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Measuring the significance of façade transparency in Australian regionalist architecture: A computational analysis of 10 designs by Glenn Murcutt

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Historians and critics argue that a key characteristic of late twentieth century Australian regionalist architecture is the close visual connection it creates between the interior and the landscape. While various design properties are allegedly responsible for this connection, one of the most tangible of these is associated with the use of transparent and layered elements in a building's façade. Indeed, as exemplified in the work of Glenn Murcutt, the importance of façade transparency is a recurring theme in Australian architecture. But is it really that significant? In this paper, computational fractal analysis is used to measure the difference between the visual complexity of opaque and transparent depictions of façades. By comparing these two façade conditions, first in sets of elevations derived from 10 of Murcutt's houses and then in a detailed review of one of Murcutt's most iconic works, the Marie-Short House, this paper calculates the visual impact of transparency on the characteristic complexity of Murcutt's architecture.

Keywords: computational fractal analysis; Australian regionalism; critical regionalism; Glenn Murcutt

1. Introduction

According to Beck and Cooper, Pritzker prize-winning Australian architect Glenn Murcutt produced 'an authentically Australian architecture that speaks of regional qualities while also participating in the international modernist discourse' (2006, 9). Murcutt is Australia's renowned exponent of Regionalism, a design movement that relies on the use of local materials, tectonic practices and ecological responses to create an architecture that is appropriate for its location and era. Regionalism, a variant of Frampton's (1983) critical regionalism, calls for architecture to remain contemporary while rejecting the *tabula rasa* approach and aesthetic ubiquity favoured by early twentieth century Modernity, in favour of a more subtle and poetic response to local conditions.

The canonical interpretation of Murcutt's architecture is that it is characterized by lightness and transparency (Figures 1 and 2). Architectural critics typically explain these qualities using spiritual, ethical and philosophical arguments about form, materiality and tectonics. While such propositions may be reasonable, the most conspicuous property of Murcutt's architecture that explains the sense of transparency they evoke, is simply that large proportions of their façades can be seen through or opened. This type of literal transparency, reliant on layers of louvres and screens, allows the interior of a building to be revealed from the outside, reinforcing the relationship between the architecture and its setting; a quality which is important in regionalist design. Façade transparency is also of interest because it is one of the few properties of the experience of Murcutt's architecture that is measurable. Thus, it offers a quantifiable property that can be used to examine and assess Murcutt's architecture without resorting to qualitative, poetic or neoplatonic readings of the relationship between form and site.

The purpose of the present paper is therefore, to calculate the significance of transparency in the visual expression of Murcutt's architecture, and through this process to begin to comment on the role of literal transparency in Australian regionalist architecture. The method used to measure the impact of transparency is computational fractal analysis. Benoit Mandelbrot developed the concept of a fractal dimension in the late 1970s as a means of describing and measuring levels of geometric irregularity in complex objects. Since that time many fields, including medicine, geology, astronomy and economics, have used fractal dimensions to measure the characteristic complexity of different forms. Inspired by Mandelbrot's work, Bovill (1996) demonstrated a method for calculating the fractal dimensions of architecture. Lorenz argues that this method is 'appropriate […] for measuring works of architecture with regard to continuity of roughness over a specific scale-range' (2009, 703). Since the late 1990s this method has also been used for a growing number of architectural studies and more recently it has undergone considerable refinement (Foroutan-pour, Dutilleul, and Smith 1999; Lorenz 2009; Ostwald 2013; Ostwald and Vaughan 2013a, 2013b).

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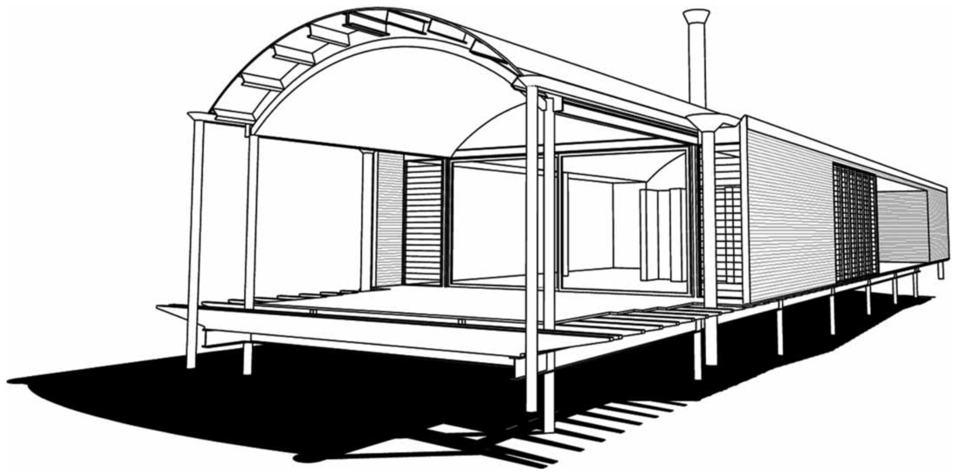

Figure 1. Glenn Murcutt's Ball-Eastaway House.

