 1 provides Aalto’s own pronouncements where he expresses the process of lighting design for Viipurin library. The daylight was so designed that it reaches an open book from different directions. This diffuse source and spread of light avoids a bright reflection to the human eye from the white page of the book. Electrical lighting design followed the same principles, too. David Pearson, American architectural scholar, discusses Aalto’s interest in using indirect lighting and his
investigations during 1927-32 in his paper titled "The Legacy of Viipuri Library". Pearson points out that Aalto used daylight in nearly all of his buildings following Viipuri. Girsberger Zurich an intimate associate of Aalto provides some important notes on this building with regards to daylighting.

"...In a library light is a primary consideration. The round form of the conical skylights resulted from the most satisfactory inner stress condition for horizontal glass surfaces. The sunlight did not stream in directly, but was reflected in thousands of reflection lines which resulted from conical, funnel like form of the skylight, so that without use of diffuse glass, a shadow free, diffuse light was obtained - ideal for the reader who could take his book to any point in the room without being bothered by shadows or stark sunlight. The artificial light followed these same principles in that it fell on the book diagonally from all sides. Sky lights provided shadowless illumination on the books on the shelves even when a person stood in front of them."  
- Girsberger Zurich

Aalto's investigation of lighting design during the Viipuri formative period led to many innovative lighting design ideas and a firm conviction to incorporate daylight in almost all future building design. Steven Groak, an American biographer in his Monograph on Alvar Aalto, states that the idea of a top lighting, central atrium took root in this building. In terms of daylighting systems (in Aalto's work), the significant outcome of the Viipuri design phase is the discovery of conical skylight.

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16 Pearson David. Source. RIBA journal, include correct bibliographic data here.  
2.1.2 Paimio Sanatorium (1927-32)

Paimio Sanatorium marks the beginning of Aalto's biologically, psychologically oriented approach. Here he was led by a rational judgement incorporating the psychological effect exerted upon a patient. He realized that hospital room is to be designed keeping a sick person lying in a horizontal position in the bed. In those days Sanatorium was required to be a sun trap, as “sun light” was essential part of the medical treatment for Tuberculosis. Some sketches made by Aalto during the design of this project (as shown fig. 1.4), suggest that he did studies on daylight and carefully considered the penetration of sunlight and illumination on the interior.

![Figure 2.2: Study sketches of Aalto for Paimio.](image)

Artificial light was designed in the same manner. Frederik Guthiem describes some of the subtle details considered such as orientation, acoustical treatment of the wall panels, special window details to ensure ventilation without drafts, special design for wash basins to make
them splash proof, and soft, neutral tones for walls and darker colors for ceilings to give a restful effect when one is lying on the bed. Aalto's personal commentary on this project helps in understanding his humanistic intent better.

"...And now I will show a series of pictures of one of my old projects. This is a project during which I came in contact for the first time with human misfortune. The project in question is the Tuberculosis Sanatorium in Paimio. When I received the assignment I was myself ill and therefore had the opportunity to make a few experiments and find out what really felt like to be sick. I became irritated at having to be horizontal all the time, and my first observation was that the rooms were designed for people who are upright and not for those who lie in bed day in and day to. Like moths to a lamp my eyes were constantly drawn to the electric light in the room, which was absolutely not designed for bedridden patients. The room conveyed neither balance nor calm. I therefore decided to plan the patients' rooms in such a manner as to provide restful atmosphere for bedridden patient. I did not use, for example artificial ventilation, which causes a disturbing draft about the head, but designed a system that draws warmed air from double-paned window. This is just one example of how we can do our little bit to alleviate people's suffering. Another example is the washbasin. I tried to design a wash basin where the running water makes no noise. The water hits the porcelain at an acute angle and therefore doesn't disturb the patient lying nearby." - Alvar Aalto.

- Viipuri Library design motivated Aalto to provide ideal lighting for the "task" of reading.

- Paimio Sanatorium required sun light for the "health" reasons.

- Aalto was trying to create a calm space, free of acoustical and visual disturbances and at the same time provide shadowless illumination on the books on the shelves even when a

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19 Ibid 1. Pp 13
person stood in front of them. In Paimio Sanatorium he was trying to provide restful atmosphere for a bedridden patient. He wanted a source that was absent from the patients visual field and provided diffused soft light. He also wanted to keep the bedridden patient in experiential contact with the outside climatic conditions, and give sense of time and orientation. He found that properly controlled daylight offered the "qualities" to meet all the above needs. And thanks to his sensitive design ability, he developed a system that provided the required control over the daylight.

Aalto's study tour of Italy in 1924 had a significant impact on his inclination to use daylight. Steven Groak suggests that the part played by strong sunlight in Italian Architecture fascinated him and had a lasting effect in his later works. Turun Sanomat building (1928-27) shown in fig A.2, Aitta Weekend Cottage (1928) shown in fig. 2.2 projects designed during Viipuri formative period, suggest that Aalto was experimenting with the application of daylighting.

Fig 2.3. Summer Villa Competition sponsored by the magazine Aitta. Entry “Kumeli”, First prize, 1928.
2.2 PREFERENCE FOR DAYLIGHT

In addition, the following Characteristics of daylight could be discussed as the reasons for Aalto's preference for daylight:

2.2.1 HUMANISTIC QUALITIES

The movement and sparkle associated with the sunlight contributes to the visual variety and enhances the excitement of the space. The quality of daylight and the effect that it creates can not be duplicated by artificial light. Aalto regarded daylight as essential to create a 'human fixture', and 'humane light'. Aalto has recognized that artificial lighting lacks physical and psychic qualities which are offered by daylight, that are essential to satisfy human needs. Daylight's adaptability to good vision (biological needs), and in general its quality in relation to man (psychological needs) seem to be the key factors for Aalto's preference for daylight.

"...The problem of reading a book is more than a problem of the eye; a good reading light permits the use of many positions of the human body and every suitable relation between book and eye. Reading a book involves both culturally and physically a strange kind of concentration; the duty of architecture is to eliminate all disturbing elements." - Alvar Aalto
2.2.2 Psychological Fulfillment

Because of the harsh climate of Finland most activities take place indoors. Finns love nature. The Finnish climate separates them from nature. Psychological connection to nature becomes important for well being. Aalto connects Finns to the outside (nature) by employing daylighting techniques. The very presence of sunlight makes one feel warm. So, introduction of sunlight into the interiors definitely has that comforting effect. Also, since people spend most of their time indoors, this allows them to keep in experiential contact with the outside world. Vladimir Slapeta in his “Organic architecture in Central Europe and Alvar Aalto” substantiates this idea.

“...in northern Europe people live too far away from Mediterraneaen region and traditionally yearn for warm sunshine. This fundamental feeling and yearning that also finds reflection in architecture. The large unarticulated facades of Alvar Aalto's constructions are oriented so as to catch the reflections of the horizontal rays from the “cold northern sun” and thus to create the illusion of more intense light than it really is. On the other hand, the semi-open and closed atria which are so typical of Mediterranean area are often used in north, too. However, their purpose is there not to offer shade as is the case in the south but to collect light and provide protection against the cold winds.”

-Vladimir Slapeta.

2.2.3 Climatic Relationship

Finland lies in a climate zone (between 60° and 70° N latitude) in which there is almost no daylight during long winter months and continuous daylight during most of the summer. Finland has four distinct seasons, each of different duration and intensity depending on the section of the country. Summer is warm, bright and intense. During summer solstice, the

day lasts for 19 hours in the capital, while in the northernmost part of Finland, the midnight sun is continuously above the horizon for 67 days. Conversely, in the winter the sun does not rise for 52 days in the north. Even in Helsinki, the shortest day in January is only six hours long. In addition the radiation is very weak because of the low solar altitude. To the north, the winter lasts longer than the other seasons combined. So, it can be easily understood why sunlight has special value in Finland. Aalto’s architecture responds accordingly and incorporates daylight prominently. This is particularly noticeable in such central spaces as atriums which provide ideal internal environments in the winter. Steven Groak suggests that this use of “central atrium spaces” is associated with Aalto’s preoccupation with the daylight and in particular, the path of the sun around the building.26

2.3 AALTO’S DAYLIGHTING TECHNIQUES

Significant works of Aalto are surveyed in order to observe the development of the daylighting systems he employed. Aalto developed several techniques to provide daylight in the interior environments and which were continuously refined and reused.

“...A low angled soft light – I call it lemon light – only peeks at the horizon for a few minutes during winter months, while during the endless days of summer it seems to float high above you in the sky – seemingly always perpendicular. Aalto understood the distinction between the lighting requirements for the winter and summer and developed a system language of light-giving devices: that are utilized in all his buildings.”27

- Richard Peters

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26 Ibid 18.
Prof Peters also conveniently categorizes the devices as follows:

1. **Rooftop lighting:** Referring to the horizontal openings in the ceiling/roof planes (Fig 2.4).

2. **Clerestories:** A system of openings in the vertical plane close to the roof (Fig 2.5.a). The treatment of the ceiling plane near the opening becomes important.

3. **Screened windows:** Wall windows with some kind of louvers to create a baffle effect. (Fig 2.5.b).

4. **Lighting Scoops:** Indirect system incorporated into the roof, usually facing away from the direct sun. (Fig 2.5.c).

### 2.3.1 Skylights (Rooftop Lighting & Lighting Scoops)
Most of Aalto's works are located in Finland which has overcast, diffuse lighting conditions where zenith is three times as bright as the horizon. Hence, it makes sense to have roof openings which can see the brighter portion of the sky dome. The northerly

![Image](image.png)

*Fig 2.4. Baker house, Cambridge, U.S.A.*
climate and overcast conditions of Finland require extraction of every solar lumen from the sun in mid-winters, and their introduction into the interior areas that are far from window walls. In view of this, the Skylights have a prominent role in Aalto's architecture. In almost all the buildings that I have surveyed (see Appendix 2) Aalto uses some kind of skylights. For the purposes of this discussion I combine Prof. Peter's Rooftop lights and lighting scoops and refer to them as “Skylights”.

“...Daylight through ordinary windows, even if they are very large, covers only a part of a big room. Even if the room is lighted sufficiently, the light will be uneven and will vary on different points of the floor. That is why skylights have mainly been used in libraries, museums, and so on.”

- Alvar Aalto

Sun light is treasured in Finland. Aalto traps as much light as possible in the public spaces (civic core) of his buildings and skylights are suitable for the following reasons:

- Skylights are a consistent source of daylight, especially in a northerly climate as Finland. With skylights it is easier to achieve uniform distribution and control the contrast levels in a space. Also, top lighting may reduce glare.

- Overhead lighting is natural phenomenon. It contributes to psychological well being. Perceptually we are used to seeing the modeling and shadows created by the overhead lighting in nature. For example, shadow patterns of the nose etc, formed by overhead lighting reveal the facial features of a person. Usually this character is the associated with the memory of a person. We may find it difficult to associate a person with facial features revealed by shadow formations in

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Ibid 20.
Fig 2.5  (a), (b) Municipal Library, Seinäjoki, Finland,  
(c) Mount Angel Library, Oregon, U.S.A.
any other way. So, it makes sense to use overhead lighting in social spaces where people meet other people.

- Keeps out the exterior acoustic noise. Especially when there is peace and concentration desired, such as in a classroom, an auditorium, or a church space.

- Vertical surfaces are visible from most of the interior space and are one of the key factors in building the character of a space. With the skylighting vertical surfaces are dynamically rendered with the changing patterns of the exterior conditions and provide a dynamic environment.

In view of the prominence of the skylights in Aalto’s architecture, and in order to perform a reasonably deep study within the time frame of this thesis I will focus on the study of “sky lit” central spaces.

