VISUAL PERMEABILITY AND THE ARCHITECTURE OF GLENN MURCUTT

Comparing the characteristic complexity of opaque and transparent building facades

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Abstract. Computational fractal analysis calculates a numerical measure of the characteristic visual complexity present in a building’s elevation or plan. In addition to measuring a building’s visual complexity, this method allows for comparisons to be made between different formal properties in the same building. The focus of the application of this method in the present research is the work of Australian architect, Glenn Murcutt. A recurring theme in Australian Regionalism is the relationship between the building interior and the landscape; a relationship which is enabled through the transparency or layering of elements in a building’s façade. Fractal analysis is typically only applied to representations of buildings with opaque surfaces. However, the work of Murcutt presents an opportunity to analyse architecture as it would be perceived in different ways. To do this, the paper computes and then compares the fractal dimensions of two sets of the elevations of ten of Murcutt’s rural houses. The first set treats the building façades as opaque while the second set includes views through open doors and transparent windows or screens. The results of these two tests are then compared to determine if there is, as Regionalist architects maintain, a significant difference in the visual character of the two options.

Keywords. Fractal Analysis; Australian Regionalism; Glenn Murcutt.

1. Introduction

In this paper ten of Glenn Murcutt’s domestic architectural works are investigated using a computational version of the box-counting method for measuring the fractal dimension of architecture. The purpose of this analysis is to quantify the visual impact of varying levels of transparency in Murcutt’s ar-
architecture and, through this, to comment on the standard Critical Regionalist argument that Murcutt’s architecture is characterised by visual lightness. Despite the significance of Murcutt’s work, the Pritzker prize-winning Australian architect has only been the subject of a small number of quantitative studies in the past, including research using shape grammar (Hansen and Radford 1986a; 1986b) and space syntax (Ostwald 2011). The present paper records the first fractal analysis of Murcutt’s work and also the first time that architecture from the Oceanic region has been analysed using this method. More importantly though, this paper offers a unique application of fractal analysis. Existing applications of the method typically analyse facades and assume (for consistency) that all surfaces are opaque (thus, all doors are depicted as closed and windows as solid surfaces). In contrast, this paper uses an approach informed by Colin Rowe’s and Robert Slutzky’s (1963) definition of transparency to investigate both a ‘literal’ and a ‘phenomenal’ reading of Murcutt’s architecture. Literal transparency occurs where a physical form is “pervious to light and air” (1963, p. 45), while phenomenal transparency occurs when a building exhibits “stratifications” which, whether implied or real, are “devices by means of which space becomes constructed, substantial, and articulate” (1963, p. 53).

Since Murcutt’s work is often described in terms of its visual lightness, and connection to site, any analysis of his architecture should consider the impact of transparency on architectural expression. However, glass is not always transparent and, at certain times of the day and under certain lighting conditions, it can be reflective or opaque. Thus, to analyse the visual complexity of Murcutt’s architecture requires a consideration of at least two different ways in which a façade can be experienced; as either opaque or transparent. In order to do this, in the present paper ten of Murcutt’s rural domestic works (built between 1975 and 2005) are analysed using two different variations of their façades. In the first set, all façade elements are represented as opaque and in the second set permeable doors, screens and glass are represented as transparent. The 80 results of this analysis are then compared to quantify the difference and determine if this is significant in terms of visual perception.

2. Fractal Analysis

In the late 1970’s mathematician Benoit Mandelbrot proposed a new model of geometry (Mandelbrot 1982). Mandelbrot’s breakthrough was to consider that objects in nature often possess characteristic complexity: this implies that natural objects frequently look alike when they are viewed at different scales. Thus a tree, when viewed from a distance, will often look similar to a
branch or even a leaf of that same tree when viewed at a closer scale. Therefore, the tree could be thought of as possessing a form of consistent complexity, or characteristic irregularity, which can be measured across multiple scales of observation.