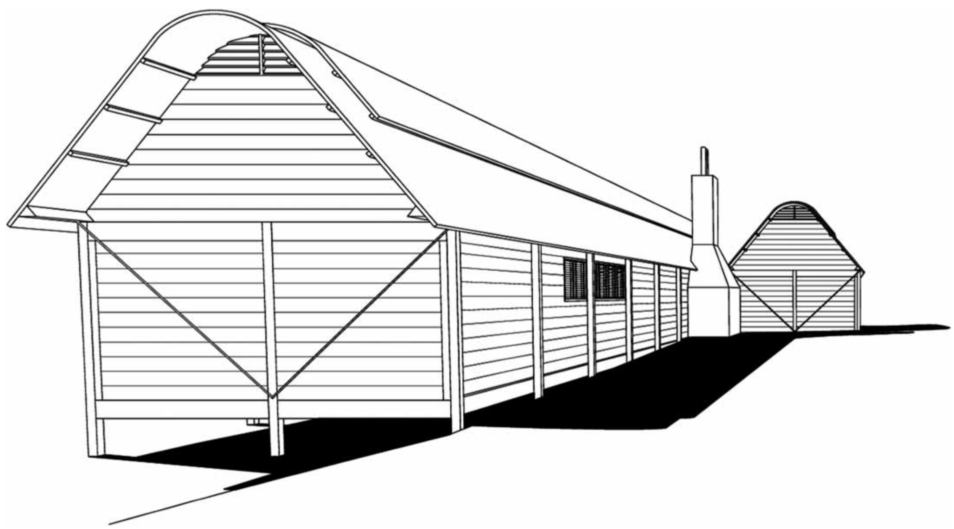

Figure 2. Glenn Murcutt's Frederick House.

In the present paper fractal analysis is used to undertake two investigations of Murcutt's architecture. The first investigation measures the formal complexity of elevations using two different variations of their façades. In the first variation, all façade elements are represented as opaque and closed and in the second variation permeable doors, screens and glass are represented as transparent or open, thereby revealing the interior. Both variations are initially applied to line drawings of elevations of 10 of Murcutt's houses that were built between 1975 and 2005. The 80 results produced in this way are then compared to quantify the difference and determine if this is significant in terms of visual perception. The second investigation is necessary because it is possible that orthogonal depictions of Murcutt's architecture may not reveal the full extent of its visual permeability. Thus, the paper analyses a set of perspective images of the *Marie Short House*, to determine if such views alter the fractal dimension results in both opaque and transparent representations. Whereas the first test provides a larger scale set of results for longitudinal comparison, and is thus more valid in a purely statistical sense, the second offers a different way of understanding the permeability of Murcutt's architecture.

Several past studies using computational means have confirmed that Murcutt's architecture has a consistent design grammar (Hansen and Radford 1986a, 1986b) and that its syntactical properties are also spatially significant (Ostwald 2011a, 2011b). Such studies demonstrate, in different ways, that Murcutt's architecture is ideally suitable for the type of computational analysis proposed in the present paper. However, the conventional application of fractal analysis is not suitable for this purpose without some variations. Thus, this paper demonstrates the first application of the method to considering transparency and the first to methodically examine perspective images.

2. Fractal analysis

In the late 1970s mathematician Benoit Mandelbrot proposed a new model of geometry which would allow scientists to measure, 'in rigorous and vigorous quantitative fashion,' a range of shapes that have previously been defined as too 'grainy, hydralike, [...] tangled, tortuous, wiggly, wispy [and] wrinkled' to be seriously considered (Mandelbrot 1982, 5). 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 of that same tree or even a leaf from that 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 and averaged across multiple scales of observation.

A fractal dimension (D) is a non-integer number. When measuring the characteristic complexity of an image such as an elevation or plan, D is a value between 1.0 and 2.0. If D has a lower value (say $D = 1.1$), this denotes an object with minimal complexity, while a high value (say, $D = 1.9$) suggests a visually complex object. D can be determined using the 'box-counting' method, which calculates the amount of detail or information present in an object over a range of scales, and then determines the average or typical level of distributed detail or information in that object (Mandelbrot 1982; Voss 1986; Bovill 1996).

A comparison between the D values of different architectural parameters is potentially an important tool in architectural design and computational analysis. As one of a limited range of quantifiable approaches to the analysis of the visual qualities of buildings and landscapes, the box-counting method can potentially assist architects to create buildings which can contribute towards studies of visual preference and also help determine the 'contextual fractal fit' of buildings into particular locations (Stamps III 2002). Since Bovill's (1996) initial application of the method to architecture, computational variations of the box-counting method 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 2013; Ostwald and Vaughan 2013a, 2013b). This method has also been used to provide a quantitative comparison between different architectural parameters including historic and modernized 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, Glenn 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, 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, 60). Spence describes Murcutt's early houses as constituting a clear formal type: 'the long thin open pavilion' (1986, 72). 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' (2003, 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 suggest that a fractal analysis of elevations of his rural domestic works would reveal consistent results and, moreover, that these would exhibit 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: $1.192 < D < 1.309$, the lowest visual complexity recorded for any architect using this method (Vaughan and Ostwald 2008). 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, 26). In this statement Murcutt argues that the visual properties of his architecture might change depending on the perspective of the viewer and the degree to which the interior can be seen or experienced from the exterior. This is certainly reflected in past space syntax analysis of the interiors of Murcutt's houses which identified that, with few exceptions, the internal configurations were both more complex and less predictable than suggested by the canonical literature (Ostwald 2011b). However, the key to visual analysis of this property rests in the interface between the exterior and interior, the façade, and the degree to which it is visually permeable.

Rowe and Slutzky differentiate two types of transparency, the 'literal' and a 'phenomenal', in their analysis of architectural design and spatial experience. Literal transparency occurs where a physical form is 'pervious to light and air' (1963, 45), while phenomenal transparency occurs when a building exhibits 'stratifications' that, whether implied or real, are 'devices by means of which space becomes constructed, substantial, and articulate' (53). In a sense, the first type of transparency is associated with visual permeability (meaning, to see through), while the second is more associated with perception of depth (implying a capacity to move through). Thus, in the context of Murcutt's architecture, this paper is more concerned with the first type of transparency, 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.