Skylights in Aalto’s work are one of the most sophisticated and well developed devices. Table 1 on pages 26-27 shows that these skylight types have been prolifically used in almost all Aalto’s buildings surveyed in a variety of situations.
<table>
<thead>
<tr>
<th>BUILDING</th>
<th>LOCATION</th>
<th>SKYLIGHT FUNCTION</th>
<th>SKYLIGHT TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viipuri Library</td>
<td>Viipuri, Finland (presently USSR)</td>
<td>“Sunken” reading area</td>
<td></td>
</tr>
<tr>
<td>1927–33</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paimio Sanatorium</td>
<td>Paimio, Finland</td>
<td>Surgical theater block</td>
<td></td>
</tr>
<tr>
<td>1927–33</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turun Sanomat</td>
<td>Turku, Finland</td>
<td>Office space</td>
<td></td>
</tr>
<tr>
<td>1928–29</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finnish Pavilion</td>
<td>Paris, France</td>
<td>Exhibition space</td>
<td></td>
</tr>
<tr>
<td>1936-37</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospital for Zagreb</td>
<td>Zagreb, Finland</td>
<td>Auditorium</td>
<td></td>
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<tr>
<td>1930 – unbuilt</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Art Museum for Tallin</td>
<td>Estonia</td>
<td>Art galleries</td>
<td></td>
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<tr>
<td>1937 – unbuilt</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Baker House</td>
<td>M.I.T., Cambridge, USA</td>
<td>Central space (Three story high volume).</td>
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<tr>
<td>1947–48</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extension to Engel’s Library</td>
<td>Finland</td>
<td>Library space</td>
<td></td>
</tr>
<tr>
<td>National Pensions Institute</td>
<td>Helsinki, Finland</td>
<td>Carrels for counselling in a 3 story high volume</td>
<td></td>
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<tr>
<td>1952-56</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pedagogical Institute</td>
<td>Jyvaskyla</td>
<td>Atrium with stairs</td>
<td></td>
</tr>
<tr>
<td>1950</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rautatalo corporate office</td>
<td>Helsinki, Finland</td>
<td>Central atrium space with fountain, café, galleries</td>
<td></td>
</tr>
<tr>
<td>building</td>
<td>1953-55</td>
<td></td>
<td></td>
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<tr>
<td>Finnish Pavilion</td>
<td>Venice, Italy</td>
<td>Exhibition space</td>
<td></td>
</tr>
<tr>
<td>1956</td>
<td></td>
<td></td>
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<tr>
<td>Otaniemi Technical</td>
<td>Otaniemi, Finland</td>
<td>Lecture theater</td>
<td></td>
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<tr>
<td>University</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>1955–64</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Church at Vuoksenniska</td>
<td>Imatra, Finland</td>
<td>Prayer hall</td>
<td></td>
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<tr>
<td>1956-9</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Cultural Center</td>
<td>Wolfsburg, Germany</td>
<td>Auditorium, Library, Social spaces</td>
<td></td>
</tr>
<tr>
<td>1958</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Baghdad Art Museum</td>
<td>Baghdad, Iraq</td>
<td>Art galleries</td>
<td></td>
</tr>
<tr>
<td>1958</td>
<td></td>
<td></td>
<td></td>
</tr>
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(continued on page 27.)
<table>
<thead>
<tr>
<th>Project</th>
<th>Location</th>
<th>Feature Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Art Museum 1958-73</td>
<td>Aalborg, Denmark</td>
<td>Art galleries</td>
</tr>
<tr>
<td>Enso Gatze: Corporate head quarters, 1959-62</td>
<td>Helsinki, Finland</td>
<td>Central atrium space</td>
</tr>
<tr>
<td>Scandinavian Bank 1962-64</td>
<td>Helsinki, Finland</td>
<td>Central atrium space</td>
</tr>
<tr>
<td>Town Center 1959-65</td>
<td>Seinajoki, Finland</td>
<td>Conference chambers</td>
</tr>
<tr>
<td>The Academic Book Shop 1966-69</td>
<td>Helsinki, Finland</td>
<td>Central atrium space (three story volume)</td>
</tr>
<tr>
<td>Hostel for Students 1962-66</td>
<td>Otaniemi, Finland</td>
<td>Student lounge</td>
</tr>
<tr>
<td>Student House 1963-65</td>
<td>Uppasala, Sweden</td>
<td>Student lounge</td>
</tr>
<tr>
<td>Sports Institute, University of Jyvaskyla, 1964-70</td>
<td>Jyvaskyla, Finland</td>
<td>Atrium</td>
</tr>
<tr>
<td>City Electric Company 1964-73</td>
<td>Helsinki, Finland</td>
<td>Central Atrium</td>
</tr>
<tr>
<td>Library 1965-70</td>
<td>Mount Angel, Oregon, U.S.A.</td>
<td>Study area, Book stacks</td>
</tr>
<tr>
<td>Pohjola Insurance Office 1965</td>
<td>Helsinki, Finland</td>
<td>Central Atrium</td>
</tr>
<tr>
<td>Scandinavian House 1965-68</td>
<td>Reykjavik, Iceland</td>
<td></td>
</tr>
<tr>
<td>Riola Church 1966-78</td>
<td>Riola near Bologna, Italy</td>
<td>Prayer hall</td>
</tr>
</tbody>
</table>

Table 2.1 A chronological survey of significant works of Aalto with the predominant skylight type used in each case identified.

**Legend:**

- ![Conical](image)
- ![Conical with exterior electrical light](image)
- ![Pyramidal](image)
- ![Directional](image)

Conical | Conical with exterior electrical light | Pyramidal | Directional
Aalto took advantage of them in situations where floor plans are large (typically in central spaces), and are inaccessible to exterior walls and windows. Also, he demonstrated skylights as architectural tools for emphasizing central spaces in a poetic way. On the other hand there are several instances of using skylights in a functional way to achieve illumination for a specific routine task. Fig 2.6 provides one such example where Aalto used a conical skylight to illuminate a stairwell.

![Conical Skylight](image)

Fig 2.3 Functional application of Conical Skylight, Mill Workers Housing, Sunila, Finland.

### 2.3.2 Skylight Types

Table 2.1 identifies the major skylight types used in some significant buildings of Aalto. For a more complete documentation of skylight types used in central spaces of significant Aalto’s buildings, one can refer to Appendix 1. From this the following skylight types can be identified.

#### 2.3.2.1 Conical Skylights

Aalto’s search for soft and “humane” light early in his career and the knowledge gained at Viipuri resulted in the discovery of the “conical skylight” that provides indirect sunlight for
Fig. 2.7 Section of Conical skylight.

all angles of the sun. “Conical skylights” are more widely used than any other type by Aalto. The first significant appearance of conical skylight is in Viipuri library for the central sunken reading area. Several later buildings with office foyers, stair and social spaces have incorporated conical skylights in a variety of ways to crown or accent the spaces. On the other hand they have been used for functional lighting purposes as in Academic Bookshop (fig 3.7), Sunila mill workers housing (fig 2.6) etc. In the M.I.T. Dormitory (fig 2.4), external electrical luminaires were added which has continued in several later works such as Rautatalo (fig 2.14), etc.

2.3.2.2 Pyramidal Skylights

The “Pyramidal skylight” first appears in the Pensions Institute. It usually employs multiple layers of glazing (see fig 2.10 and fig 3.12), which houses electrical lighting fixtures and also serves as a thermal buffer. The most sophisticated version of this type can be found in Academic Book Shop. It is also used in a variety of ways and situations ranging from central activity zones to meditations spaces in churches.
2.3.2.3 **Directional Skylights**

The idea of "Directional skylight" appears to have originated during the design phase of Zagreb University Hospital competition entry in 1930. It was used in the Auditorium to indirectly light the audience and the demonstration area in two different ways. The Technical Institute auditorium is perhaps the first built example of this refined version of directional light. Basically the "Directional skylight" tends to hide the light source. It has

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**Fig. 2.9** (Left) Zagreb Hospital Auditorium, (Right) Auditorium of Helsinki Technical University.
been used in a greater variety of ways than any other type. Generally, it is associated with lecture halls, meeting places, and libraries.

2.3.2.4 MISCELLANEOUS SKYLIGHTS

They are combinations or variations of the above three types, devised to suite a specific context. Aalto's Libraries present good examples, expressing his desire to use indirect light.

Pedagogical Institute of Jyväskyla (fig. A.8), Scandinavian Bank (fig. A.17), Sports Institute at University of Jyväskyla, present good examples for variations of “Conical Skylights”.

Church at Vuoksenniska (fig A.12), City Electric Administration Building (fig. A.23), Pohjola Insurance Office (A.25), Scandinavian House (fig. A.26), Riola Church (fig. A.28) present good examples for variations of “Pyramidal Skylights”.

Helsinki Technical University at Otaniemi (fig. A.11), Aalborg Museum (fig. A.15), Town Center at Seinajoki (fig A.19), Library of the Mount Angel Benedictine College (fig. A.24) present good examples for variations of “Directional Skylights”.

Wolfsburg Cultural center (fig. A.13) is a classic example for the combination of all the three types.
2.4 AALTO SKYLIGHT TECHNICAL COMPONENTS, CONTRIBUTING FACTORS

Aalto was interested in the use of indirect light and has mastered the use of daylight by devising many skylights with a baffle effect avoiding the harsh contrast that accompanies the direct rays of the sun. Some of the characteristic features of the skylighting systems devised by Aalto are as follows.

2.4.1. Skylight Cavity

![Skylight Cavity Diagram]

Fig. 2.10 Fuller Moore's analysis showing the effect of sloping lightwells.

The opening through the ceiling / roof volume in Aalto's skylights is characterized by:

1. Sloped sides
2. White painted matt surface treatment (interior lining)

A sloped skylight well diffuses light admitted through a small roof opening over a larger area before entering the room cavity. In addition it shields the direct sunlight from entering the room directly. The white matt lining does help multiple reflections by diffusing the light and thus making it softer. It also whitens the light which is critical relative to the
Fig. 2.11 Aalto incorporates skylight cavities to diffuse light: (a) conical skylight, (b) pyramidal skylight, (c) directional skylight.
Lemon light in Finland. This greatly helps the color rendition of the interior. Fig 2.11 shows Aalto's use of the skylight cavity in three types of skylights.

"The concrete cones are so constructed that the sunlight always remains indirect. The surfaces of the cones spread the light in millions of directions."—Aalto

2.4.2. Exterior Reflection to Skylights (Creation of a local climate)

In most multistoried commercial buildings, Aalto creates an exterior well in the center of the building. It is surrounded by higher floor offices. These office spaces have several (in most cases continuous strips from wall to wall) windows opening into the well. The skylights are in the well, i.e. the skylight is at the bottom of the well embraced by four vertical planes (offices). These vertical planes with much glazing on them reflect substantial amount of light and make an indirect source of light for the skylights.

Fig. 2.12. Sectional view of Rautatalo building.

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Ibid 20.
2.4.3. Glazing Materials

Aalto uses clear glazing in all his buildings. This provided the most suitable conditions for solar heat collection, viewing, interior color rendition, and quantitative light. Aalto makes use of double and triple glazing as a thermal barrier.

2.4.4. Transparent Surfaces

Fuller Moore discusses the effects of surface configuration of the glazing above and below the ceiling plane. He suggests that if the skylight uses clear glazing the effect is negligible in terms of reflection geometry. However there are other advantages which Aalto fully exploits.

Shape of the skylights above the roof plane:

![Diagram of skylights](image)

Fig. 2.13 Shaping of Aalto's skylights above roof plane; (a) conical, (b) pyramidal, (c) directional.

Aalto shapes them such that they do not accumulate snow (see Fig. 2.13). Also, notice that the snow cover as shown in (b) and (c) of above figure contributes to reflecting more light into the interior of the room.

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2.4. Shape of the skylights below the roof plane:

As in Aalborg Museum (Fig. A.15), Academic Bookshop (Fig. A.19), Scandinavian House (Fig. A.26) etc., the bottom portion of the skylight is so modelled as to reflect some light onto the ceiling. In addition, this contributes to the softer framing of the skylight aperture.

2.4.5. Interior Distribution of Light

Aalto's interiors are always white or some close color. Materials and textures used in the interior help multiple reflection of light thus diffusing it further. The ceiling plane is always white and is used as a principle reflector. This helps distribute the light, and bring down the contrast levels and harshness of the interior.

2.4.6. Articulation of Skylights

(a) Structure: The skylights are so well articulated into the building structure that they become integral part of the design theme. The following pronouncement of Aalto helps us understand his philosophy in this regard better.

“...It is possible in a scientific way to ascertain what kinds and what quantities of light are ideally the most suitable for the human eye, but in constructing a room the solution must be made with the aid of all the different elements that architecture embraces. Here the skylight system is combined product of the ceiling construction (a room almost sixty feet wide needs a ceiling construction with beams height enough for the erection of the deep cones) and special technical limits in horizontal glass construction...”\(^{31}\) - Alvar Aalto

\(^{31}\) Ibid 20.
(b) **Electrical light:** Aalto's preoccupation for naturalness called for overhead lighting. This is speculation can be substantiated from the fact that skylights were equipped with external electrical lamps to maintain the character of light brought in the space. Aalto was sensitive to the design of artificial light which becomes important in the winter conditions. Aalto considered the distribution of artificial light by following the same principles as the daylight when he designed lighting fixtures for each building. This luminaires also help melt snow in some cases.