A fractal dimension \((D)\) is a non-integer number. For measuring the characteristic complexity of an image, elevation or plan, \(D\) is a value between 1.0 and 2.0, with lower values (say \(D = 1.1\)) denoting an object with minimal complexity and high values (say, \(D = 1.9\)) suggesting a visually complex object. \(D\) can be determined using the “box-counting” method, which calculates the amount of information present in an object over a range of scales, and then determines the average level of distributed information in that object (Mandelbrot 1982).

A comparison between the \(D\) values of different architectural parameters is potentially an important tool in architectural computational analysis. As one of a limited range of quantifiable approaches to the analysis of the visual qualities of buildings and landscapes, the method can potentially assist architects to create buildings which can contribute toward studies of visual preference and also help to determine the “contextual fractal fit” of buildings into particular locations (Stamps III, 2002). Since Bovill’s (1996) presentation of the method, computational variations have been developed and tested for a large number of examinations of plans and elevations of buildings (Joye, 2011; Vaughan and Ostwald, 2011; Lorenz, 2012; Ostwald and Vaughan, 2013). This method has also been used to provide a quantitative comparison between different architectural parameters such as old and modernised versions of the same building (Zarnowiecka, 2002) or different levels of visual layering in elevations (Ediz and Ostwald, 2013).

3. Permeable Qualities in Architecture

With few exceptions, Murcutt’s rural domestic architecture has been described by historians as providing an exemplar of Arcadian minimalism – a rigorous modern evocation of the form and tectonics of the primitive hut. For example, Philip Drew proposes that Murcutt’s talent lies in his capacity to shape “a minimalism that is austere and tough so that all that remains is an irreducible core” (1986, p. 60). Rory Spence describes Murcutt’s early houses as constituting a clear formal type: “the long thin open pavilion” (1986, p. 72). Francoise Fromonot argues that Murcutt’s houses are all “variations on the same theme” and that these design “prototypes” represent a “relatively homogenous body of work. An analysis of [which] reveals a number of constants which could be called characteristic, analogous to those identifiable in specimens which illustrate a species” (1995, p. 60). Drew, Fromonot and
Spence are not alone in identifying in each of these houses a local variant of a more universal type.

These descriptions of Murcutt’s work would suggest that a fractal analysis of elevations of his rural domestic works would reveal consistent results and that these would indicate a low level of visual complexity; meaning that $D$ will be closer to 1.0 than 2.0. Previous fractal analysis of the work of Minimalist modern architect, Kazuyo Sejima, found a consistent and low set of results for three of her houses: $1.192 < D < 1.309$ (Vaughan and Ostwald, 2008) and descriptions of Murcutt’s work imply that it will possess dimensions of a similar range. However, Murcutt himself notes that a simple form does not necessarily imply the presence of a simple interior or experience; “[t]he house [may be] very simple. But remember simplicity is the other face of complexity” (2007, p. 26). In this statement Murcutt suggests that the visual properties of his architecture might change depending on the perspective of the viewer. This is reflected in past space syntax analysis of Murcutt’s interiors which identified that, with few exceptions, the internal configurations were both more complex and less predictable than the canonical literature suggests (Ostwald 2011). However, the key to visual analysis of this property rests in the interface between the exterior and interior, the façade.

Powell (1992) argues that Murcutt treats the façade of the Marie Short house “as a diaphragm which filters the sun and the wind. It allows views out from every part of the house and there are generous fly-screened verandahs” (Powell, 1992, p. 27). Murcutt himself states that, in this house a layered “system of sliding slatted timber screens, insect screens and glazed doors [...] allows for many options [which] can be adjusted to accommodate varying climatic conditions” (qtd in Beck and Cooper, 2006 p. 175). It is this layered and transparent quality that mediates between the apparent simplicity of the building form and the more complex visual experience of the interior as seen from the landscape.