4. Analytical method

There are several methods for calculating the fractal dimension of an image or object. The most common of these is the box-counting approach (Mandelbrot 1982; Voss 1986). 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* (version 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, Dutilleul, and Smith 1999; Cooper and Oskrochi 2008; Ostwald 2013, Ostwald and Vaughan 2013a). These settings ensure that the image is prepared and processed in a manner which provides both repeatable results and minimal methodologically derived errors (< 0.5%). The settings used for the present research are: grid disposition = edge growth; grid scaling = 1.1.41421; starting image size = 125 dpi, image position = centre–centre, White space =50%, line thickness = 1pt.

Investigation 1: Elevation Views

For each of the 10 selected houses by Murcutt, all four elevations were drawn twice. The first variation showing all doors closed and all windows opaque and the second showing the building with the internal walls and fixed furniture visible through open doors, screens and windows (Figures 3–4). The elevations were 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 2013b). The drawings used for the analysis were all digitally re-traced from published working drawings (Drew 1985;

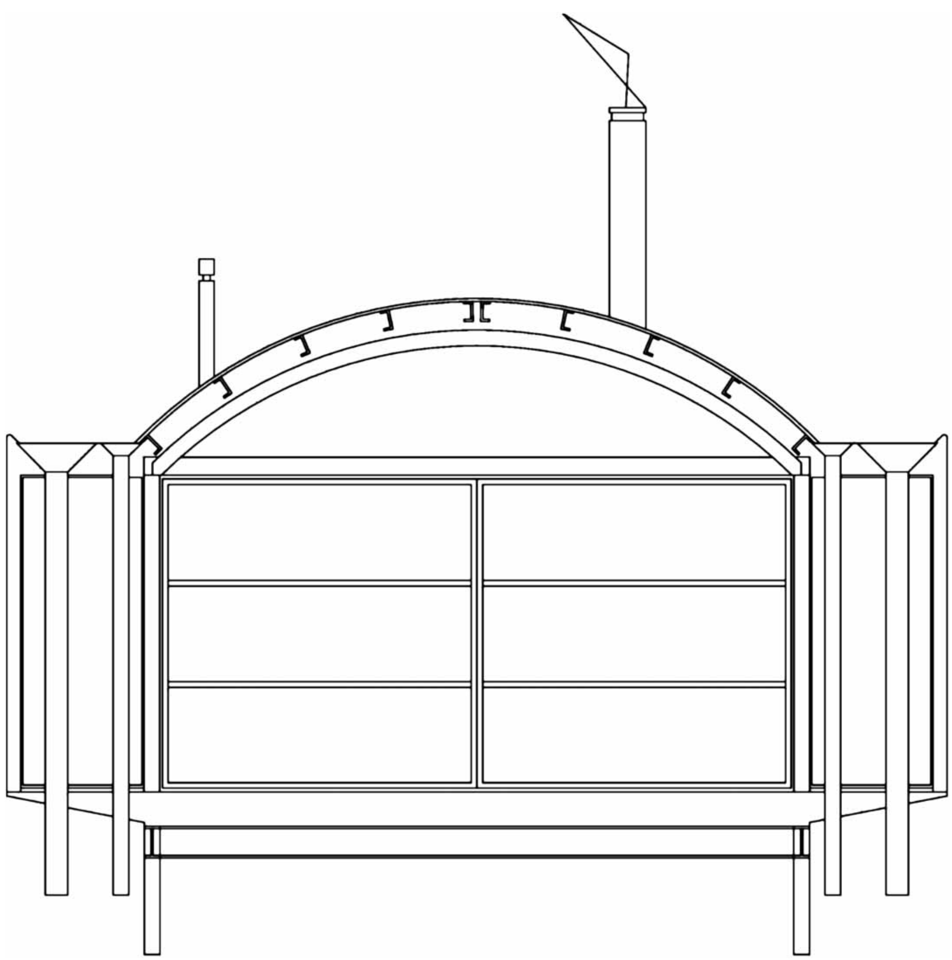

Figure 3. Ball-Eastaway House east elevation; opaque elevation.