![Image of skylights](image)

Fig. 2.14. An exterior view of skylights in Rautatalo building.

We will study the more about the similarities and the differences of these types in the following chapters.

### 2.5 Thematic Relationships

The relationship between the skylight type and its specific spatial use can be organized as:

- **Chronology** (fig.2.15)
- **Type** (fig. 2.16)
- **Function** (fig. 2.17)
Fig. 2.15 Chronological arrangement of significant works of Aalto. Skylight types used in the central spaces in each case are indicated by using the same notations as in Table 2.1.
Fig. 2.16 Classification of works of Aalto by the skylight type. Chronological order is still maintained.
Fig 2.17 Formation of Subgroups based on the similarities in the essence of human function of the spaces. Author's motivation is to observe if Aalto's choice of skylights is rule-based. This arrangement suggests no such preoccupations and we can observe that each device has been used in a wide variety of ways.
The basis for this outline is the William C. Miller's approach to themes which analyzes the works of Aalto and "Family Tree" arrangement published in A+U extra edition on Aalto. The Chronological arrangement shows the origins of each skylight type. Aalto's projects possess a rich variety and each must be treated individually, case by case. One cannot fit Aalto's works into a topological order. Comparative analysis illustrates the following points:

1. Reoccurrences are irrespective of chronology.
2. Skylight types are integrated into the space such that the light suits the human function it illuminates.

2.6 SELECTION OF CASE STUDIES:

Having identified the types of skylights, I have decided to study three discrete spaces that meet the following criteria.

- The space should provide a good example for the exclusive use of a one of the three skylight types.
- The space should have been acknowledged as one of the very best, in terms of lighting design by a good cross-section of the architectural scholarly community including architects, lighting designers, historians and critics.

After a survey of significant Aalto's buildings (shown in Appendix B), I have chosen the following three spaces for the case study:

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2.6.1. **CASE FOR “CONICAL SKYLIGHT”**

“Central atrium space” of the Rautatalo Building, Corporate head quarters for Iron Millers, Helsinki, Finland makes a good example for the use of conical skylight. This space serves as a formal foyer space for the offices, and piazza like urban space for social interaction. There is a coffee shop with open cafeteria seating arrangement under the balcony space. This space is naturally lit using a conical skylighting system. The Rautatalo atrium space is a major success in Finland and set a trend for interior social spaces such as shopping malls etc., in Finland.

2.6.2. **CASE FOR “PYRAMIDAL SKYLIGHT”**

“Central atrium space” of the Academic Bookshop, subsidiary of Stockman’s books stores, Helsinki, Finland makes a good example for the use of pyramidal skylight. The Finns are renowned as the world’s most voracious buyers and readers of books. This space serves as a market hall for books with an informal imagery. This space is naturally lit using three huge pyramidal skylights suspended in the ceiling, and compose the major visual elements in the space. The pyramidal skylights used here are acknowledged as the most sophisticated versions of the pyramidal skylights. The Academic Bookshop building is a major success in Finland.

2.6.3. **CASE FOR “DIRECTIONAL SKYLIGHT”**

“Prayer hall space” of the Riola Church, Parish community Church, near Bologna, Italy makes a good example for the use of directional skylight. This space serves as a church and the community assembly hall. Aalto’s wife and co-designer of this building expresses the intent here to help the churchgoer into concentration and devotion. The traditional
notion of a church is, especially in Italy, a peaceful, enclosed sanctuary like place\textsuperscript{33}. This space is lit by a north facing "directional skylighting system" which is composed of curvilinear scallops, and vertical windows placed high up in the ceiling construction. The lighting in Riola is acknowledged as one of the best by renowned architectural lighting experts such as William Lam, Fuller Moore, and Henry Plummer.

CHAPTER III

CASE STUDIES

"The study of light is some thing more than a mere investigation of illumination. Light and things belong together, and every place has its light. Light, things and places can only be understood in their mutual relationship. The pheneromology of things and places is also the phenomenology of light."34

- Plummer

In this chapter we are going to look into three significant buildings of Aalto with the intent of understanding how Aalto handled natural light in the figural central spaces. Each of this buildings is representative of a skylight type. They also possess variety in terms of the human needs to which they cater. The framework of the analysis35 of these spaces consists of identifying: (i) primary elements (the essence of human function they serve) (ii) morphological elements (physical components of the enclosure such as walls, floor, ceiling etc.,) (iii) time and memory (cultural basis associated with the design of the space).

In relation to each of these categories, we will examine how lighting influences each of them. Finally, we will express conclusions as to Aalto’s intent in designing the lighting systems.

"the luminist wishing to experience life rather than data seeks a different kind of spatial phenomenon, one which is invigorated instead of merely conveyed by light."36

- Plummer

35 Adalto Natalini suggests this line of thinking in his Figures of Stone.
36 Ibid 34.
We will also examine how the choice and the detail of the skylights relate to the climate, function, personal relationships, formal implications and the visual tasks of the place.

3.1 CASE 1 RAUTATALO BUILDING
HELSINKI, FINLAND. (DESIGNED IN 1952, BUILT 1953-5)

Rautatalo meaning "Iron house" is the head quarters building of Finland's Association of Iron Dealers and occupies a significant as well as cramped urban location. Proximity to several significant public buildings such as the Finnish National Theater, the Swedish theater, and the University of Helsinki creates a potential for attracting crowds. Shops occupy the entire street level and mezzanine level and the first floor houses the hall which this study addresses. The upper floors provide office space. One of the significant things about this building is the way Aalto dealt with the Urban complexity by using a central atrium to make a cultural statement.

3.1.1 PRIMARY ELEMENTS

The top-lit central court symbolically serves as an entrance foyer for the offices above and as circulation space for the shops. The space beneath the office balconies houses a coffee shop with seating area which serves the people working in the offices, shoppers and the general public. There are three kinds of activities talking place around this foyer space.
Fig. 3.1 Plans, Section of Rautatalo Building.
1. Office circulation. People waiting for elevators at the foyer level and those walking at higher levels.

2. People visiting the Shops.

3. People using the Coffee Shop area.

3.1.2 Morphological Elements

The balcony walls, columnade, screen walls, planters, flooring, and ceiling constitute the major elements of the planar composition defining the space. Screen walls clad with blue and green ceramic tiles stand at each end of the hall. These are typically found in public spaces in Aalto’s buildings. The balcony walls stepping back in ascending order are clad with travertine which becomes a typical feature in several later works, particularly office buildings. The columns are exaggerated and textured to look monumental giving an effect of columnade. The planters are attractively placed such that they separate the cafe area and define the edge of the central hall and some creep up the balcony walls linking the upper floors, further signifying the centrality of the central hall. The monumental columns seen in the first floor do not continue in the upper floors thus distinguishing the public space from the office space. Also, it should be noted in this connection that the walls of first floor are treated with wooden battens making a vertical texture, where as the walls of upper floor offices are planar, off-white painted stucco finish. There is a fountain which is generally empty placed at one end of the hall. The flooring, fountain, planters are of white carrara.
Fig 3.2 An interior view of Rautatalo building central foyer space devoid of any activity.

The interior court is naturally lit by forty conical skylights. The ceiling modulation is planar and the placement of skylights adds linear spatial emphasis. The shape of the conical skylights as seen from the inside is circular and acts as a neutral element in terms of composition. Also, unless one looks up, the sky or sun is not directly visible through the aperture of the skylight. The colors used in the interior hall are mostly white and the materials used are mostly natural except the blue ceramic tiles on the screen walls. The most striking feature of this space is the intimateness of the scale.

3.1.3 Cultural Aspects

Drinking coffee with friends is culturally significant in Finland. Until Aalto designed this space, this event could not occur during winter months because of the climatic effects on the open air cafes. The Rautatalo open cafeteria arrangement provides just the right
atmosphere for this social gathering all year round, a piazza like urban space where people can meet other people, watch people and spend some time at leisure.

"...Aalto therefore sought with Rautatalo a covered piazzetta and its open-plan cafe to bring to the Finnish capital the social advantages of the Mediterranean climate. The Rautatalo cafe became an instant success and is always well patronized, in fact it fulfils precisely the function and ritual that Aalto had in mind"\textsuperscript{37}.

- Malcom Quantrill

Figure 3.15 shows the circulation pattern in the building. The Skylight hall is approached from the street level by a flight of stairs. There are vertical circulation elements such as stairs and elevators to go to upper floor office spaces. This point constitutes the place of

![Image](image-url)

Fig. 3.3 Fountain, Planters in the skylight hall in the Rautatalo building.

entry or threshold to the building. The skylight hall can be seen from this point revealing the grandeur of the office building. Here, Aalto is providing a grand atrium space for an

Institutional building, so people can look into, pass by, or be there. Beyond this point, it is interesting to note that there is no distinctly defined path going through the central space though intended for use by every one. Though it is shorter to access the cafeteria by walking diagonally across the hall people prefer walking along the edge defined by the balconies overhead.

The foyer space basically serves as a neutral space in the center. It can be used for circulation by the shoppers, office people, or the coffee drinkers. There are no specified path patterns in this space. One is at his or her own free will to choose the path. However, Aalto also provides path around the foyer space reflecting his understanding of the introverted nature of the Finnish people.

The arrangement seating and the placement planters differentiates the cafe area from the central hall. As pointed out by Quantrill, psychologically it is more soothing to mix with people in the cafe and look into the central space than to be walking across the court and gather everyone’s attention. The planters, fountain, the stone bench (fig. 3.3) which are typically found in piazzas in Italian hill towns which Aalto admired all through his life, add a monumental touch and make the space feel like a public space. The space is replete with diffuse soft light. The materials like marble, blue ceramic tiles used for major horizontal and vertical surfaces in the atrium are usually used for the exterior finishing. It looks obvious that Aalto deliberately created this monumental feeling and designed the path around to enhance the centrality of the space. This monumentality also symbolizes the grandeur of the foyer of a corporate building.

"The Rautatalo piazzetta and cafe comprise an outstanding contribution to the complexity of urban life in Helsinki; and internal shopping malls became the vogue in Helsinki during the 60s, although none is as successful as Aalto’s. In his Rautatalo design he succeeded in raising the office and
commercial building to the level of a social and cultural statement, much of the success of which depends upon the intimacy of its small scale. 38" - Malcom Quantrill

38  Ibid 31.
Fig. 3.4 Rautataло foyer space with human activity.
3.1.4 Lighting

The qualitative lighting objective in atria is to create sparkle and the visual interest of a sunlit outdoor scene.

Visual Task

To create a neutral space where people can go, pass by or look into. To provide uniform, horizontal lighting conducive for revealing facial features, clothing, etc., for interpersonal communication.

Daylighting Technique

The Central court is a three storied volume articulated in a well formed by the higher floors accommodating offices (see figure 3.6). There are forty roof monitors placed close to each other on the roof at fourth floor level as shown in the fig. 3.5. The external electrical lights to the skylights can be seen in fig.2.8 in Chapter 2.

Fig. 3.5. Sectional view of Rautatalo foyer space, showing the reflection geometry.
The skylights used here are the same as those used in the central reading space in Viipuri Library. The skylights are fitted with external electrical lamps to supplement lighting in the winters and during night times. The sectional geometry of these skylights is developed so that they do not let the direct sun rays in (see Fig. 2.5, 2.9).

The following observations made by Fuller Moore on Aalto's conical skylights is helpful in understanding their mechanism.

