

NEXUS

Architecture and
Mathematics

Conference Book

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FUNCTION SHOULD FOLLOW FORM: FUTURES FOR THE RADIANT LOGIC OF CARNEGIE PUBLIC LIBRARIES

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Introduction

This study builds on previous work to present a multidimensional analysis of a set of Carnegie library buildings and aims to foster the potential for their collective radiant logic to endure. At the turn of the Twentieth century, Andrew Carnegie supported the construction of over 2800 public libraries, across Britain and America many of which are now facing closure. Although designed by different architects, the common influence over the procurement of these buildings had a significant impact upon the standardisation of the public library typology. Specifically, economic design strategies with respect to light for public interiors were iteratively refined. Both spatial arrangements and socio-functional rules associated with increasing access to knowledge were developed. The relations between formal features and their latent shared identity will be analysed using both space syntax and luminance mapping in an attempt to derive indicators for decision-making with respect to adaptive re-use.

The Research

Scope and Purpose

Today many public libraries are under threat of closure as public funding is constrained. As a result, many library buildings are in a poor or non-existent state of repair. Designed at a time when light was expensive and heat cheap, their performance has caused problems in later years when the economic shift to cheap artificial light and expensive heat changes the priorities of users. Many have developed serious defects or been significantly altered. Seeking to save the buildings, proposals for mixed or altered use have become popular. This study seeks to develop a platform to assess aspects of the level of “changeability” of these libraries and thus their adaptive reuse potential, using new and existing sample case studies. The assessment in this paper focuses on the buildings’ predisposition to physical change based on their original intent in terms of environmental design.

Carnegie developed standardised plans and used design reviews to place emphasis on efficiency. The detailed deliberation through academic and professional journals for the design of natural and artificial light distribution in buildings is evident during the era in which the libraries were built. This work builds upon previous findings demonstrating that daylight design was prioritised for surveillance rather than for reading or navigation in Carnegie library buildings (Prizeman 2012).

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Both spatial configuration and daylight characteristics are key features for analysing the actual social function of public buildings. Nonetheless, the interaction dynamics between these two organizing principles can remain unclear. This study will identify how hybrid daylight-syntax zones in a sample of Carnegie libraries are now used. Their current use is described as it often differs from the original intention (Fig. 2). Archival evidence and informed readings of original design intentions will contribute to more nuanced interpretations of the results.

By widening the focus and deploying statistical analysis, this on-going investigation aims to deliver further evidence of a shared performance-integrated design heritage that otherwise may not be obvious. As the strategies and details deployed were common to other public buildings of the time, the findings may suggest opportunities for consideration for other typologies.

Method

The research is presented here in four steps: 1) survey of historic information and definition of criteria for analysis; 2) configurational/space syntax and daylight analysis; 3) integrated visualisations of light-syntax patterns; 4) interpretation and analysis of results with regard to the potential for adaptation or re-use.

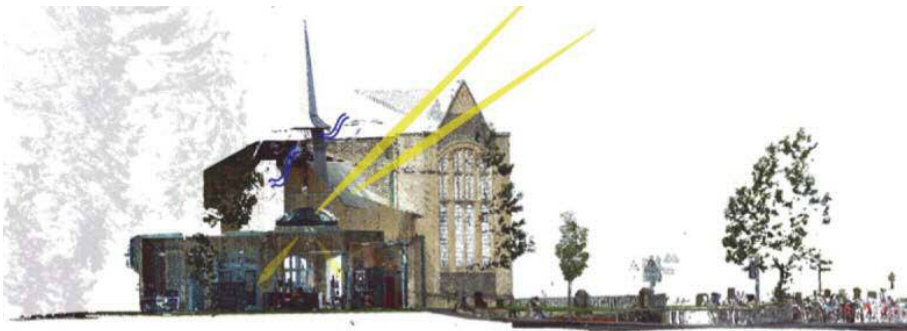


Fig. 1. Transverse section of Cathays Carnegie library, Cardiff, UK



Fig. 2. Cathays branch, information desk. Left) historic photo © Coflein; right) DLS survey

Space Syntax theory (Hillier and Hanson, 1984) states that individuals moving through a space make navigational decisions based on what they can see, and follow by preference long lines of sight. Furthermore, the studies of Andersen (2015) show that daylight affects the way occupants experience and interact with a building. Previous research suggests that differences in daylight influence occupation patterns in spaces with undifferentiated configurations (Dubois et al., 2007). Accordingly, human-centred notions related to natural lighting such as visual responsive comfort, visual delight, contrast and visual interest explain why daylight may also be important to way-finding indoors, affecting the overall impact of Space Syntax on the perceptive-cognitive apprehension of spaces.