4. Analytical Method

There are several methods for calculating the approximate fractal dimension of an image or object. The most common of these is the box-counting approach (Mandelbrot, 1982). The box-counting approach – for calculating the approximate fractal dimension of a two-dimensional image – takes as its starting point a line drawing, say the façade of a building. A grid is then placed over the drawing and each square in the grid is analysed to determine whether any lines from the façade are present in it. Those grid boxes that have some detail in them are then marked. Next, a grid of smaller scale is placed over the same façade and the same determination is made of whether
detail is present in the boxes of the grid. A comparison is then made of the number of boxes with detail in the first grid and the number of boxes with detail in the second grid. Such a comparison is made by plotting a log-log diagram for each grid size. When the process is repeated a sufficient number of times, it leads to the production of an estimate of the fractal dimension of the façade.

The box-counting process was traditionally a manual exercise, however, several programs now automate this operation, including Archimage (vers. 1.16), developed by the authors, which is used in the present study. Past research using the method identifies optimal settings for its application (Foroutan-pour et al, 1999; Cooper and Oskrochi, 2008; Ostwald 2013, Ostwald and Vaughan, 2013). These settings ensure the image is prepared and processed in a manner which produces both repeatable results and minimal methodologically-derived errors (< 0.5%). The settings used for this research are: grid disposition = edge growth; grid scaling = 1. 1.41421; starting image size = 125dpi, Image position = centre-centre, White space = 50%, line thickness = 1pt.

For each of the ten selected houses (see next section) by Murcutt, all four elevations were drawn twice, one representation providing a typical elevation, with all doors closed and all windows opaque. The other version of the elevation showing the building with the internal walls and fixed furniture visible through open doors, screens and windows. The elevations are drawn with consistent graphic conventions following the standard procedure for selection of significant lines for “detail design” where “design” is taken to include not only decisions about form and materiality but also movable or tertiary forms and fixed-furniture which directly support inhabitation (Ostwald and Vaughan, 2012). The drawings used for the analysis were all digitally re-traced from published working drawings (Drew, 1985; Beck and Cooper, 2006; Frampton, 2006; Gusheh, 2008; Murcutt, 2008).

The particular variation of the standard method used is as follows (see Table 1 for abbreviations and definitions).

a) The 40 (10 houses by 4 elevations for each) “opaque” views of each individual house are identified as Set 1.

b) Each elevation of each house is analysed using Archimage software producing a $D_E$ outcome

c) The $D_E$ results for the elevations of each house are averaged to produce a separate $D(\mu_E)$ result.

d) The range ($R_E \%$) between the highest and lowest $D_E$ results in a single house is calculated and expressed as a percentage.
e) The median ($M_{(E)}$) is calculated for the combined $D_E$ results for all elevations of all houses in Set 1.

f) The 40 “transparent” views of each individual house are identified as Set 2. Steps (b) to (e) are repeated for Set 2.

Table 1: Abbreviations and definitions.

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<thead>
<tr>
<th>Abbreviation</th>
<th>Meaning</th>
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<tr>
<td>$D$</td>
<td>Fractal Dimension.</td>
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<tr>
<td>$D_E$</td>
<td>$D$ for a specific elevation.</td>
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<tr>
<td>$\mu_E$</td>
<td>Mean $D$ for all of the visible elevations of a building.</td>
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<tr>
<td>$M_{(E)}$</td>
<td>Median $D$ for a set of all elevations.</td>
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<tr>
<td>$R_{(E)}$%</td>
<td>Range between the highest and lowest $D_E$ results in a single building expressed as a percentage</td>
</tr>
<tr>
<td>$R_{(E)}$%</td>
<td>Range between the highest and lowest $D_E$ results in a set of buildings expressed as a percentage</td>
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5. Glen Murcutt and the ten houses

All ten houses included in the present analysis are characteristic of Murcutt’s oeuvre possessing long, narrow forms, often separated into pavilions and all being located in a rural setting in New South Wales, Australia. However, these ten houses can be separated into two distinct groups of five. This first group of five (1975 – 1982) comprises the Marie Short, Nicholas, Carruthers, Fredericks and Ball-Eastaway houses. Drew describes the first four of these houses as “really members of a series, [because …] taken together, they represent a progressive development and refinement of the longitudinal house type” (1985, p. 92). These four also directly prefigure a fifth house – an intermediate work in Murcutt’s oeuvre – the Ball-Eastaway House (Figure 1) (Farrelly 1993; Fromonot 1995). These are all elevated buildings, which “touch the earth lightly” on posts or piers, and have enclosing roofs with a central ridge running through the centre of the pavilions.