"...At Wolfsburg, due to the low ceiling height and the small, shielded configuration of the perimeter scoop, central illumination is supplemented by a field of small, round skylights with clear, horizontal glazing. The ceiling thickness forms a well to minimize direct sunlight penetration. The well is conically shaped, with smooth, white plaster sides. Diffuse light from the skydome is admitted directly. On clear days, however, only the upper part of the well is sunlit. The bright surface, in turn, illuminates the space below, as well as the remaining white plaster sides. Diffuse light from the skydome is admitted directly. This bright surface, in turn, illuminates the space below, as well as the remaining white surfaces within the well. Because sunlight typically strikes only the uppermost part of the well (unseen at normal viewing angles), and because other lower part of the well is smoothly curved, matted white plaster that appears evenly bright (due to the diffuse interreflections within the cone), these wells have the appearance of horizontal luminous disks in the plane of the ceiling. Their true shape is apparent only when the occupant intentionally looks up. This same devise is found in many Aalto buildings, usually in a single line (such as above a corridor), reinforcing a linear spatial emphasis." 39

- Fuller Moore

At this juncture, we can observe that some of Aalto's principles we have discussed in section 2.4.2, Chapter 2, are implemented here. The office floors above block the direct sun at the same time their wall surfaces reflect substantial amount of light from different

39 Ibid, Pp 43
directions onto the roof monitors which are fitted with clear glass. The light undergoes multiple reflections on the 5 feet deep, white conical interior surface of the skylight. White marble clad surfaces balcony walls (about 7 feet high) further reflect the light striking them.

Each ray of sunlight undergoes millions of reflections achieving a really soft, fluid quality by the time it really reaches human senses. Most of the interior surfaces are white in color, which helps the multiple reflections and in turn, not only causes uniform distribution of light but reduces the contrast levels. Since the light entering the space is mostly indirect, i.e. reflected by the sky and the wall surfaces (both interior and exterior), it is stable throughout the day in terms of its directionality. The coffee shop area in the first floor is illuminated with electrical lighting. So, the day light is predominantly serving one purpose i.e. of illuminating the the central atrium.

The Impression

The atrium gives an impression of an exterior space. The following can be identified as the contributing factors:

- The materials used such as marble for the balcony walls and the flooring and the blue ceramic tiles are typically found in the exteriors of the buildings.
- The planter creeper, plants, the fountain, and the bench add a flavor of an outdoor space.
- Scale contrast with the entry, the space under the balcony.
- Contrast between the electrical light and the daylight. The atrium is predominantly illuminated by the daylight where as the surrounding subsidiary spaces are illuminated by electrical lighting.
One perceives a daylit space differently than an electrically lit space. This is because of the softness and the dynamic of the daylight. The approach to the atrium space is from the street through stairs and a small lobby space lit with electrical lighting. There is a visual stimulation as one glimpses the spacious three story, uniformly daylit space from the relatively narrower and electrically lit lobby. This also applies to the people walking from one office to another in the upper floor balconies.

Daylight adds perceptual dynamic to the modeling and the plasticity of the atrium space. The architectural surfaces take different values and colors by the direction, movement and quality of sunlight and the sky conditions. Dark blue ceramic tiles turn gray under overcast skies, the white marble reflects the hue of everchanging light of the day, from soft purple in the early morning to the bright white of midday to warm pink at twilight. The interested reader is referred to study the color photos on page 98 in Alvar Aalto: Architectural Monographs 4, and Page 55 A.I.A. Journal / September 1979 which show the changes in modeling for different lighting conditions.

Most of the activity at the atrium level is created by the Coffee shop. Fig 3.1 shows the open cafeteria seating arrangement under the balcony space. This space is lit with electrical luminaires (point sources), typical non-uniform "task-oriented" restaurant lighting. The individual seating units are accentuated by overhead electrical luminaires. The lighting, the ceiling height, the furniture, and the surface textures give this space a character of an "indoor space". A person sitting in the coffee shop area has view from an indoor space into this outdoor like space. The lighting used here reinforces the respective themes too. The point sources of electrical lighting give the coffeeshop space a character of an indoor space. Also, the lighting levels for this electrically lit space are stable, where as the atrium space has perceptual dynamic of the daylight.
**Personal relationship**

A person sitting here can have a cup of coffee and food, a little chat with another person and can watch the people entering the building, people walking from one office to another, people shopping, and people walking into the Coffee Shop.

Because of the multiple reflections off the surfaces of exterior light well, skylight cavity, and the architectural vertical surfaces of the balcony walls, the light reaches horizontal working spaces at an almost horizontal angle. Such a light is ideal for revealing the facial features softly and builds a mood for interpersonal communication. Similarly the electric lighting mounted externally strikes the sides of the skylight cavity and the vertical surfaces of the room and reaches the horizontal working surfaces at an angle. The multiplicity of the rays of light tend to reduce the glare.

**Impression of the skylight form**

The skylights appear as bright planar circular disks arranged linearly. Morphologically the Circular shape is neutral. Their linear arrangement gives the ceiling a horizontal and neutral modulation.

Perhaps, that is why Aalto repeated this system of lighting in several atrium, social spaces where people meet other people in his later works such as Esu Getzt, Scandinavian Bank, M.I.T. Dormitory, Student House, Student Hostel etc (See Appendix 2).

Because of the uniformity, the character of the daylight is calm and it plays a neutral role in providing an ideal setting for people meeting other people.
3.1.5 Intent

A fountain, a planter, a plant creeper, a screen wall, a bench exist in the central area surrounded by solid, planar balcony walls. These are the typical elements one finds in piazzas of Italian hill towns, open places for social interaction. The Rautatalo central hall space is acknowledged as a phenomenological derivation of the Italian piazza. However, Aalto adds a tone of regionalism here by enclosing it indoors and making it meet the specific cultural needs of Finnish.

The people walking in the upper floor balconies pass by this space. The people shopping pass through this space. The people drinking coffee look into this space or they can be there.

The seating arrangement is segregated from the central hall so the Finnish people who are “environmentally shy”\(^{40}\) can look into the central space while having a cup of coffee with their friends. At the same time the seating arrangement is flexible enough so that if one wants, one can drag a chair and sit in the central hall. In fact, most of the photographs show this space as devoid of any activity. On the other hand, another picture (shown in figure 3.6) shows some activity as well as indicating that the seating arrangement is flexible.

The creepers crawling over the balcony walls add a monumental touch giving a feel of ruins. The theme here is a new urban social space for the Finnish with the advantages of an Italian piazza. The lighting theme associated with revelation of the space reinforces this idea. The light is calm and displays the space and objects of interest such as the fountain

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\(^{40}\) Ibid 31.
and planter. The light touching the objects displayed here is fluid and inert in the sense it does not change with the position of the sun. Plummer, states that homogeneous realm of levelled even and clear light induces a state of permanence to the space.
Fig 3.6. An interior view of Rautatalo skylight hall with activity near the Coffee shop.
3.2 CASE 2. ACADEMIC BOOKSHOP
HELSINKI, FINLAND. (DESIGNED 1962, BUILT 1966-9)

The Academic bookshop is a subsidiary of Stockman’s bookstore and is one of the largest and most significant bookstores in Finland. This building is located on the same street as the Rautatalo building with Saarinen's cooperative bank separating them. Hence the challenge of the site in terms of urban complexity is almost the same in both cases. As in the case of the Rautatalo building, the top-lit interior volume of Academic bookstore is the most intriguing element, wherein Aalto took the cultural statement made in the Rautatalo building, one step further.

3.2.1 PRIMARY ELEMENTS

The bookshop is primarily a shopping place for books. First, second and part of third floors cater to display and sale of books while the upper floors serve the administrative needs. The first floor is directly accessible from the street through a lobby which also houses vertical circulation core for the upper floor office space. The second floor is almost an extension of first floor which can be accessed by escalators. There are two entrances into the building leading into a entry lobby. The arrangement of the book shelves essentially defines the path. There is a major central aisle formed by the arrangement of numbered book counters in the central space in the hall which continues to the end of the hall with sub aisles on either side to access the counters. There are two escalators leading to the second floor as one progresses into the central space from the entrance lobby. There is
Fig. 3.7. Academic Bookshop; Plans, Section.
a passage defined by the arrangement of the shelves which goes all the way around along the balcony wall. There are taller bookshelves arranged perpendicular to the walls first floor at escalator end forming sub aisles. There are categorized book counters arranged in a similar way as in the of second floor. The open arrangement of the bookshelves strikingly and colorfully displays books. The Space under the escalators is used for cash counters. There is scope for human movement and activity almost all over the store area.

Fig. 3.8. An interior view of Academic Bookshop.
3.2.2 Morphological Elements

Undoubtedly the first thing to catch a shopper’s attention the moment he / she enters the interior space is crystal like skylights appearing to protrude into the interior space through a polygonal aperture in the plain ceiling. Modulation of the ceiling makes one of the most interesting features. The ceiling is painted white. The scale of this skylights is interesting. They are sized (measure approximately 19’ x 9’) such that the aperture is large with minimal ceiling area in between them. Typologically the skylight is an improvisation of the skylight used previously in the Pensions Institute. It is detailed with the great artistic mastery of Aalto to appear like an interesting object. Detailing of the skylight and the principles lighting involved are discussed more elaborately in the next chapter.

The balcony walls, columnade, flooring, and the ceiling are the major planar elements defining the space. The flooring is wooden textured and is harmonious with the book cases. Bookshelves are the major visual elements in the space. There are two types of display book shelves. One of them is a regular vertical type about 8 feet tall and is chiefly placed on the periphery, along the walls and beneath the upper floor galleries on both floors. The other is a counter island type, especially designed to display books more elaborately. These are centrally placed in rows on either side of the main aisle in the first floor and along the main path in the second floor. They are numbered and categorized. In addition, they are placed all along the balcony wall in the second floor with a slight variation in design. They are the main focus of human activity.
Fig. 3.9. Island type book shelf Aalto uses to display the books in the central space.

As in Rautatalo the balcony walls are clad with white carrara marble and step back in ascending order creating galleries at higher levels overlooking the central space. The columns are exaggerated in proportion and with typical "Aalto-esque textural treatment" stand in a row on either side of the court making a major vertical element. However, it is noticeable that as in the case of Rautatalo, the columnade is not extended beyond the second floor, distinguishing the public spaces and office spaces. The third floor walls are painted off-white almost as in Rautatalo.

3.2.3 Cultural Aspects

Finnish people are widely known for their enthusiasm for reading and the book store has special significance in Finnish society. The Academic Bookshop is an extension to Stockman’s store which was one of the largest stores in the country at that time. Aalto made the Bookshop to meet this imagery and provided for one of the major social activities of that society, i.e. shopping for the books. Quantrill makes some interesting observations in this regard which help to understand what Aalto was trying to achieve.
"...Both Pensions Institute and Iron house are tentative exercises in this genre since they have a purely visual rather than a completely physical and social interaction between the lower level and the galleries above. In the academic Bookshop, however, Aalto was able to achieve the perfect marriage between commercial function and urban complexity. What was missing in Rautatalo piazzetta was the sheer intensity of human activity. The Finns were renowned in spite of the exorbitant price of print in their country as the worlds most voracious buyers and readers of books." [41] -Malcom Quantrill

3.2.4 Lighting

The sectional geometry used here, as a three story volume, is very similar to Rautatalo, with a central hall and stepping balconies. We can observe the application of "the exterior well" element to create a "local climate" (recall our earlier discussion in section 2.4.2).

Fig 3.10. Sectional view of Academic Bookshop showing reflection geometry

[41] Ibid 31. Pp 165-169
Simulation studies for different positions of sun show that the light in Rautatalo is stable and steady whereas light in Academic Bookshop has direction and intensity as typical exterior lighting. At times a direct incidence of sunlight strikes through the skylights into the interior, especially during the middle of the day leaving a high brightness in the interior. The bottom layer of triple glazing system used in the skylight glows, as the result of internal multiple reflections between the facets of glass, like a crystal.

Observe Fig 3.11 an incidence of sun in the interior space. Simulation studies show that this creates bright patterns on the interior surfaces such as the balcony walls and which change dynamically during the course of the day (we will discuss more about this in the next chapter).

Fig. 3.12. The layering of the "Pyramidal Skylight" used in Academic Bookshop.

"...Light and shade charge space with optical forces. The frozen air begins to stir, to acquire directions and stresses. Bright zones advance and expand perceptually, while dark areas recede and shrink."

- Henry Plummer

Bright zones focus our attention.

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42 Ibid 34. Pp 75-136
Visual Task

Primary visual task is to create high contrast lighting conducive for reading the dark print on light background. The qualitative lighting objective in a Bookshop is to create an excitement of a market place. The books are to be displayed in such a way that the eye can glance at and search for different books. At the same time, the space should be replete with the excitement of shopping activity. The visual senses are to be stimulated and are attracted to several dynamic optical forces in the space.