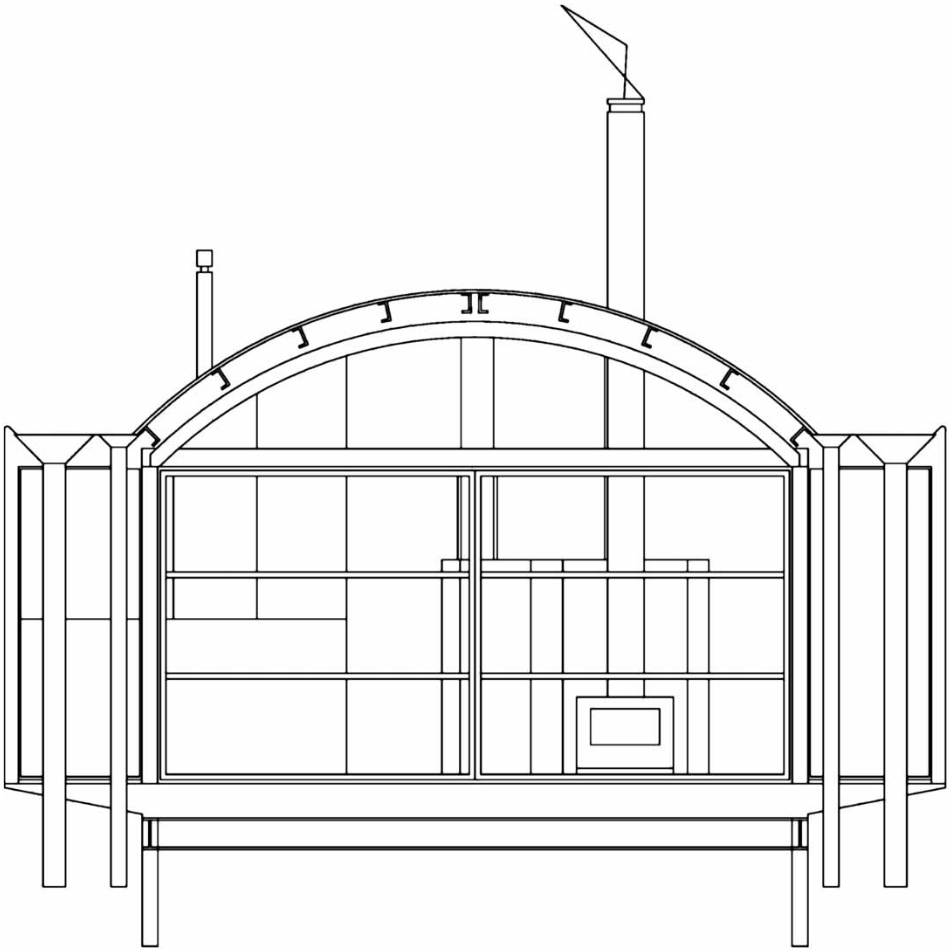

Figure 4. Ball-Eastaway House. East elevation; transparent variation.

Beck and Cooper 2006; Frampton 2006; Gusheh 2008; Murcutt 2008). The particular variations of the method used are as follows (see Table 1 for abbreviations and definitions).

(a) The 40 (10 houses by four 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_{EO} outcome.
(c) The D_{EO} results for the elevations of each house are averaged to produce a separate $D(\mu_{EO})$ result for each house.
(d) The range ($R_{EO\%}$) between the highest and lowest D_{EO} results in a single house is calculated and expressed as a percentage, and the range between the highest and lowest mean results is similarly produced as a percentage ($R_{\mu EO\%}$).
(e) The median ($M_{\{EO\}}$) is calculated for the combined D_{EO} results for all elevations of all houses in Set 1.

Table 1. Abbreviations and definitions.

Abbreviation	Meaning
D	Fractal dimension
D_{EO}	D for a specific *opaque elevation*
D_{ET}	D for a specific *transparent elevation*
D_{VO}	D for a specific *opaque* perspective *view*
D_{VT}	D for a specific *transparent* perspective *view*
μ_E	Mean D for all of the elevations of a building
μ_V	Mean D for all of the perspective views of a building
$M_{\{E\}}$	Median D for a set of all elevations
$M_{\{V\}}$	Median D for a set of all perspective views
$R_{\{E\}\%}$	Range between the highest and lowest D_E results in a set of buildings expressed as a percentage
$R_{\{V\}\%}$	Range between the highest and lowest D_V results in a set of buildings expressed as a percentage
Difference	The difference between the mean transparent and mean opaque results for each house expressed as a percentage

The 40 'transparent' views of each individual house are identified as Set 2. Steps (b)–(e) are repeated for Set 2, producing D_{ET} results for the elevations, a $D(\mu_{ET})$ result for each house, and $R_{ET\%}$, $R_{\mu ET\%}$ and $M_{\{ET\}}$ results for the set.

While this first approach provides a standard and consistent set of results, for the present research topic, which is about perceptions of transparency, the fact that many interior elements in Murcutt's architecture are precisely aligned to exterior columns, walls and window openings might make them invisible in a transparent elevation drawing. To examine this possibility, the second approach utilizes a set of perspective representations of the *Marie Short House*.

Investigation 2: Perspective Views

Powell 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' (1992, 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' (Beck and Cooper 2006, 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 points in the landscape. To test this proposition, two sets of perspective views, one opaque and one transparent (Figures 5–6), were prepared for the *Marie Short House*, in accordance with the following procedure. For the transparent version, all louvres were assumed to be open and transparent or retracted (many retract into ceiling brackets). There are also two specific cases which are worthy of noting. First, the wooden gable-end brackets were treated as transparent, even though they actually have thickness, and a movable partition to the second bedroom was left closed.

(a) To locate the positions from which the perspective views are generated, a circle is drawn around the plan of the building. The radius of the circle is determined by generating a 110° angle (representing the high acuity cone of vision) which can contain the longest elevation within its viewing arc. Thus, this distance replicates the point where a person standing on a line perpendicular to the longest elevation can comfortably see the entirety of that elevation. Once the radius is determined, then the circle can be generated, and divided into 12 30° segments (the sub-cardinal points of a 12-point compass). Each of these positions becomes a generation point for a perspective view of the building.
(b) 12 'opaque' views of the *Marie Short House* are generated and identified as Set 3.
(c) Each view is analysed using *Archimage* software producing a D_{VO} outcome.

