

DAYLIGHTING IN CAMBRIDGE LIBRARIES: SHIFTING FOCUS OVER TIME

Ayona Datta
Graduate Research Associate
College of Architecture and Environmental design
Arizona State University, PO Box 871905
Tempe, AZ 85287-1905
ayona.datta@asu.edu

ABSTRACT

This paper aims to explore the various transformations of Cambridge libraries over the ages focusing mainly on the changing role of daylighting in library design. The libraries have been categorised chronologically into four different groups: Medieval libraries, libraries between 16th cent and Reformation, libraries between Reformation and 19th cent and modern libraries. The study shows that with the shift from the rules of classicism in medieval libraries to individual styles in modern libraries, the architect has opened up enormous possibilities for design innovations in daylighting. Unlike other environmental services the elements of daylighting are undoubtedly the most visual and expressive. The particular challenge of modern library design is to manipulate natural light for reading and book storage while avoiding reflections on the VDU. It is still a field not fully explored and it remains to be seen how daylighting design can successfully meet all the needs of a modern library.

1. INTRODUCTION

The history of Cambridge libraries dates back to about the beginning of the University itself in the early 13th cent. The university curriculum was designed for students who were already or going to be monks or priests. The only buildings required for their purposes initially were a place to hold meetings and ceremonies, a library for the use of students and schools for teaching. Books were bequeathed for the use of these students even before the foundation of colleges.

When colleges arose similar donations were made by their founders or by their subsequent benefactors, and

thus in time considerable collections were amassed and the library became a recognised element of the collegiate arrangement. The library has shifted from being an insignificant part of the college building into a separate building in many cases. It has also undergone various transformations regarding its location, layout, size and daylighting approach. This essay aims to explore the various transformations of Cambridge libraries over the ages focusing mainly on the changing role of daylighting in library design.

2. METHODOLOGY

The libraries have been categorised chronologically into four different groups: Medieval (before 16th century), libraries between 16th cent and Reformation, libraries between Reformation and 19th cent and modern libraries. One prototype library has been chosen from each category for the purposes of this study. The daylight factors (DF)¹ have been calculated by physical measurements for one typical bay of each of these libraries in order to understand the daylighting strategies involved in their layout and design.

3. MEDIEVAL LIBRARIES (BEFORE 16TH CENT)

Medieval libraries were integrated into the inner cloisters of the college buildings and could be housed in relatively small spaces [9]. They were usually placed on the first floor or even higher, for the sake of preserving their contents from damp. Vitruvius laid down the rules that

¹ Daylight Factor (DF) is the ratio of inside illumination on the workplane to unobstructed outside illumination at a given point of time expressed in percentage.

Libraries ought to face East because their use requires morning light that will preserve their contents from decay [12]. It appears probable that these considerations influenced the builders of the earlier colleges, the inmates of which rose very early in the morning and would have been glad to get as much light as possible for their studies. Most of the libraries (16 out of 17) of Cambridge erected before the beginning of 16th century thus have major glazing area facing East-West².

A medieval collegiate library was a long narrow room lit by equidistant windows on either side and occasionally by a window at one end. The bookcases and the seats for the readers were placed at right angles to each of the longer walls (Illustration 1) the former in the space between the windows and the latter in front of them. The windows and ceiling heights were much lower than that seen in later libraries and the windows in themselves were narrower and close together and coming down to within a short distance from the floor.



Illus. 1: View of Jesus College Library, Cambridge. Photo: Author

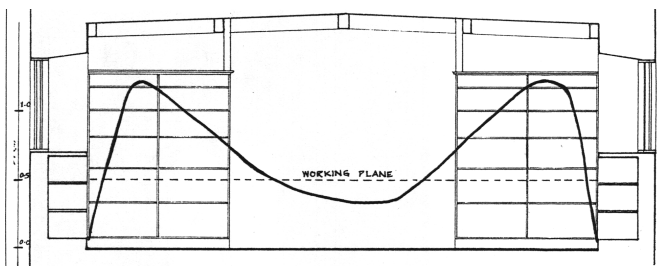


Figure 1: Daylight Factors across the width of the library shown in section. Source: Monitoring by author

² The exception was Queen's College library built in 1448.