After the completion of the Ball-Eastaway House, Murcutt retained his linear planning style but he developed more elaborate sections, typically featuring curvilinear steel structures, as well as producing a series of larger houses. The second set of five houses (1984 – 2005) sit directly on, or in, the ground, and are characterised by rooflines which tilt upward in a skillion or butterfly form (the Southern Highlands house being the only exception, as it combines the two roof types). This later group comprises the Magney, Simpson-Lee, Fletcher-Page, Southern Highlands and Walsh Houses. Significantly, nearly all ten houses considered in this paper have been altered or extended since being completed and many have been resold. In all cases, the
version of the house analysed here is the original, and the original naming of each house has also been retained.

Figure 1: Ball-Eastaway House, East Elev., opaque (left) and transparent (right) variations.

6. Results

The results from the opaque representations of Murcutt’s work display a fairly consistent set of dimensions and a clear clustering pattern can be seen for both the early and later houses. The individual elevation results for the early houses fall between $1.3433 < D_E < 1.5010$, with a range of $R_{[E]} = 16\%$ (figure 2). These results show that Murcutt produces a similar level of characteristic complexity for all elevations of each of the early houses. It is interesting to note that the two houses from this set with the widest range in individual elevation dimensions, the Nicholas and Carruthers Houses ($R_E = 11\%$ and $R_E = 12\%$ respectively), are on a site which required Murcutt to accommodate severe winter winds; a factor which might account for the different treatment to each elevation in these two buildings. For the Frederick and Ball-Eastaway Houses, the results are in a remarkably tight range ($R_E = 2.8\%$ and $R_E = 0.7\%$ respectively).

While the mean results for the opaque views of Murcutt’s later houses do not fluctuate as strongly as the earlier ones, the individual elevation results for the later houses fall in a wider range than those of the earlier set, $(1.3732 < D_E < 1.5756$, with a $R_{[E]} = 20\%$), suggesting that in all of these later works Murcutt began to treat each elevation differently. The Median for the opaque views of all ten houses is 1.4096.

For the transparent elevations, the early set of houses produced results between $1.3433 < D_E < 1.4849$, with a range, $R_{[E]} = 14\%$. While the later set of houses produced results between $1.3753 < D_E < 1.5977$ with a range of $R_{[E]} = 22\%$. The overall Median for all ten houses is 1.4361 (figure 3). The variation in results between the transparent views present a similar pattern to the opaque views.
Figure 2. Results for opaque views of Murcutt’s houses.

Figure 3. Results for transparent views of Murcutt’s houses.

Figure 4. Comparison of mean transparent and opaque views of Murcutt’s houses.
7. Conclusion

While the results for these ten houses are generally in the lower half of the fractal dimension spectrum (that is, where \( D_E < 1.5 \)), they do not reflect the suggestion, repeated by many authors and critics, that Murcutt’s work has a very low level of visual complexity akin to that of other Minimalist architects (where \( D_E < 1.3 \)). With both median results in the range \( 1.4096 < D_E < 1.4361 \), Murcutt’s architecture is not dissimilar to fractal dimension results derived in past research for many modernist works.

The higher fractal dimension results for the transparent views were also to be expected, as the elevations depicting the interior through the facade naturally contain more detail. What was unexpected is the low level of difference between the two sets of results. The most obvious interpretation of this is that transparency, again despite popular opinion, is not a strong determinant in Murcutt’s architecture of visual complexity. While this may be true, another practical explanation might be found in the fact that many interior elements in Murcutt’s architecture are precisely aligned to exterior columns, walls and window openings, making them effectively invisible in a transparent façade drawing. While beyond the scope of the present paper, a comparative analysis of perspective views with opaque and transparent representations could be used to test this idea. However, there are many additional issues that would complicate such a study, which is why the façade analysis method is the most reliable and objective.

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References