Aalto's Daylighting Techniques

The central atrium space is lit by three pyramidal skylights suspended from the ceiling. The book cases in the second floor level are lit by a combination of sidelighting through the south facing windows supplemented by overhead fluorescent lighting arranged in regular geometric grid. The third floor level has supplementary electrical lighting (point sources with spherical distribution).

Because of the exterior light well and the 6 foot deep skylight cavity, light is diffused and reflected from vertical surfaces above the ceiling before entering the building interior spaces. Then it is reflected off the white walls and the marble clad balcony walls. The result is a space replete with light coming from multiple directions without glare for the most part.

There is some direct sunlight and the sparkles of the sunlight reflected off the glazing surfaces of the exterior light well hit the interior architectural surfaces such as balcony
Fig. 3.11. An interior view of Academic Bookshop. Notice the incidence of the sun on parapet walls.
walls, book cases and the flooring. The sparkles created by the brightness patterns on the vertical surfaces are more effective in creating excitement as they can be seen from most part of the interior.

The Impression

First thing one perceives as one enters the bookshop interior is the dynamic form of skylights protruding into the space through the ceiling. Overall, the interior of Academic Bookshop is perceived as a dynamic space full of excitement and human activity.

As shown in Fig 3.11. a person in the first floor level is in the midst of heaps of books, because of the open arrangement and spaciousness of the space. One can see the human activity around the space, and the sparkles on the vertical architectural surfaces. The person at second or third floor levels gets to see the excitement from another view. At higher levels one can also see the sparkles created on horizontal as well as vertical architectural surfaces. The lighting at different levels is different. The second floor level has windows providing sidelighting and street views. The third floor level relies mostly on electrical lighting for the display of books in the vertical book shelves. There are no horizontal book display at this level. The experience at this level is very different, as there is not much human activity happening here.

Direct sunlight streaming in creates sharp shadows and sparkles. In toplighting the walls (vertical surfaces) are the most important illuminated surfaces as they are visible in most of the interior space. By intercepting the direct sunlight, the balcony walls are redistributing the light to the desired surfaces and areas. The balconies are clad with polished white marble which reflects the hues of the striking light. Because of the crisp and changing patterns of the sunlight on these illuminated walls, they can be a satisfying substitute for a
window view, satisfying the biological information needs for orientation. We can see from Fig 3.11 the direct sunlight on the balcony wall creates interesting patterns of light and shadows of the skylight frame. The sparkles on the colorful display of books, banners at the eye level as well as those suspended in the air and hung on the balcony walls create patterns of light and shade which together with the bright colors charge the space with optical forces. These optical currents stimulate the visual senses, which liberate people to imagine and to take action.

“A charged light-field arouses its occupants in various ways. The most immediate resuscitate is visual, as we are released from the sensory-deprivation tanks of objective space, and instead, are perturbed by a world of provocative stimuli and currents. Yet beyond this encircling vivacity, an optical field also enhances aliveness by liberating people to imagine and, very often, to take action. ...We are given opportunities to respond and act “in”, “through”, and in relation “with” the world, to move and settle with some personal initiative and human dignity, to envision and perform deeds that reaffirm our selfhood, and thus engage in the most human activities we know—freedom, creativity, and play.”

- Henry Plummer

**Impression of the skylight form**

The pyramidal skylight hardware is totally exposed and uses three layers of clear glazing. The detailing of the skylight is handsomely executed, and makes it a positive design feature rather than purely functional use. The form is visually dynamic and appears as if a crestal drooping from skies, protruding into the innerspace through the ceiling. This makes the people inside feel closer to the light. The clear glazing also allows a glimpse of the sky to be seen evoking a positive emotional response.

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43 Ibid 34.
3.2.5 INTENT

Rautatalo and the Academic Bookshop provide two different experiences. Most notable is the intensity of human activity. As noted earlier, the Rautatalo atrium space is devoid of any human activity most of the time. Whereas in the Academic bookshop there is lots of activity planned in the central space and it is visible all the time.

“Aalto’s atrium for the Academic Bookshop, is more in scale with a subsidiary hall, the frigidarium, say of Hadrian’s therame at Leptis Magna or to seek a more modern image, which surely was in Aalto’s mind, that of the nineteenth century market hall”44. - Malcom Quantrill

Aalto is providing a dynamic informal environment, where people can spend time at leisure shopping for books. The design of the the counter island book cases displays the books such that one can glance at it and the eye can search for different books. Their arrangement defines the circulation pattern pattern in an informal way. The skylightgs are the most dominating visual elements in the interior. Their sculptural treatment together with the colorful display of banners supended from the ceiling and posters on the balcony walls and book counters add a festive charactor to the interior.

44 Ibid 37.
3.3 CASE 3. RIOLA CHURCH  
NEAR BOLOGNA, ITALY. (DESIGNED IN 1966, BUILT 1976-8)

This church, designed in 1966, is part of parish center complex. It was not built until 1978 after Aalto's death. Thus, the construction drawings and the details were not prepared by the master but by his associates. Though located in the country side, the site planning of the complex appears somewhat urbanistic. The main square in the front, the parish house, the freestanding bell tower, and the landscaping are yet to be completed. The church and the community assembly function share the same space.\(^{45}\)

3.3.1 PRIMARY ELEMENTS

This church serves essentially as a place of meditation (spiritual) and and for congregations (community meetings) of parish community. The Altar is located in the main hall of the church at one end with a baptistry and organ located adjacent to its left side and priests quarters on the right side. The rear wall has a collapsible door opening into the raised piazza (platform) which is used as the main entry. The seating is arranged on either sides of the aisle between the rear wall and the altar with flexibility serve both meditation and congregational purposes. This hall can be divided by a "canvas partition" housed in a channel, to serve the congregational purposes.

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Fig. 3.13. Riola Church, Plan, Section, Elevation.
3.3.2 Morphological Elements

The plan of this building is derived from Aalto's typical fan shape and is extended into the third dimension. The space is modeled on a perspective grid with the altar as the focus. Six portal frames support the four curvilinear scallops which allow day light into the space. The forms used in the interior are highly plastic and idiosyncratic. The entire interior is colored white. The geometry of the surfaces defining the space is not planar but is plastic and treated in a idiosyncratic way which is typical of Baroque. One can not agree more with William C. Miller's remark that the section of Riola Church is a synthesis of form, space, structure, and light.

3.3.3 Cultural Aspects

Traditionally especially in Italy the notion of a church is a peaceful, enclosed, sanctuary like place. The same notion is maintained here.

"...the church does not open into the scenery but with its closed walls and plain form has an intention to help the churchgoer into concentration and devotion. The church hall is nevertheless full of light which softly enters the room through windows placed high up in the ceiling construction."46

- Elisa Aalto

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46 Ibid 45.
3.3.4 Lighting

Fig. 3.14. Sectional view showing the reflection geometry in Riola Church. Different concentrations of light at different parts of the space in this building, with no clue where it is coming from creates a "mystic feeling".

Aalto used directional skylight with more variations than any other types. In Lecture Theater in the Helsinki Technical University at Otaniemi (1949) (see Fig. A.11), Council Chambers in Seinajoki Town Hall (1950) (see Fig. A.18), and Auditorium in Wolfsburg Cultural Center (1958) A.13 Aalto uses the directional skylight in three different ways. In all these cases their orientation does not permit a direct view of the sky where as in Riola, one can look up into the sky through the clear glazing of the monitors. **Is this to relate the interior space to the heavens?** The ceiling modulation has a strong directionality focussing upon the altar.
**Visual Task**

The primary visual task in a church space is to help person concentrate and meditate. Ceremony is fundamental in Church architecture. The following are metaphoric functional elements of a church space:

- Altar Space
- Minister's Pulpit
- Holy Cross

These elements should be the major focus of the interior space. The space should be filled with a mystic religious feeling.

**Aalto's Daylighting Techniques**

There are three continuous scallops with vertical windows facing North axially arranged such that the size of the vertical windows reduces gradually towards the altar. The North orientation permits the steadiest level of illumination with a minimum glare. Brightness patterns vary with the distance from the vertical windows. There are three narrow vertical slits in the wall separating the Altar from the baptistry. Besides establishing a visual connection between the two spaces, they create interesting patterns of brightness on the partition wall as well as the rear wall of the Altar. There is a pyramidal skylight in the center of the Baptistry which allows direct sun into that space.

The axial arrangement of the seating, closed walls, and the plain form help concentrate on the Altar. Arrangement of the Baptistry, the Choir space, and the Organ space (overlooking the altar space) establish the centrality of the altar.
The Impression

As one enters the interior space, one perceives it as a mysterious and sacral space. The arrangement of the seating, gradation of the form towards the altar, and the lighting of the space in general create an immediate focus towards the altar. The rhythmic arrangement of the portal frames not only establishes a visual order but also nicely frames the view of the Altar space. There are different concentrations of light formed at the different parts of the space. The source of light (vertical windows) are placed high in the space and are not visible at the normal viewing angles. This creates a mystic feeling. Also, Aalto's manifestation of form especially near the Altar space with organic modulation and sculptural character provoke a mystical sense.

Ceiling is the most manipulated surface in the interior. The sky light is the primary source of light. Since this light is mostly diffuse and lacks directionality, it can be manipulated for interior modeling. This is the reason for the differential concentrations of light. The zones closer to the vertical windows placed high in the space receive more illumination and thus look brighter. The side wall is the major architectural surface in the visual field in the interior space. The rendition of the side wall surface is darker at the bottom and gradually becomes brighter at the top as you go closer to the vertical window. Similarly, since the curving sidewall acts as the area source of illumination for the spaces (see fig 3.14) and the surfaces on the right side a similar gradation effect is formed from to left to right of the space. i.e. it becomes darker as you go away from the side wall. The transformation of the gradation is really soft and it is very pleasing for the eye. These patterns fluctuate with the changes in the exterior lighting conditions and add a perceptual dynamic of the daylight. This lighting effect together with the plasticity of the form makes the whole space fell like a cloud. The surface modeling as well as the plasticity of the form are so soft that it looks as if the objects are melting. Reima Pietila, a student of Aalto (now a renowned Finnish
Architect) calls this novel quality of Aalto's church interior spaces “ante-modular fluidity” and describes the feeling as experiencing a liquid space\textsuperscript{47}.

The soft and washed out shadows of the scallops formed on the portal frames and the one the rear wall of the Altar suggest the direction of the overhead lighting.

Also, because of the volumetric perspective distortion the scallops bend towards the altar. At this point one can perceive the artistry of Aalto, the perspective distortion contains more sensorial information than a box like cubical volume. As the scallops bend down, the vertical windows get close to the bottom portion of the curved side wall. This is causing subtle gradations on the curving wall along the major axis. i.e. the brightness at some six feet height from the floor on the curved side wall near the altar space is more than that at about the same height at rear end of the hall. This causes a visual dynamic, a movement of the eye towards the Altar. Also, the light entering through the vertical openings on the baptistry side as well as the direct sun light entering the baptistry are through the pyramidal skylight make the Altar area the brightest and visually the most interesting because of the variations in the brightness patterns.

3.3.5 Intent

In order to understand Aalto's motives for the development of Riola church interior space, it is beneficial to observe the characteristics of other church spaces Aalto designed (see fig 3.15). Karl Faig's "churches" in Alvar Aalto 1898-1976 (see bibliography), Akira Mutoh's introductory essay in GA document on Alvar Aalto (see bibliography),

Fig. 3.15 Aalto's Churches

Miller identifies a pattern of organizational concepts and tectonic components that took root in Aalto’s in the design of Michael Agricola during his formative period in 1930 and are reflected in the following churches:

- Seinajoki (designed in 1952)
- Vuokseniska (designed in 1956)
- Wolfburg (designed in 1958)
- Detmrode (designed in 1963)
- Rio1a (designed in 1966)
- Lahti (redesigned 1970)

And they are as follows:

- In the sanctuary Chancel becomes the formal focus and acoustical source.
- The walls splayed form creates a forced perspective.
- The section stands the plan form on edge, further reinforcing the formal and acoustical properties of the chancel’s location.
- Pulpit with sculptural backdrop, altar with cross, pipe organ accent the white planar quality of the overall spatial conception.
- The ceiling becomes the most manipulated surface in the space.
David Morton suggests that the church of “Michael Agricola (1930)” for Helsinki, design of which coincided with Viipuri formative period, seems to constitute point of departure for Aalto’s organic attitude towards the organization of space in the later churches.