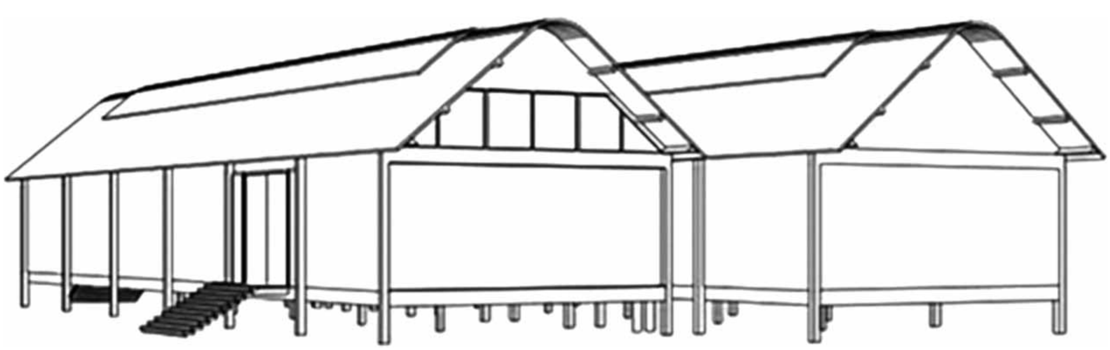

Figure 5. Marie Short House Perspective; opaque variation.

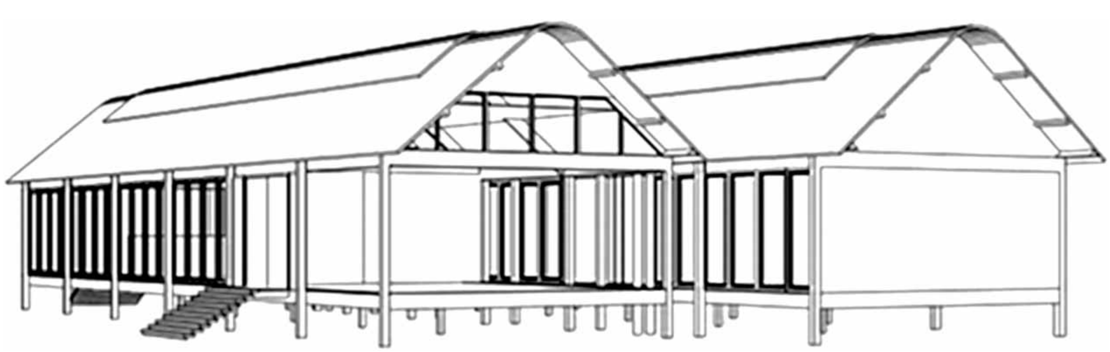

Figure 6. Marie Short House Perspective; transparent variation.

(d) The D_{VO} results for the views of the house are averaged to produce a separate D (μ_{VO}) result.
(e) The median ($M_{\{VO\}}$) is calculated for the combined D_{VO} results for all views of the house.
(f) 12 'transparent' views of the *Marie Short House* are generated and identified as Set 4. Steps (b)–(e) are repeated for Set 4 producing equivalent outcomes but for the permeable façade representation (D_{VO}, μ_{VO}, $M_{\{VO\}}$)

5. Glen Murcutt and the 10 houses

All 10 houses included in the present analysis are characteristic of Murcutt's design approach possessing long, narrow forms, often separated into pavilions and all being located in a rural setting in New South Wales, Australia. However, these 10 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, 92). These four also directly prefigure a fifth house – an intermediate work in Murcutt's oeuvre – the *Ball-Eastaway House* (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 characterized by rooflines which spring 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 10 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.

The *Marie Short House* (1975) is the first of Murcutt's famous regional houses credited as heralding both a new Australian style (MacMahon 2001) as well as being a key critical regionalist work (Frampton 2006). The house consists of two, similarly sized pavilions that are axially displaced. The *Nicholas House* (1980) and the *Carruthers House* (1980) were built on adjacent sites as country retreats for the families of two lawyers. While the *Nicholas House*, like the *Marie Short House*, has a two-pavilion *parti*, it is the first of Murcutt's houses where the pavilions are unequally sized. The main pavilion is clad in timber boards and lined with glass louvres and cedar external blinds. In contrast, the south edge of the house has a distinctive solid wall, clad in corrugated iron and with a curved roof above. The *Carruthers House* (1980) is, at first glance, even more straightforward in its form and design than the *Nicholas House*. Fromonot describes it as a 'simple timber barn roofed with corrugated iron' (2003, 112). With the exception of the chimney, the single pavilion sits lightly on posts above the ground plane. Externally, the south wall is almost fully enclosed protecting the inhabitants from winter winds. The *Fredericks Farmhouse* (1982) is described by Drew as 'the finest of Murcutt's series of long houses' (1985, 121). The house features two pavilions, constructed of timber post and beam, with external western red cedar cladding. The five of these early works was designed as a house and private gallery. The *Ball-Eastaway House* (1982) has a 'train carriage' plan and whereas the first four houses were clad largely in timber, and with exposed timber detailing, the *Ball-Eastaway House* has a more industrial feel with metal cladding.

The *Magney House* (1984) is a single, linear pavilion on an open site. Constructed primarily of steel, the house, which Frampton describes as having 'a peculiarly aeronautic character' (2006, 68), is visually dominated by its narrow side-profile displaying an undulating, partial-butterfly roof form, which is 'a genuine departure for Murcutt' (Drew 1986, 60). The *Simpson-Lee House* (1994) is a double-pavilion residence sited on a rock ledge. Both pavilions are linear and have mono-pitch roofs that lift up towards the views, and a timber footbridge connects the two pavilions with a reservoir pool in between. The *Fletcher-Page House* (1998) is another narrow, linear building sited on sloping grassland. The roof of the *Fletcher-Page House* is tilted upwards to the north, and parallel to the hillside, forcing the northern façade to be partly hidden. In response to this, on the southern side of the house, large openings are positioned towards the primary views. The house is clad in cedar weatherboard and is constructed with a steel frame that rests on a concrete slab. The *Southern Highlands House* (2001) marks a significant increase in the size of Murcutt's residential work. To protect against severe winter winds, the house

Table 2. Elevation analysis results for sets 1 and 2.