The daylighting in medieval libraries is of significance since there were no means of artificial lighting and the readers were dependent solely on natural light for reading. Jesus College old library has been chosen for the study since it incorporated the typical features of libraries during that period.



Illus. 2: View of one bay in Jesus College library. Photo: Author

3.1 Jesus College

Jesus College library has a low ceiling height (2.8 m) 14.6 m long and 6.6 m wide and has seven bays on each side with a narrow window in each bay rising from 1.1m to 2.3m and facing E-W. The floor and the walls are made of oakwood of a dark polish that reduces their reflectance considerably (Illustration 2).

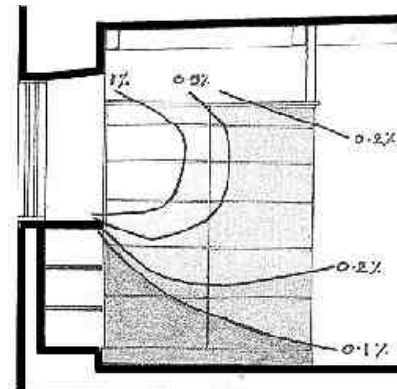


Figure 2: Section showing Daylight Factors on the bookshelves perpendicular to the window. Source: Monitoring by author

The overall Daylight Factor (DF) in the library was very low ranging from 1% to 0.1% since there was a very low Internally Reflected Component (IRC)³ owing to the use

³ IRC- Internally Reflected Component that is the light reflected from the surfaces inside the room. The lighter the colours in the room, the higher will be the IRC.

of wood on the floor and ceiling. The windowsill was at a higher level (1.1m) than the workplane (0.9m) that resulted in low (below 0.1%) Daylight Factor close to the window. This increased to above 1% in the middle of the bay and went down to less than 0.3% in the corridor (Figure 1). The bookstacks at right angles to the window had Daylight Factors ranging from 0.1%-1% (Figure 2).

4. LIBRARIES BETWEEN 16TH CENT. AND REFORMATION

The 16th century libraries were very similar to the medieval libraries in their layout since these libraries were either the original medieval rooms or built on medieval models. The designers were in the habit of copying the designs of their predecessors without venturing to introduce any important innovation. However, with the invention of printing, a well-stocked library towards the end of the 16th century might have contained many hundreds of volumes. A new library was usually constructed as a wing jutting out from the exterior of the quadrangle or as a completely detached building [9].

It is seen that after the 16th century, the considerations for personal comfort began to be generally accepted and the major glazing areas of the libraries changed from East-West to North-South, since this commanded maximum warmth in such an orientation. All the libraries (14 in number) erected between the end of the 16th century and Reformation have their major glazing areas facing North-South.

4.1 Trinity Hall

The library in Trinity Hall is an excellent example of a prototype 17th century library that has remained largely unaltered over the ages and is therefore useful for the study.

The library range at Trinity Hall built about 1600AD is of two storeys. The library occupies the whole of the first floor, 19.8m long by 8.8m wide, with eight equidistant windows in each side wall rising from 0.9m near the floor to about 2.3m above the floor and a window of four lights in the western gable. It has a plain curved white plaster ceiling.

The placement of the bookcases perpendicular to the windows allows the light from the windows to fall at an oblique angle across the bookstacks and emphasise the bookspines. The sill being low reduces the silhouette effect of the wall below with reflected light from the floor. Reflections from the floor and the ground outside

light up the curved ceiling above that reflects the light back into the library (Figure 3). Deep window reveals are splayed, increasing the effective width of the opening and providing contrast grading to reduce glare from the window. Slender tapered glazing bars painted white also reduce glare and make the view out more comfortable. As the window head is high, light comes from a brighter part of the sky thus increasing the Sky Component⁴ in the bays.