“..Michael Agricola is composed longitudinally of a central space terminated at the extremes by the integration of a tall form at the front by a low, downward-curving apse at the back. A vaulted ceiling ends at the apse, where the altar is placed in the center of the visual line before the sloping enclosure. The rigid distinctions between ceiling and wall are blurred as the modulation of free planes fuses the dimensions of height and depth into a perspective that culminates at the altar.”

- David Morton.

The idea of a flowing organization of space diminishing toward a focal point can be seen in later churches.

Reima Pietila identifies a “Gestalt phenomenon” in Aalto’s church spaces. Gestalt shape is a cloudy appearance between vanishing and emerging.

The “Gestalt” Phenomenon implies that there are no fully right or wrong outlines. “The Gestalt Shape” is a cloudy appearance between vanishing and emerging. It’s certainly a much more real phenomenon that we usually assume. Many artists have exploited the Gestalt-principle especially in informalistic painting or sculpture. In architecture the grand master of this direction is undoubtedly Aalto.

- Reima Pietila

- **Spatial organization**: The space grows around a moving space grid. Modern rational idiom as applied to Aalto's church space would be “sacral form follows ceremonial function”. The spaces are clearly separated for profane use.

- **Organic appearance**: Aalto has his own species of biological architecture one senses a novel quality, a peculiar modernity - experience of the “liquid space” or “ante modern fluidity”.
• **Optical illusion**: Aalto creates a strong optical illusion through architectural use of "antematerials, space, and light". It seems as if the volumetric substance of the chapel would be in continuous motion towards the altar, then falling down behind it, vanishing into virtual horizon.

We can observe that the spatial characteristics in Riola are consistent with those identified above. To keep things within the scope of this thesis, let us limit our discussion to the lighting in this space.

As the eye moves towards the Altar the profane element reduces and when one reaches the Altar space there is transcendental feeling. Reima Pietila's observation of the optical optical illusion typical of Aalto's church spaces is dominant here. There is a notion of continuous motion towards the altar created by the distortion of form and the gradation of light.

Streams of light enter the space through north facing scalloped monitors. The white surface of the scallops softens the light mutilating its directionality. The whole interior is painted pure white with forms and shapes that are extremely soft and plastic. The scallops and the side wall facing the scallops act as a huge area sources. The shadows lack directionality. Fig. 3.14. shows the elements acting as primary area sources of illumination.

"...Fluidity and fluctuation arise as shapes begin to melt together intertwining and overlapping. We can never fully objectify shadowy things because they have lost so much of their factual dimensions, figures, seams, location and distinction."48

- Henry Plummer

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48 Ibid 34.
This plasticity of the form is taken further by smoothing the edges of the portal frames. Both articulation and revelation of the objects is so soft that it looks as if it is melting. The fluid like diffused light softens the shadows and makes them look as if they are melting away.

"As soon as we eliminate or objectify shadowy remissions, obliterating their poetic bridges to the subconscious, we lose a crucial grounding in "who" we are, "where" we are from and perhaps "where" we are going"—Eliade

The space has "organic characteristics" typical of Aalto’s churches. The light is so soft and fluid like that it obscures the differences between the functional and non-functional elements of the church. Aalto is pouring light where it is needed, the target being the altar space. Another target is the baptistery which has a pyramidal skylight (which permits a direct incidence of sun). The soft light spilling through vertical partition between the altar and the baptistery creates brightness patterns on the rear wall of the altar and connects the two spaces.

Another point of interest in this building is that there is no electrical lighting used to supplement natural lighting. The differential concentrations of light are not just incidental. Aalto demonstrates the technique used by the previous builders of churches, and temples through light, semi darkness, and darkness which stirs the soul. Electrical lights are not utilized to reveal this space. That gives us a lot to think about. The effect created here in this space can not be duplicated with artificial lighting. There is no way to achieve those subtle grades of soft light as on the rear wall on the altar. Fig A.28. shows the poetic rendition of altar space towards the baptistery.

49 Ibid 34. Pp 83
The darkness must be such as is enhanced and made all the more perceptible by contrast with some last vestige of brightness, which it is, as it were, on the point of extinguishing; hence the "mystical" effect begins with semi-darkness that glimmers in vaulted halls, or beneath the branches of a lofty forest glade, strangely quickened and stirred by the mysterious play of half-lights, has always spoken eloquently to the soul, and the builders of temples, mosques, and churches have made full use of it.

- Rudolph Otto

3.4 Comparative Analysis

The Circulation Pattern

The circulation pattern denotes the human movement through the space. The circulation pattern in Rautatalo atrium space is not specified, but is neutral. That is, there is no distinctly defined path. However, people can walk through this space to get to one shop from another, or to use the coffee shop, or to the offices. This space just acts as a neutral space. In Academic Bookshop the arrangement of book shelves essentially defines the

![Diagram](image)

Rautatalo  Academic Bookshop  Rioja church

Fig 3.16 Circulation patterns in the three Case-studies.

50 Ibid 34.
path. Also, the second floor level is accessible by centrally and visibly placed escalators as indicated by a white headed arrow in the fig 3.15. Thus the circulation through the skylit central space is dynamic. In Riola church the approach into as well as the path inside the space is axial. Thus we can say the circulation pattern here is axial.

**Character of Light**

A point light source shows the textural values of the object effectively and due to its directionality, it tends to create a strong shadow, thus showing the depths. An area source does not have a particular direction (depending upon its size in relation to the object), and softens the shadows and the object is revealed with some softness. One is not better, but we should recognize that they create two different effects. Each one of them has its own place in design.

Key words repeatedly used while describing these cases are “diffused light”. Direct light is nascent in the sense that it is pure and is directly coming from its source. In a metaphorical sense that is it. It possesses some definite qualities attributed by its source. Diffused light (natural light) touches so many things like the sky, clouds, trees, roofs, ground etc., and each one of them attribute some quality unique to that thing. Diffused natural light has much more complex qualities. Aalto is utilizing this quality of light and planning a geometry to diffuse it further to delineate the spaces and shapes.

**Ceiling Modulation**

Three ceiling modulations convey three distinct themes. In the Rautatalo the circular skylights which are neutral shape, are arranged to go with the planar definition of the space and maintain the intimateness of scale. In the Academic Bookshop modelling of the crystal
skylight shape is dynamic and eye catching. The bottom portion protruding into the interior space reflects light on to the ceiling and helps softer framing of the skylight. The scale of the skylights create an open to the sky feeling. In Riola church, the ceiling creates a directionality focussing upon the altar. In all the three cases the ceiling is painted white and is used as a principle diffuser of light in the space.

3.4.1 Summary:

<table>
<thead>
<tr>
<th>Case</th>
<th>Primary Elements</th>
<th>Morphological Elements</th>
<th>Cultural Aspects</th>
<th>Light</th>
<th>Aalto's Intent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rautatalo</td>
<td>Entrance Foyer, Circulation Space, Coffee shop</td>
<td>Balcony walls, Columnade, Screen Wall, Marble flooring, White Ceiling</td>
<td>Drinking Coffee, Social atmosphere</td>
<td>Stable, Homogeneous</td>
<td>To create an indoor Social space.</td>
</tr>
<tr>
<td>Riola Church</td>
<td>1. Meditation 2. Congregation</td>
<td>Portal frames, Scallops, Curving side walls, Flooring</td>
<td>Enclosed sanctuary like space.</td>
<td>Mystic, Differential Concentrations</td>
<td>To stir the soul with light, semi darkness, and darkness</td>
</tr>
</tbody>
</table>

In this chapter, we have recognized the application of “Aalto’s Principles” we have discussed in Section 2.4.1, Chapter 2 such as use of skylight cavity, creation of a local
climate in Rautatalo Building and the Academic Bookshop, use of colors and textures in the interior space, shaping the skylights etc. We will be examining these principles more closely in the next chapter.
CHAPTER IV

SIMULATIONS

While investigating the spaces in the previous chapter, certain speculations and thoughts about the working mechanism of the skylighting devices took root in my mind which, when combined with the desire to get a better feeling for light and space, initiated the physical model simulation studies.

4.1 PHYSICAL MODELS

For the purposes of architectural design, light has no scaling factor. Therefore physical models are appropriate to model the space and light. Lighting designers like William Lam, Fuller Moore have endorsed simulation as a means of study for better understanding. Some of the scale models used by Aalto during the design process, such as Essen Opera House and Riola Church as shown in fig 4.1 suggests that Aalto used physical models to

Fig. 4.1. Study model Aalto used while designing Riola Church, a photograph of the finished building.
some extent to make or verify his lighting design decisions. The scale of the models indicates a desire on his part to evaluate both lighting and acoustics.

My observations were made at two levels using two types of models in each of the three cases. The first level models were of the total space at scale of 1:50 to 1:30. The second level models were of the individual skylights at a scale of 1:10.

4.1.1.1 Space Models:

Intent: To model daylight in the space, material textures, and colors. The scale chosen and the detail for these models fit the scale and intent of the effort.

Case 1 Rautatalo: Fig 4.2 shows the model built to the scale of 1:50. A view port is located at first floor level near the fountain end. Several photographs of the space published in books are taken from approximately this point. It is helpful in one way to choose this location for a view port so that the pictures of the simulation study can be compared to the photographs of the actual space.

Case 2 Academic Bookshop: Fig 4.3 shows the model built to a scale of 1:50. Two view ports were built to allow views at first and second floor levels.

Case 3 Riola Church: Fig 4.4 shows the model built to the scale of 1:30. The big rear door was used as view port.
Fig.4.3. Space model of Academic bookshop being tested for clear day conditions.
Fig. 4.2. Space model of Rautatalo building.
Fig. 4.4. Space model of Riola Church
4.1.1.2 Skylight Models

Models were built to a larger scale to detail the skylight devices better. This is a comparative evaluation of three types of devices. A rectangular bay of generic space based upon the Rautatalo and Academic Bookstore spaces at a scale of 1:10 was built. Several ceiling planes representing the three skylight systems were also built.

The models were mostly built with chip boards of several colors and textures. In addition, spray paints were used to model the colors and textures. Special care was taken to avoid extraneous light entering the modeled space. The following are notable.

- The joints and corners of the model were sealed with an opaque black tape.
- The chip boards used were fairly opaque.
- The models were mounted on a rigid opaque base.
- View ports were built with special care, such that they can be closed when not in use.

Human figures were placed in the model to give a sense of scale.

4.1.2 Testing Conditions

Finland has overcast sky conditions for major part of the year (recall our earlier discussion on Finnish climatic conditions in section 2.3, chapter 2). Fuller More suggests that Aalto's "daylighting design solutions" are heavily influenced by local (typically overcast, northerly) daylight environments. Therefore we shall examine the performance of the

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devises with this preoccupation. We will test the Skylights for the following two conditions.

**Condition 1 Overcast sky:**

The School of Architecture, Kent State University\(^{52}\) "Environmental Technology Lab" has a facility to simulate diffuse sky conditions, which is a cubical void with interior lined with white diffuse surfaces (foamcore) and several fluorescent luminaires. Though it is not a true sky-dome simulator it is appropriate for the present study to simulate for overcast sky conditions.

**Condition 2 Clear day:**

Real exterior daylight conditions were used in simulating clear weather. Fig. 4.3 should give an idea about the method followed to simulate the clear day conditions including directionality of the exterior sun light. The physical model was mounted on a revolving stool. Observations made by rotating the the model in a horizontal plane. These simulations studies were conducted during Aug 27-31, 1990.

**Motivation:**

As we have observed in Chapter 3, Section 3.1.4 the skylights in Rautatalo and Academic

\(^{52}\) School of Architecture, Kent State University, is a member of Daylighting Network of North America.
bookshop are shielded from the direct sun. The well created by the upper floors collects light. Thus the skylights receive light from the surrounding walls, and the skydome. Since light undergoes multiple reflections between the interior walls of the well, it lacks any discernable direction. It is almost equivalent to diffuse sky conditions. In Riola church, since the skylights are facing north, the sky is the primary source of illumination. In other words the local climate we are facing in our case studies has predominantly diffuse light conditions. Since the purpose of this study is more of phenomenological pursuit rather than making some analytical observations a decision was made to limit the study to diffuse exterior light conditions. Also, as we have discussed in Chapter 3, we are interested in studying the dynamism of the space during the course of the day. The method was devised to study the space for different timings of the day.