House	Set 1: Opaque μE	Set 2: Transparent μE	Difference (%)
Marie Short	1.4253	1.4327	0.74
Nicholas	1.4240	1.4369	1.29
Carruthers	1.3909	1.4012	1.02
Frederick	1.3970	1.4024	0.53
Ball-Eastway	1.4397	1.4557	1.60
Simpson-Lee	1.4793	1.4963	1.70
Fletcher-Page	1.4723	1.4796	0.73
Magney	1.4700	1.4863	1.63
Southern Highland	1.4617	1.4639	0.21
Walsh	1.4639	1.4730	0.91

has a protective shield in the form of a curved metal plane along the entire length of the southern façade which wraps over the roof edge. Finally, in the *Walsh House* (2005), the detailing and materials used to construct the north and east faces display a higher level of articulation compared with those of the south and west. Tilted up to the north, the roofline extends past the high northern windows in order to protect them against the summer sun.

6. Results – investigation 1: elevation views

The μ_{EO} results for the opaque set show a relatively consistent set of dimensions and a clear clustering pattern can be seen for the results of both the early and later houses (Table 2). For example, the elevation results for the early houses are in the range, $1.390 < \mu_{EO} < 1.4397$, or 4.9%. For the later set the range is, $1.4616 < \mu_{EO} < 1.4793$, or 1.77% (Figure 7). For the complete opaque set, the range

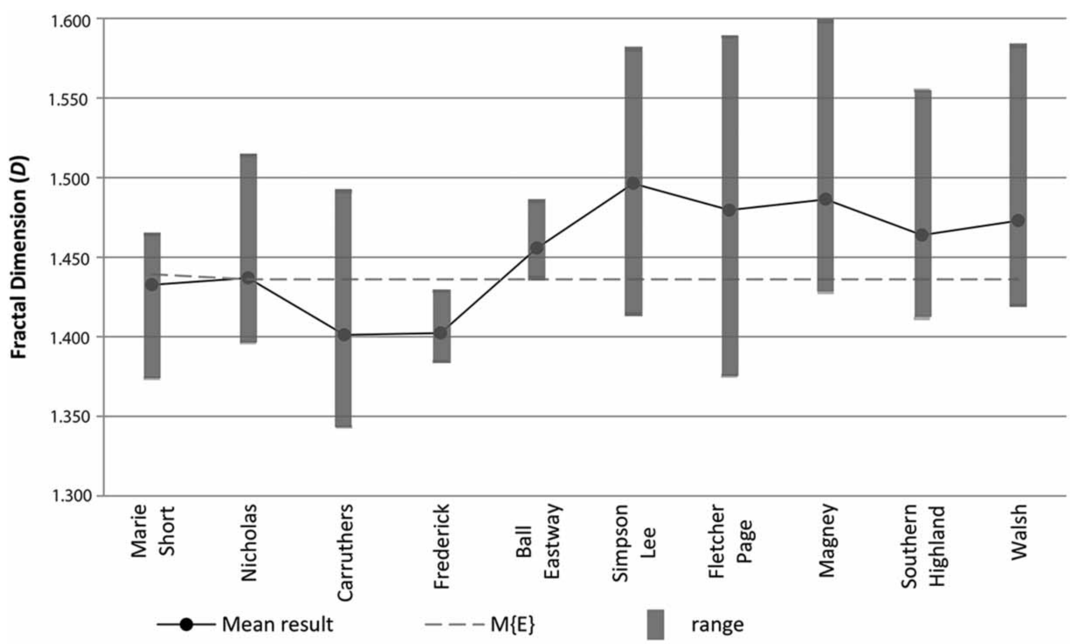

Figure 7. Results for opaque elevations of Murcutt's houses.