The configurational metrics results of this study are produced via the computational processing of the libraries' floor plans, which are extracted from both measured surveys and scans using terrestrial laser scanning and structure from motion to develop 3D models. *Control*, *Integration* and other visual-spatial measures are mapped inside the libraries by means of a Visual Graph Analysis (Turner et al., 2001). A further diachronic study of the interiors is used to demonstrate the variation in VGA values in relation to the evolving configuration of the libraries over time (Fig. 3). The daylight seeking "butterfly" plan of one library footprint is analysed by mapping its *Connectivity* value along the perimeter (Psarra et al., 2001). Finally, the concepts of *Isovistas* and *Visual Fields* developed by Benedikt in 1979, are used to describe what can be perceived from crucial locations within the libraries. For description purposes, some statistical measures of the viewsheds are presented, including *Area*, *Occlusivity* and *Compactness*. The daylight analysis is done using the validated Radiance engine (Reinhart and Herkel, 2000). The simulations calculate both illuminance and luminance conditions of side-lit and sky-lit spaces. While Illuminance is a measure for the amount of light on a surface (lumens/m^2), luminance refers to the intensity or perceived brightness emitted by a light source or reflecting surface that is given in a certain direction and then received by the human eye.

The illuminance maps are then superimposed over the VGA analysis to generate integrated visualizations. Subsequently, a correlation analysis between the syntactical analysis and the daylight measures tests the degree of their interdependence. This is done in three ways: Firstly, for the correlations involving simulation data, the spot value of illuminance averaged over a yearly time period is taken and paired with averaged integration and physical connectivity values taken from the four closest grid points. Secondly, correspondences between daylight directionality of increasing and decreasing light levels and the spatial navigation in sample libraries are highlighted. Thirdly, the analysis is supported by location specific measures of luminance, which are used to create 360 degree representations from a certain point of view. Specifically, luminance is mapped in order visualize the effects of glare within the corresponding isovist. In this way the validity of the hypothesis regarding the hybrid light-syntax zones is examined in terms of how these buildings are used today.

Finally, we resort to the *Spatial Assessment of Generality and Adaptability* (SAGA) method to derive the degree of changeability of the examined libraries. Previous research shows that SAGA has been successfully used to study historic housing

typologies by focusing on configuration and area measures to account for existing and potential connections between spaces (Herthogs et al., 2017). This kind of assessment helps to extend the results of the typical Space Syntax analysis by generating new indices that depict the generality (potential for passive change) and adaptability (potential for active change) qualities of the spaces that compose the library buildings.