4.1.2 PHOTOSGRAPHS

Viewport:

Decisions on location of camera were made such that it would not let any extraneous light into the space or block any light that exists in the space and at the same time captures a view close to human eye level (most commonly experienced). Limitations such as lack of availability of special lenses, forced some compromises on the field of view one really would have wanted to achieve.

Lenses used:

Based upon Fuller Moore suggestion that view captured by 17 mm wide angle SLR camera
is close to that of human eye, we used that lens. We used Kodak Gold 200 ASA print film for pictures and Kodachrome 200 ASA for slides.

**Camera Settings:**

A Nikon SLR automatic camera with built in light meter was used. Our photographic philosophy has been to capture an image that would be close to the experienced reality. Hence, aperture setting decisions were left to the discretion of the camera and were variable for different pictures. These pictures are only valuable to study the effect, as the camera mimics the adaptation of the human eye. They should not be compared for the quantity of light in each condition.

**Disclaimer:** The photographs taken during the study seem to overstate the ceiling.

### 4.2 Analysis and Observations

#### 4.2.1 Rautatalo Building

As can be seen in the photograph in fig 4.5, the space model shows a stunningly intimate interior space replete with remarkably homogeneous light under either clear day or overcast condition. There is no discernible patterns created in the space by light. These pictures are taken under simulated overcast sky conditions. Curiosity to know whether the uniformity of the distribution was due to diffused exterior lighting conditions prompted taking some more pictures under sun on a clear day. Observations made for different directions of light under clear sky on a sunny day revealed that the homogeneity of the light was unaffected. fig 4.6 shows photographs taken at different orientations of the physical model.
Fig 4.6 shows pictures of the generic space. The shadows are not particularly distinct and they appear washed and soft. It is impeccably stable light. Visually the space looks very stable. The linear arrangement of circular apertures of the skylights (circle is a neutral shape in itself) plays a supportive role by reinforcing the planar organization of the place.

4.2.2 Academic Bookstore

Space model simulation studies of the Bookstore space have helped clear up the differences between the Rautatalo central space and the Bookstore space. The overall interior environment in the Bookstore is brighter than that of Rautatalo. Perhaps this is because of the differences in aperture geometry. The quality of light is still soft and shadows are not distinctly sharp. Fig 4.9 shows the photograph taken for simulated diffuse sky conditions. There are no shadows formed of the book cases which should give an idea about softness of the light. Fig 4.10 shows a photograph taken at second floor level.

Observations made under sunny clear sky conditions revealed some more interesting points. As can be seen in fig 4.11 there is an incidence of the direct sun light on the balcony wall. Also, the reflections of the higher floors outer walls facing the interior court are causing some incidence into the interior space which is more noticeable in this case than in case 1, which supports the idea that creation of the interior well is an intentional decision to gather light to infiltrate in to the interior court. Further, photographs in fig... show that
Fig.4.5. Interior of the space model of Rautatalo interior under overcast conditions.
Fig. 4.7 Conical "Skylight model" studies for overcast condition.
the mark made by the direct incidence of sun is not static but changes with the course of the day. In other words the modelling of light in the interior changes dynamically with the course of sun during the day.

The complexity of the detail of the pyramidal skylights stimulated the author to look deeper into how it is enhancing the transmittance of light from exterior to interior. It took a while to first understand the construction of these skylights before 1:10 scale model of these skylights was made. Fig 4.8 shows the triple glazing arrangement of the skylight. From the sectional drawing of this skylight it appears that the reflective properties of the plane glass used as glazing is contributing to softening the light within the skylight cavity. In addition, the lower layer of glazing protruding into the interior space should help diffuse some light to the second and third floor levels. Studies were also made to see how each of these layers is contributing to the spatial rendition. Fig 4.8 a, b, c,d show pictures taken in sequential order with first, first and second, and all three layers of the skylight in place. To the author's disappointment these pictures do not show significant differences.

This study did help in understanding the differences in the effect created by the skylights at Rautatalo and Academic Bookstore. The distribution of light, as can be seen in fig 4.11 is not so homogeneous as in Rautatalo building. There are some brightness patterns at the bookstore created by the light on the surfaces.
Fig. 4.8. Pyramidal "Skylight model".
Fig. 4.9. Space model study of Academic bookshop for overcast conditions.
Fig. 4.10. Space model study of Academic bookshop for overcast conditions. A view from second floor level.
Fig. 4.11a. Space model study of Academic bookshop for clear day conditions. A view from first floor level. Notice the position of the direct incidence of sun. Observe how it changes with the course of the day in b, c, d.
Fig. 4.11 b. Space model study of Academic bookshop for clear day conditions.
Fig. 4.11.c. Space model study of Academic bookshop for clear day conditions.
Fig. 4.11.d. Space model study of Academic bookshop for clear day conditions.
Fig. 4.12. Pyramidal "Skylight model": Exterior view showing the layering of the Skylight.
Fig. 4.13. Pyramidal "Skylight model" studies for overcast day conditions.
4.2.3 Riolano Church

The "directional skylight" as a device has been used with more variation and complexity than any other type. Recall our discussion in Chapter 3 about the use of directional skylight in a variety of ways. Basically, the "directional skylight" consists of scallop painted white serving two purposes.

1. to diffuse light into the space
2. to shield the source of the light (aperture) from the view.

Interestingly in Riolano, scallop orientation does not remove the view of sky from inside. Variance of the orientation of the scallops caused some curiosity as to what is happening in each one of these situations. The study was constructed around this aspect i.e. to study how the orientation of the scallops affect the modelling of a given space. The exterior lighting conditions are maintained the same i.e. diffused cloudy conditions (utilizing the light box) for each of the situations. Fig 4.17.a shows the generic models prepared for this purpose. Fig 4.17, 4.18, and 4.19 shows the results which are amazingly different.

Distribution of light is noticeably different for each of the orientations.

One discernible point is the discrete human visual perception of the space. That is, each of these visual orientations is causing a disparate human visual orientation in the space. The scallop oriented perpendicular to the visual axis (as in lecture theater) acts neutral (or does not induce any particular visual orientation) and permits the soft light to pour into the space evenly. Fig 4.17 shows that the space is revealed symmetrically.

On the other hand, when the skylight is parallel to the visual axis, a strong linear spatial orientation is perceived by the way the skylight modulates the ceiling. From fig. 4.18 it
can be observed that the space rendition is not all that even.

Diagonally oriented scallop reinforces the cognition by modifying the modelling of light in the space. Fig. 4.19 shows that the space rendition is noticeably uneven and with different concentrations of light formed at different parts of the space.
Fig 4.14, Space model simulation studies of Riola Church for overcast conditions
Fig. 4.15. Space model simulation studies of Rola Church for overcast conditions.
Fig. 4.16. Space model simulation studies of Riola Church for clear day conditions as on Aug 31, 1990
Fig. 4.17. Directional "Skylight mode" simulation studies for overcast conditions.
Fig. 4.18. Directional "Skylight model" simulation studies for overcast conditions.
Fig. 4.19. Directional "Skylight model" simulation studies for overcast conditions.
4.3 CONCLUSIONS:

4.3.1 ARCHITECTURAL SPACE

From the space model simulation studies we learn that the directionality of exterior lighting (on August 31, at 41° N Latitude) has little effect on the interior space modelling. The interior space looks very stable and static. The Rautatalo skylights do not read as cones from the inside. Instead, they look like circles arranged in lines. It feels like an enclosed space. Where as in the Academic Bookshop it is different. There is a direct incidence of sun in to the interior and the light quality changes interactively with the change in the directionality of exterior lighting. The interior space is lively. In the Academic Bookshop the space looks more open to the sky than in Rautatalo where it looks enclosed. In the Riola church the light is really soft for both overcast and clear day conditions and whole space looks plastic.

4.3.2 LIGHT DISTRIBUTION

In case of Rautatalo both the space model and the generic model studies indicate that the distribution of light is uniform. There are not any prominent patterns created by the light on the walls or the floor. Generic space studies show that the walls are washed consistently with pure light. In the Academic bookshop the distribution of light is not particularly uniform. It is brighter in the center than at the edges. The Riola church the light distribution is variable ranging from bright areas in the prayer hall area to the semi dark areas in the choir area. The patterns created by light coming in form different hidden sources on the rear wall of the altar creates a magical effect.
4.3.3 Ceiling Modulation

Lighting design was integral with the design of the ceiling.

Ceiling modulations convey three distinct themes. They are summarized as follows:

- The skylight shape as seen from the interior is neutral (circle), in the Rautatalo building. Their arrangement reinforces linear spatial emphasis. The scale of the the aperture makes the ceiling plane more readable and gives a feeling of enclosure. This adds feeling of intimateness to the space.

- In Academic Book shop, the crystal shaped bottom protrudes in to the space and looks like display of a fancy object suspended from the ceiling in a market place. The scale of the aperture is so big that the planarity of the ceiling is destroyed. And this feels like more open to sky.

- In Riola church the skylight and the ceiling are synthesized in to one entity inducing a strong linear directionality in the space with a focus on altar.
CHAPTER V

CONCLUSIONS OF THE STUDY

The impetus for this thesis derives from my enthusiasm to learn about the architectural daylighting as demonstrated by Aalto. The two major objectives of this thesis are:

(1) Discover his intent behind using the daylighting and
(2) Learn Aalto's daylighting techniques.

Another sub-objective was to explore the simulation as a means of understanding the effect of light in the space.

We have identified the suitability of skylighting for Finnish climate in which most of Aalto's works are located. Perhaps, this is why skylights play a prominent role in Aalto's architecture. We have observed from the survey of Aalto's works from the chronological view point (see fig. 2.11 and discussion in Chapter II) that the use of natural light has been one of the preoccupations of Aalto since the design of Viipuri library and almost all the later buildings incorporate natural light. Therefore, this study was focussed on the study of skylights. Three case-studies were selected for their spatial richness, functional diversity and for the three different daylighting techniques used. Initially the computer was tapped as a tool for performing simulations along side physical model simulations. Unfortunately since the state of the software available was not very supportive for the purpose, the study was restricted to physical model simulations. Physical model simulations proved to be extremely helpful in understanding the modeling of the day light and the spatial quality.
Literature research helped in understanding the climatic conditions, cultural context, and function of the buildings. Aalto's own pronouncements especially the collection of his writings in *Sketches* (see bibliography) proved extremely helpful in understanding his intentions. Writings of prominent architectural scholars like Malcolm Quantrill, Reima Pietilla, Henry Plummer, and Fuller Moore describing their first hand experiences of the effect of light in Aalto's spaces, helped a great deal too.

In Chapter 2, we identified the origins of these three skylights and their reoccurrences. We have also identified the technical components and contributing factors (section 2.4.2) of the Aalto's skylights which convinced us that these skylights are sophisticated and very well developed daylighting devices.

"Skylight model" simulation studies (see Chapter IV) for Conical, Pyramidal, and the Directional skylights revealed (1) the differences in the modeling of light in the space, (2) effect of their placement patterns on the ceiling modulation, and (3) the visual impression created by the form of the skylight itself. Also, the "Space model" simulations have helped us get a feel for the spatial character and the light in these spaces. Our analysis in Chapter III helped us understanding the functional patterns, cultural traditions, and Aalto's intent in each of the case-studies.