Illus. 3: View of Trinity Hall Library. Photo: Author

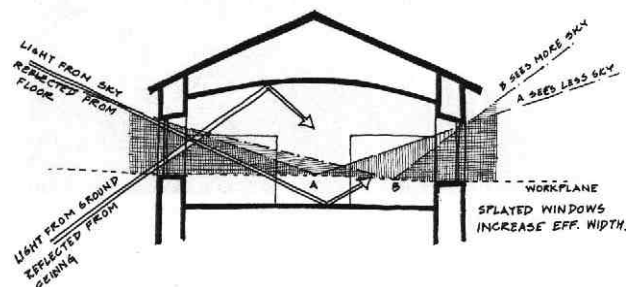


Figure 3: Section through width of the library showing Sky Component and Externally Reflected Component.

The Daylight Factors near the window (4%) are higher than that of medieval libraries (below 0.1%) since the windowsill is lower than that of the workplane (Figure 3). The corridor has the lowest daylight factor (1%) since the bookstacks act as internal obstructions and the Sky Component (SC) is also greatly reduced. The N-S orientation of the room also increase the DF near the south window as compared to the north.

4 SC- Sky Component is the amount of sky visible from the reference point. In case of a normal height window, the sky component increases when we move closer to the window and reduces when we move away because we see more sky or less sky respectively. In case of clerestory windows, the opposite is true.

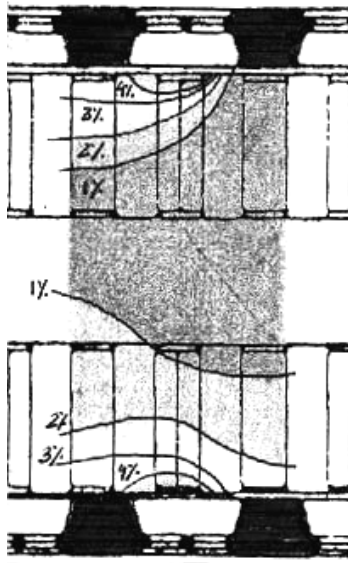


Figure 4: Daylight Factors across the width of the library. [14]

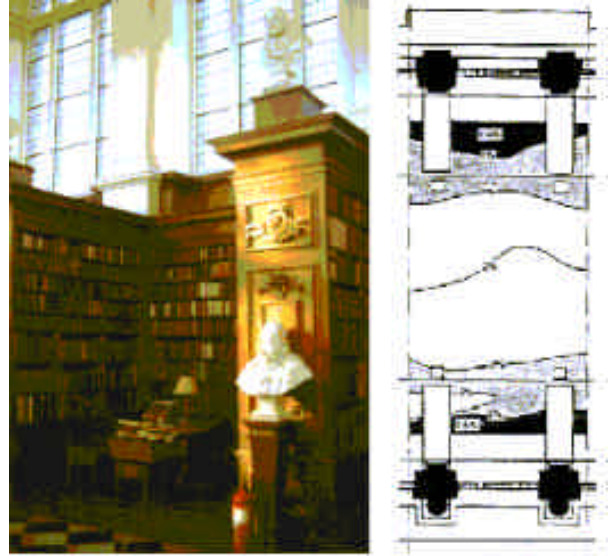
5. LIBRARIES BETWEEN REFORMATION AND 19TH CENT.

The rule of placing the libraries above the ground floor and the practice of admitting air beneath the library by means of an open arcade or cloister continued to be employed in several examples at the revival of classical architecture in the period between Reformation and the 19th century.

10 libraries erected between the Restoration and pre-war period have the major glazing area facing East-West. The others (8 nos.) followed a North-South orientation. The libraries with an East-West orientation were still following the example of the medieval libraries, whereas the libraries facing North-South were more concerned about personal comfort as mentioned earlier. This was significant since most of the formal urban forms were usually arranged around a courtyard without any preference to orientation. Only in the case of the library, emphasis was laid on the orientation. During this period architects also started giving distinctive character to the library. The library built by Sir Christopher Wren at Trinity College is the noblest and the most successful example of this treatment.

4.1 Trinity College

Trinity College library designed by Sir Christopher Wren has been studied as a prototype of this period since it initiated a rethinking in library daylighting and later buildings tried to use the same techniques as applied by him.