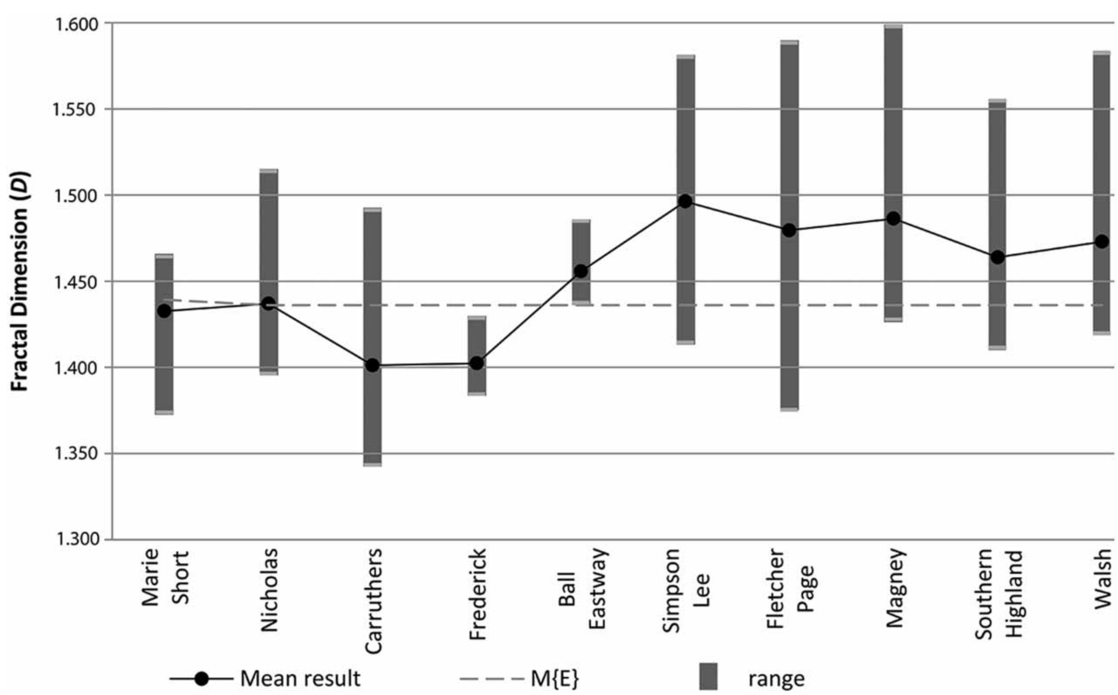

Figure 8. Results for transparent elevations of Murcutt's houses.

between mean results for individual houses is 6.67%. The mean result for the complete set of opaque elevations of all 10 houses is $\mu_{\{EO\}} = 1.44239$.

The μ_{ET} results for the transparent set show a similarly consistent set of dimensions and once again a clear clustering pattern can be seen for the results of both the early and later houses. For example, the elevation results for the early houses are in a range, $1.40115 < \mu_{ET} < 1.455725$, or 5.45%. For the later set of houses the range is, $1.463875 < \mu_{ET} < 1.4963$, or 3.24% (Figure 8). For the complete transparent set, the range between mean results for individual houses is 9.515%, slightly higher than for the opaque set. The mean result for the complete set of transparent elevations of all 10 houses is $\mu_{\{ET\}} = 1.45278$.

When the results for an individual house are examined more closely, the permeability of each elevation is clarified. For example, the *Ball Eastway* House demonstrates one of the higher differences between its mean transparent and opaque elevations (1.60%). In this house, the north elevation has very little difference (0.30%) between the opaque and transparent versions of its façade, while the south elevation has no difference at all, with a stable result of $D = 1.4375$ reflecting the unchanged appearance of that elevation. However, the east (Figures 3–4) elevation is noticeably different (3.9%) when its large expanse of glazing is represented transparent.

When comparing the difference between the mean results for each house, for opaque and transparent elevations, the house with the greatest difference is the *Simpson Lee House* (2.24%) and the house with the least is the *Southern Highlands House* (0.22%). The mean difference between the complete set of opaque and the complete set of transparent elevations is 1.0776% (Figure 9). Thus, the transparent versions always result in a higher visual complexity (because they reveal some additional details in the interiors), but the actual difference is almost insignificant, and in many elevations there is not even a single change. This result matches the reality of many of the houses where Murcutt often deliberately faces completely solid or blank façades towards dominant wind directions (providing screening) while opening up entire façades which are more sheltered, However, in practical terms, the open façades do not feature any additional details even though they are more transparent, because Murcutt's houses are often only a single-room wide, and thus there is no extensive depth of space visible through a permeable façade. Furthermore, as alluded to earlier in the paper, a complicating factor is 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. For this reason the next investigation is

Table 3. Perspective analysis results for sets 3 and 4.

View position	Set 3: Opaque D_P	Set 4: Transparent D_P	$R_{P\%}$
30°	1.4416	1.5855	14.39
60°	1.4973	1.5950	9.77
90°	1.5380	1.6113	7.33
120°	1.5474	1.5567	0.93
150°	1.6026	1.6084	0.58
180°	1.5477	1.5512	0.35
210°	1.5034	1.5240	2.06
240°	1.5462	1.5708	2.46
270°	1.5334	1.5501	1.67
300°	1.4597	1.5094	4.97
330°	1.5294	1.6353	10.59
360°	1.5022	1.6276	12.54
μ	1.5207	1.5771	5.575

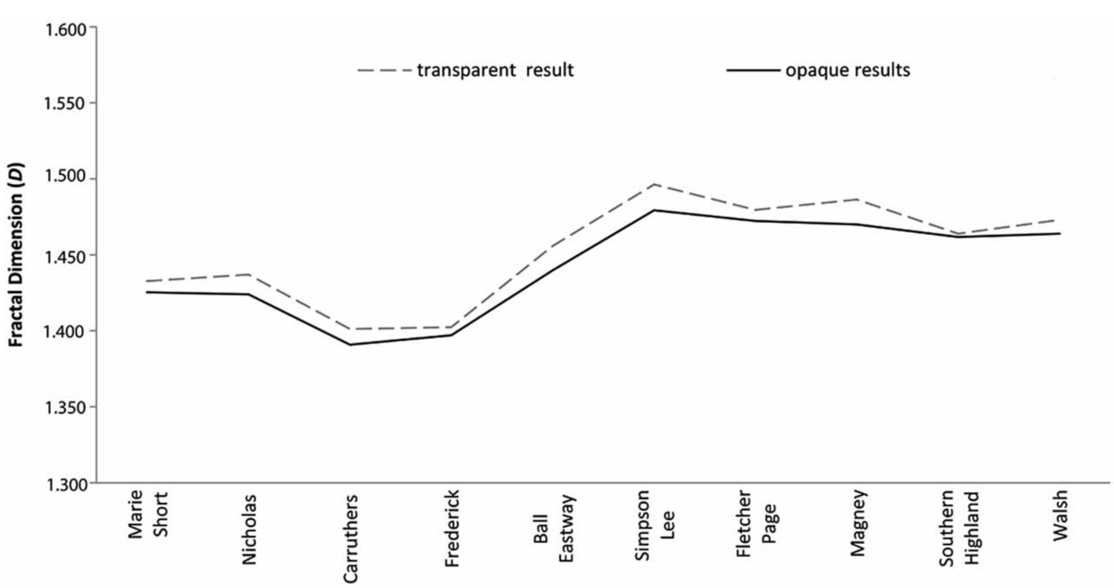

Figure 9. Comparison of transparent and opaque elevations of Murcutt's houses.