From Chapter III and Chapter IV, we have summarized the comparative analysis of the case-studies in Table 5.1. This shows that biologically and psychologically oriented solutions with strong roots in cultural traditions, aimed at the integration of man to his surrounding environment, reflects Aalto humanistic approach to architectural design.
<table>
<thead>
<tr>
<th>Skylight Type / Case</th>
<th>Function</th>
<th>Personal Relationship</th>
<th>Visual Task</th>
<th>Daylighting Technique</th>
<th>Daylighting Character</th>
<th>Interior Brightness Patterns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conical Skylight</td>
<td>Foyer space for institutional building.</td>
<td>People / People</td>
<td>To create a neutral space where people can meet other people.</td>
<td>Horizontal Skylights.</td>
<td>Uniform distribution.</td>
<td>Soft / Uniform.</td>
</tr>
<tr>
<td>Rautatalo Building Helsinki</td>
<td>Urban Piazza</td>
<td></td>
<td>To provide uniform, horizontal lighting to reveal facial features etc., for interpersonal communication.</td>
<td>Light is reflected off the surfaces of the exterior light well.</td>
<td>Generally exciting and has the perceptual dynamic of the changing time.</td>
<td>No distinct textures or brightness patterns.</td>
</tr>
<tr>
<td>Academic Bookstore Helsinki</td>
<td>A Market hall for selling books.</td>
<td></td>
<td>To create the visual excitement of a market place.</td>
<td>Light is reflected off the surfaces of the exterior light well.</td>
<td>Sharp shadows brighten the room, adds visual excitement.</td>
<td>Use of highly reflective surfaces.</td>
</tr>
<tr>
<td>Directional Skylight</td>
<td>Ceremony, Meditation.</td>
<td>People / God People / Form</td>
<td>To create a focus.</td>
<td>Vertical windows and Scallop facing North.</td>
<td>Causes visual focus.</td>
<td>Brightness patterns create sparkles.</td>
</tr>
<tr>
<td>Riola Church near Bologna, Italy</td>
<td>A Mystic Religious space.</td>
<td></td>
<td>To create a mystical feeling.</td>
<td>One horizontal Skylight (in the Baptistery), Narrow vertical slits (in the Altar space).</td>
<td>Directional.</td>
<td>Variable shadow quality ranging from soft to sharp.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Attributes the character of a cloud.</td>
<td>Direct incidence of the Sun in the interior space.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No Artificial light to supplement.</td>
<td>Use of highly reflective surfaces.</td>
</tr>
</tbody>
</table>

Table 5.1 Summary of Aalto's daylighting design philosophy in the three case-studies.
5.1 AALTO'S INTENT

Aalto's philosophy of daylighting aims at creating humanistic architecture. These three case studies demonstrate the great mastery and artistry of Aalto in achieving this character and the effect of light though the design of three different daylighting systems. From these threes case studies I have attempted to generalize Aalto's philosophy of daylighting as I perceive it.

In brief, Aalto's design intent is to use daylighting through the following aspects:

1) **Biological**: Daylight to provide healthful environment and to create a mediation between indoors and outdoors.

2) **Psychological fulfillment**: Daylight to provide a delightful environment or to build the right mood in a space.

3) **Climatic Relationship**: The lighting solution is to be appropriate for the climate of the building.

4) **Visual task**: To meet the illumination requirements of the task, such as reading, displaying, etc. Light is to be a good servant to man.

5) **Cultural traditions**: The character of the space is to have the "time and memory" and spiritual meaning. The character of the light is to be in harmony with this.

6) **Functional Patterns**: Lighting solution is to be derived from the functional needs of man.

7) **Articulation**: The lighting solution is to be well articulated with the form and the structure of the space. Artificial lighting is to be provided in such a way that it maintains the character of the space.
5.2 AALTO'S DESIGN TECHNIQUES

This study shows that the conical, pyramidal, and directional skylights are well developed and sophisticated devices. The following can be identified as the guiding principles for Aalto's daylighting design.

5.2.1 CHOICE OF DEVICE - CLIMATIC CONNECTION

The techniques Aalto adopted are appropriate to the climate zones of the buildings. For example, Rautatalo building and Academic Bookshop are located in Helsinki, Finland (61° N) where the climate is typically overcast. An overcast sky is three times as bright as the horizon as at the horizon. It is therefore, appropriate to use top lighting (horizontal skylights) in this climate zone. In clear day conditions the horizon is brighter than the zenith and hence it makes sense to use vertical windows. Therefore, Aalto uses vertical windows in the case of Riola Church which is located near Bologna, Italy (45° N) where the climate is typically clear.

5.2.2 REFLECTION GEOMETRY:

Planning the lighting geometry becomes very important in daylighting design because it is significant in terms of visual task and the characteristics of the object being revealed. The lighting geometry is planned such that the light reflected from the exterior surroundings is collected and introduced into the interior space through specially designed lighting devices. These devices diffuse light into the space indirectly. As discussed in Chapter 3, the sectional geometry of the interior space helps multiple reflections of the light (see fig. 3.5, 3.10, 3.14). This causes uniform distribution of light and reduction of contrast levels in the space which give a soft quality to the objects in the space.
5.2.3 Choice of Material:

Most of the interior textures are white or light colored and matte textured which contributes to uniform distribution of light in the interior by diffusion.

Variable Plasticity and modeling:

- The color rendition of marble, blue ceramic tile changes with the differences in the quality of exterior lighting.

- Aalto also uses sculptural surface textures whose modeling changes with the change in the directionality of the light. For example in the Academic Bookshop the corduroy like vertical texture on the columns changes its visual patterns with time.

5.2.4 Pattern of the Sources

The pattern formed by the arrangement of the skylights influences the modulation of the ceiling. Aalto achieves a ceiling modulation which is harmonious with the spatial theme (recall our earlier discussion of ceiling modulation in Section 4.3.3). Again, the case studies provide excellent examples to illustrate this point. The skylight devices are very well articulated into the structure.

The closer arrangement of conical skylights as in Rautatalo building, reduces the contrast between the ceiling and the skylight aperture. Conical skylights read as bright planar disks and reinforce the linear spatial emphasis. In Academic Bookstore the central arrangement skylights and the form of the skylights makes them the focal design elements. In Riola the skylight pattern causes an axial focus towards the altar.
5.2.5 Form of the Skylight

The form of the skylight has morphological implications on the modeling of the interior space. Aalto's skylight forms are integral part of the design theme. The case studies provide good examples to illustrate this point.

- In Rautatalo, the skylights read as flat circular disks. Circle is a neutral shape. The skylight makes a neutral element in the space.

- In Academic Bookshop, the form is visually dynamic and makes a positive design feature in the space.

- In Riola, the skylight form is almost absent from the visual field because of the strong focus towards the altar. The Skylights create a mystery by their absence.

5.2.6 Articulation

The skylights are well articulated in the building structure. Also, the modelling of skylights is inseparable from the ceiling modulation. Artificial lighting fixtures are thoughtfully articulated with the skylight devise such that they maintain the character of the lighting in the space and are visually pleasing. Electrical light also reinforces the daylight and helps maintain the illumination levels.

5.3 Aalto's Solutions

Aalto has strived to create humane, diversified, sensorially rich, and spiritually meaningful environment. Aalto treats daylighting as one of the elements to embody sufficient psychological factors in mans built environment. With his special personal vision, Aalto
imparts to these spaces a form which strongly influences people, not only intellectually but also psychologically.

![Diagram](image.png)

**Fig 5.1** Chart showing Aalto's motivations in the three case-studies.

We have recognized that Aalto's point of departure is task in Viipuri Library, health in Paimio Sanatorium, and emotion in the three case-studies.

The selection and the detailing of the skylights in each case has been predominantly guided by the climate, function, personal relationships, and the visual task of the individual space as we have discussed in Chapter III. Though they are well developed and used repeatedly, the skylight devices are not standardized solutions waiting for the problem. The choice of selection or their application is not rigidly rule based. In each case, Aalto's lighting solutions derive from the context and the nature of the problem itself. Aalto himself
addressed this issue.

"...Each task is different and, consequently, solutions cannot be reached schematically. Examples that I have set remain individual and are valid in other applications only as a method. In architecture too much remains at the stage of analysis, although we are in need of synthesis. Nothing is more dangerous than separating analysis and synthesis."^53
- Alvar Aalto

The Rautatalo building and the Academic Bookshop demonstrate this point eloquently. Though situated in adjacent sites, and somewhat similar in terms of building program, as our study showed they provide two different experiences due to the different lighting systems employed.

5.4 VALUE OF SIMULATION

Speculation of the performance of the daylighting design and effect created could be complex. Physical model simulations could help us visualize the space and make design decisions. They are simple and accurate enough to make design decisions. Best of all they do not require any additional skills than those possessed by traditional architects and designers. My experience with simulations during this study shows that it is almost as good as being in the actual space. Photographs tend to be less reliable as they do not provide the same cone of vision and hence the same feeling of experiencing the space. In addition photographs overstate the ceiling. There is evidence that Aalto used the physical model simulation while designing Riola church. I strongly believe and recommend that simulation is an effective design tool to predict the effect of daylight in space and to make design decisions.

APPENDIX A

(Plates)
1927 VIIPURI Municipal library competition entry: 1st design October 1927;

Fig. A.1.

1928–9 TURKU Offices and plant for Turun Sanomat

Fig. A.2.
Fig. A.3.
1936–7 PARIS  Finnish Pavilion for World's Fair: 1st prize, 'Le Bois en Marche'

Fig. A.4.

1937 TALLIN  Museum of Art

Fig. A.5.
Fig. A.6.

Fig. A.7.
1950  JYVÄSKYLA  Pedagogical Institute (later University) of Jyväskylä

Fig. A.8.

1952  HELSINKI  'Rautatako' office and commercial building
(1953–5)

Fig. A.9.
1958 WOLFSBURG, Germany
(1959–63) Cultural centre, Wolfsburg, competition entry

Fig. A.13.

1958 BAGHDAD, Iraq
Art Museum, Baghdad, competition entry

Fig. A.14
Fig. A.15.
Fig. A.17.
1959 SEINAJOKI
(1960–65)
Town centre, Seinäjoki,
competition entry: 1st prize

Fig. A.18.

1962 HELSINKI
(1966–9)
Stockmann department store
expansion

Fig. A.19.
Fig. A.20.
1963–5 UPPSALA, Sweden  Student Association House for the nation 'Västmanland-Dala'

Fig. A.21.

1964–70 JYVÄSKYLÄ Sports Institute, University of Jyväskyla

Fig. A.22.
1964–70 HELSINKI Administration building for the City Electric Company
(1970–73)

Fig. A.23.

1965–70 MOUNT ANGEL, Oregon, USA Library of the Mount Angel Benedictine College, Mount

Fig. A.24.
Fig. A.25.
APPENDIX B

(Excerpts from Aalto's Article on "The Humanizing of Technology")
"...the main problem connected with a library is that of the human eye. A library can be well constructed and can be functional in a technical way even without the solving this problem, but it is not humanly and architecturally complete unless it deals with the main human function in the building, that of reading a book. The eye is only a tiny part of the human body, but it is the most sensitive and perhaps the most important part. To provide a natural or an artificial light that destroys the human eye or that is unsuitable for its use, means reactionary architecture even if the building should otherwise be of high constructive value.

Daylight through ordinary windows, even if they are very large, covers only a part of a big room. Even if the room is lighted sufficiently, the light will be uneven and will vary on different points of the floor. That is why skylights have mainly been used in libraries, museums, and so on. But skylight, which covers the entire floor area gives an exaggerated light, if extensive additional arrangements are not made. In the library building the problem was solved with aid of numerous round skylights so constructed that the light could be termed indirect daylight. The round skylights are technically rational because of the monopiece glass system employed. (Every skylight consists of a conical concrete basement six feet in diameter, and a thick jointless round piece of glass on top of it without any frame construction.) This system is humanly rational because it provides a kind of light suitable for reading, blended and softened by being reflected from the conical surfaces of the skylights. In Finland the largest angle of sunlight is almost 52 degrees. The concrete cones are so constructed that the sunlight always remains indirect. The surfaces of
the cones spread the light in millions of directions. Theoretically, for instance, the light reaches an open book from all these different directions and thus avoids a reflection to the human eye from the white page of the book. (Bright reflection from book pages is one of the most fatiguing phenomena in reading.) In the same way this lighting system eliminates shadow phenomena regardless of the position of the reader. The problem of reading a book is more than a problem of the eye; a good reading light permits the use of many positions of the human body and every suitable relation between book and eye. Reading a book involves both culturally and physically a strange kind of concentration; the duty of architecture is to eliminate all disturbing elements.

It is possible in a scientific way to ascertain what kinds and what quantities of light are ideally the most suitable for the human eye, but in constructing a room the solution must be made with the aid of all the different elements that architecture embraces. Here the skylight system is combined product of the ceiling construction (a room almost sixty feet wide needs a ceiling construction with beams height enough for the erection of the deep cones) and special technical limits in horizontal glass construction. An architectural solution must always have a human motive based on analysis, but that motive has to be materialized in construction that probably is a result of extraneous circumstancs. The examples mentioned here are very tiny problems. But they are very close to the human being and hence become more important than problems of much larger scope.