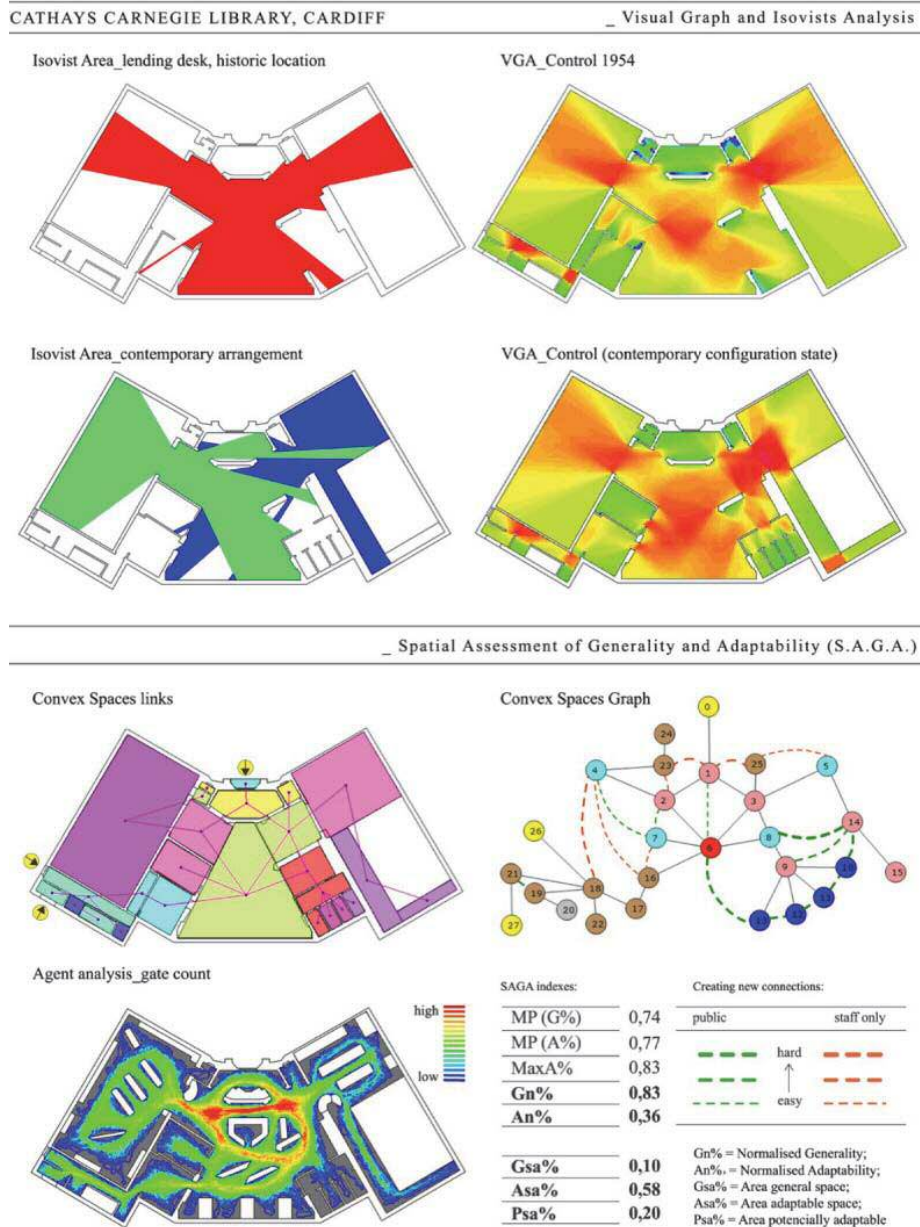


Fig. 3. Pilot study of Cathays Carnegie library: i) Diachronic VGA control and Isovist area analysis in relation to the positions of the lending desks in different historic moments (1954 and 2017); ii) Cathays library spatial assessment of generality and Adaptability (Ground floor); iii) Agent analysis according to the current disposition of furniture

The use of SAGA generates enriched architectural descriptions of the libraries through a number of specialised metrics useful to develop decision-making guidance and known as *Mean Permeability* (MP = average normalised distance from all spaces to all others), *Normalised Generality* ($G_n\%$) and *Normalised Adaptability* ($A_n\%$).

Within this research, SAGA is slightly modified, adapted and extended in order to account for the various designs of Carnegie libraries. The syntactic measures are calculated by using the open-source (research purposes only) Space Syntax software Agraph. This software extracts from the building layout its convex graph and calculates the values of the *Relative Asymmetry* (RA) of all the spaces in different hypothetical conditions. Preliminary results show that, in the case of Cathays library in Cardiff, the aspect of Generality is prevalent from a configurational point of view, but the surfaces are highly adaptable in terms of their area measures (Fig. 3ii).

Conclusion

This paper presents an exploratory investigation of the potential for both space syntax and daylight analysis to contribute to the better understanding of buildings for conservation purposes. The exploration is assisted by the consistency and extent of the available data for Carnegie libraries but potentially extends to other typologies of the time. Ultimately, the wider research project aims to use the transatlantic basis of the Carnegie programme as an opportunity to stimulate the development of new methodologies for the salvage, re-use and re-invigoration of these shared inherited ‘gifts’.

Acknowledgments

This work forms part of a 40-month research project: Shelf-Life; Re-imagining the future of Carnegie Public Libraries funded by the Arts and Humanities Research Council, UK.

Fig. 2 credit: Black and white photograph showing part of the interior of Cathays Public Library, Cardiff. C440851 Accession Number NA/GL/2009/012e Collection Cathays Library Collection. Reproduced by kind permission of Cathays Library.

http://map.coflein.gov.uk/index.php?action=do_collection_details&cache_name=&numlink=440851#tabs-4.

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