Illus. 4: View of one bay in Trinity College Library. Photo: Author

Figure 5: Daylight Factors across the width of one bay of the Library [15]

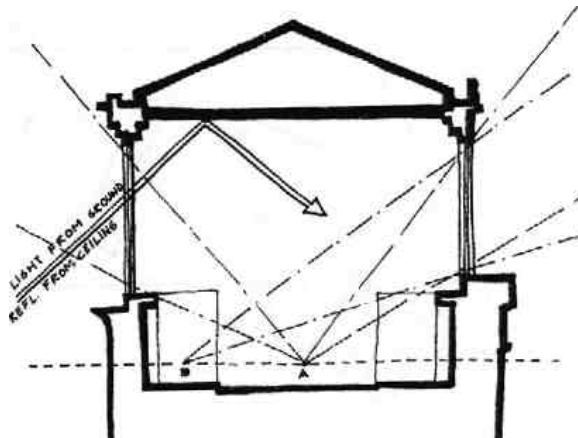


Fig. 6: Section through library showing distribution of daylight. Point A sees more sky than point B and is thus brighter.

The library consists of one great compartment 12m wide, 63m long and 10.6m high. It has projecting bookcases and wall cases down each side forming 13 bays. The white ceiling and sidewalls reflect and diffuse the light, increasing Internally Reflected Component.

The ground floor of the library forms an open undercroft with open fenestrations and doorways. The arches on the ground floor were filled in till the springing point to gain extra height in the library floor above. By doing this, windows in the library rose high and gave place to the

bookstacks against the walls and being high could afford to be large and thus could have stone mullions and have the glass pointed [5]. This method of raising the cill level of the windows as well as the ceiling height achieved more uniform and increased natural lighting that could light up the book spines as well as give ample amount of light on the workplane.

Unlike the medieval libraries the stacks parallel to the windows receive daylight from the clerestory windows on the opposite walls (ref. Fig. 6) and thus are better lit than the stacks perpendicular to them. The central corridor is also more illuminated (DF of 3%) than the bays (DF of 0.5%) (ref. Figure 5) since it sees more of the unobstructed sky through the clerestory windows that increases its Sky Component. The variation of Daylight Factors within each bay is also relatively small (0.5%-2%) as compared to earlier libraries. This reduces the local brightness contrast and increases visual comfort.

5. MODERN LIBRARIES

The post-war libraries in Cambridge usually are separate buildings with a distinctive character. The rules of raising them above the ground level need not be adhered to with the invention of damp-proof courses in building construction. The advent of Information Technology and VDUs has changed the concept of storage of knowledge. Moreover the easy availability of steel and glass has increased glazing areas in these buildings.

However, the main feature of the modern library is the distinction between the places where books are stored and the places where they are read. The storerooms that are often placed in the lower floors are darker areas where lighting levels are relatively low and humidity and air temperature are controlled. The IT spaces are also placed in darker areas and the lighting is usually artificially controlled. The reading areas on the other hand are at higher levels as in Darwin College and are generously daylight. Nevertheless, it is very difficult to find a prototype modern library since they are often characterised by individual architectural styles.

5.1 Darwin College

Darwin College library was chosen for the study since it is more recently constructed and incorporates characteristics common to many modern libraries.

In the Darwin College library there is a complete segregation of the reading area and the storage area [13], the former at a higher level and the latter at a lower level (ref. Illus. 6). The bookstacks have a row of clerestory

lighting above them and are almost wholly lit by Internally Reflected Component. This results in a very even quality of light on these stacks with DF ranging from 0.5%-2%. The walls and the roof are painted white to diffuse the light as well as reflect it back into the room. On the first floor, the reading areas face the north and south. The reading area on the north has clerestory lighting and thus gets a more uniform distribution of daylight varying from 1%-3% DF (Figure 7).