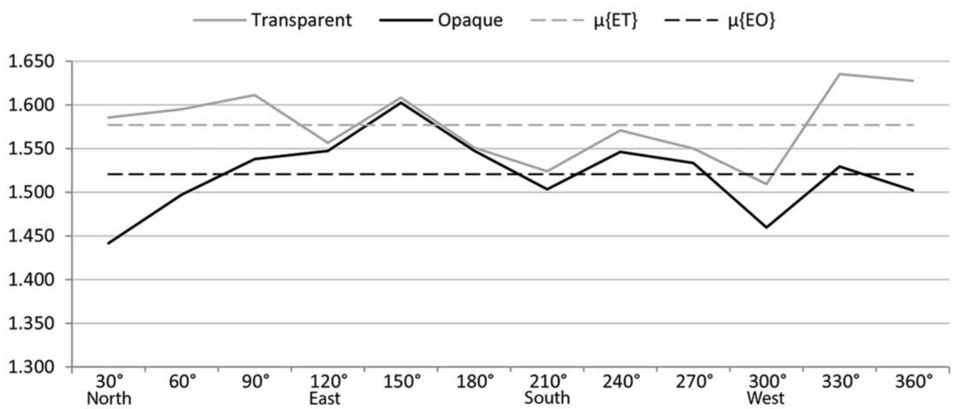

Figure 10. Comparison of transparent and opaque perspective views for the Marie Short House.

focussed on perspective views which should reveal if this is the case.

7. Results – perspective analysis, sets 3 and 4

The mean for the opaque perspective view results for the *Marie Short House* is $D_{\mathrm{VO}} = 1.5207$, whereas the mean for the opaque elevations of the same house was $D_{\mathrm{EO}} = 1.4253$; a difference of 9.54%. The mean for the transparent results for the perspectives of the *Marie Short House* is $D_{\mathrm{VT}} = 1.5771$, whereas the mean for the transparent elevations of the same house was $D_{\mathrm{ET}} = 1.4327$; a difference of 14.44% (Table 3). Whereas the difference between the opaque and transparent elevations for the *Marie Short house* was $R_{\{\mu_{\mathrm{E}}\}} = 0.735\%$, the difference between opaque and transparent perspectives for this house is $R_{\mathrm{V}} = 5.575\%$; 7.58 times higher. Furthermore, from specific viewpoints the difference between opaque and transparent views was up to 14.5% (30° position), but it was also often less than 1% difference in visual impact (120°, 150°, 180° positions) (Figure 10). Thus, perspective views of the same house do reveal a higher level of characteristic visual complexity than the elevations do. However, in the case of a largely non-permeable façade (with few openings, louvres or screens) the difference can be very minor (<1%), while it can be up to 14% higher for specific, permeable façades in front of deeper spaces. Nevertheless, even at its most complex, a difference of 14% is still relatively minor in terms of characteristic visual complexity.

8. Conclusion

When historians and critics talk about the lightness and transparency of Glenn Murcutt's architecture they are most likely responding to more than just the formal and spatial properties of his work. Materials, colours, and textures all play a role in the way Murcutt's architecture is portrayed. In particular, his interiors are often warmly coloured and illuminated, with polished timber floors, recycled timber furniture and artwork on walls, all of which are in stark contrast to the often grey, weathered exteriors of these same houses. Such factors no doubt exaggerate the sense that the interior is on display to the outside world, or that it is closely connected to the landscape. However, if we only consider Murcutt's architecture from the point of view of its geometry, its spatial and formal expression, then literal transparency is clearly not an especially significant factor. Perhaps coupled with these other more phenomenal cues (like colour, light, warmth and texture) the literal transparency is given depth, and thereby begins to conform to Rowe and Slutzky's other type of transparency, but such a question is beyond the scope of the present paper.

From this analysis, and especially the detailed study of the *Marie Short house*, it might also be inferred that the qualities of lightness and transparency, which are conventionally identified in Australian regionalist architecture, may also be more a factor of phenomenal rather than literal properties. This is in accordance with the standard poetic readings of the genre, even if the evidence collected here suggests that it is not a specific by-product of space and form.

Finally, Murcutt's architecture is typically described as minimal, Arcadian or even neo-platonic, all descriptions of simple geometrically formed structures. Yet, the spectrum of fractal dimension results recorded here for Murcutt's architecture, while in the lower half of the scale (that is, where $D_{\mathrm{E}} < 1.5$), is still far short of the levels recorded for other minimalist designers (where $D_{\mathrm{E}} < 1.3$). Indeed, the range of results for Murcutt is not dissimilar to that of other Modernist architects. Once again, there is likely to be a spiritual, poetic or phenomenal explanation for the way Murcutt's architecture is characterized as simple and pure. In particular, Murcutt's houses are often pictured as freestanding objects in the landscape, artificially exaggerating their apparent simplicity. Whatever the underlying power of Murcutt's architecture is, it does possess some transparent façades, and its forms are relatively simple, but the real explanation for its character is clearly not just a factor of the form, space and geometry within his work.

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