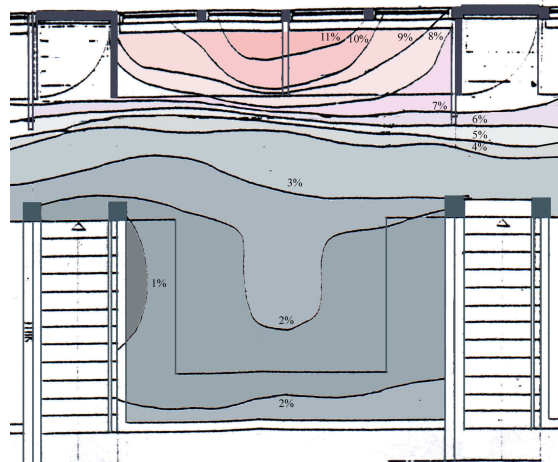


Figure 7: Daylight Factor distribution in one bay in Darwin College library [15]



Illus. 5: Low level storage in Darwin Library

The south side however is a source of glare and reduced visual acuity (Illustration 6) due to the large glazed area and the contrast between high luminance of the sky as seen through the window (1215 lux) and the reduced luminance of the adjacent areas (window frame-7 lux, table top-95-115 lux, book-285 lux).



Illus. 6: View of reading-area showing glare through the window. Photo: author.

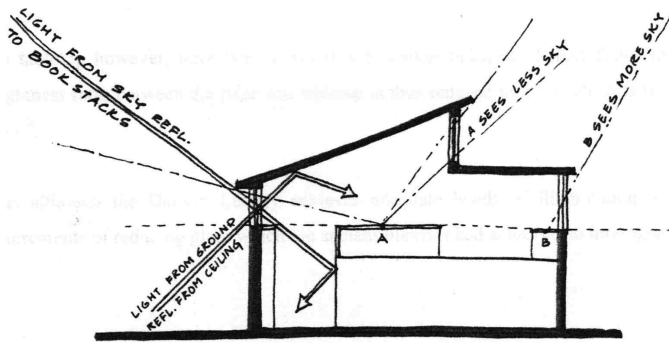


Figure 8: Section through library showing distribution of daylight.

6. ANALYSIS AND CONCLUSIONS

In the medieval times, books were the determining factor for the position, orientation and daylighting of libraries since the library had to offer protection to a content that had a great economic and social value. In the 16th century there were more concerns over comfort and we see that the orientation changed to N-S to command maximum solar gain. After the Reformation Trinity College library brought about a rethinking in daylighting strategies and later buildings tried to use the same techniques of high sill level, clerestory windows and diffused lighting in library design.

In recent years, with the invasion of information technology, there have been new demands made on the daylighting design of libraries. The daylighting of the modern library has had to adapt to three types of functions: storage for the books, visual comfort for the reading tasks and ease of seeing the VDU. For the first time in the history of Cambridge libraries, the

daylighting techniques in both the reading and storage areas have been very distinctive. For the first time too modern libraries have tried to create a relationship with the outside through the use of large glazed areas with a view out.

The study thus shows that with the shift from the rules of classicism to individual styles in design, the modern architect has opened up enormous possibilities for design innovations in daylighting. What we should learn from the past though are the unique solutions to manipulate natural light to provide visual and thermal comfort in the absence of artificial light as discussed earlier. Nevertheless, the basic principles of providing uniform illumination levels, reducing glare and increasing the use of natural light for visual and thermal comfort still remains the same. In modern times, the focus has also shifted more towards human comfort rather than preservation of library resources. Although in earlier libraries we see a concerted effort to cut out glare, recent studies [16] have proved that glare from natural sources such as water as in the case of Darwin library can be an attractive quality. They have also revealed that a small library space such as that of Jesus college library can create a feeling of darkness especially when combined with low internal reflectances.

Daylighting in architecture is thus a key concern, both aesthetically and functionally. Unlike other environmental services the elements of daylighting—windows and surfaces are undoubtedly the most visual and expressive. The particular challenge of modern library design is to manipulate natural light for reading and book storage while avoiding reflections on the VDU. What does all this signify in the modern context? A general conclusion can be that the designer needs to be aware of all the parameters, both quantitative (DF) and qualitative (human perception). Unlike medieval times there can be no universal truth that one can apply to get good results. Quantitative and qualitative parameters must coexist and complement each other. How each designer will then interpret and apply the basic daylighting principles will give a unique identity to the building he/she is designing.

Daylighting in modern libraries therefore presents interesting challenges. It is still a field not fully explored and it remains to be seen how daylighting design can successfully meet all the demands of a modern library.

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