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Digital Cosmopoiesis in Architectural Pedagogy: An Analysis through Frascari

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Abstract

This article derives from three observations of architectural drawing: the current ubiquitousness of digitization, the ongoing disputation of digitization in architectural pedagogy and the capacity of architectural drawing to simultaneously represent and communicate qualities of tangibility and intangibility. In its analysis, this article refers primarily to the writings of Marco Frascari (1945-2013), who was, through works such as *Eleven Exercises in the Art of Architectural Drawing* (2011), a strong critic of digital drawing. This article begins with an overview of the effects of digitization on architectural drawing, which are summarized in terms of their deleteriousness on the intangible qualities of architectural drawing, as seen predominantly in perspectives and sketches. This article then defines intangibility in architectural drawing and locates it within Frascari's theory of cosmopoiesis, and identifies marks, entourage (especially human entourage) and narrative as key elements of cosmopoiesis in architectural drawing. Finally, this article analyses the effects of digitization on architectural drawing from the standpoint of cosmopoiesis, with an emphasis on the key elements that were identified earlier, before concluding with some recommendations for preserving cosmopoiesis when drawing in a digital environment. This article holds that, in architectural pedagogy, a complete return to analogue drawing is neither feasible nor necessary because what is required instead is an awareness of the main areas in which digital drawing is most likely to fail, so that digital drawing retains the cosmopoietic qualities that characterize some examples of analogue drawing. This article argues that an understanding of the cosmopoiesis of architectural drawing is vital to transcending the apparent incompatibility of intangibility and digitization.

Introduction

Digitization in architecture is traceable to 1958, with the commercial availability of the plotter, but the origins of digital drawing in architecture are captured in a single event in 1963, in which Ivan Sutherland publicly presented a film documenting his Sketchpad software and its use (Bruegmann 1989: 140). Of digitization, it has been said that '[n]o technological innovation has given rise to greater expectations within the architectural profession' (Bruegmann 1989: 139), and '[a]s a technological innovation in the field, its importance equals that of the introduction of paper' (Ackerman 2000: 23). In recent decades, digitization in architectural drawing has been rethought through the re-emergence of analogue techniques, and the hybridization of digital and analogue techniques.

Despite the current ubiquitousness of digitization in architecture, there remains much criticism for digital drawing, with Marco Frascari (1945-2013) prominent among those who have asserted the reductive effect of digitization. A corollary of the resistance to digital drawing is the uncertainty of its place in architectural pedagogy. Several pedagogical studies of architectural drawing advise the coadoption of analogue and digital techniques (Lyn and Dulaney 2009; Wallis et al. 2014; Kara 2015), and yet there are limited attempts to engage with a single body of criticism, such as that of Frascari, to address the seeming oppositionality of these two techniques in architectural pedagogy. Such a method of inquiry appropriately begins by referring primarily to the writings of Frascari to provide an overview of the effects of digitization on architectural drawing. This overview reveals the simultaneously tangible and intangible qualities of architectural drawing.

Tangibility and intangibility in architectural drawing

Frascari wrote, in 'Lines as architectural thinking': 'Our contemporary world is based on unnecessary hastiness: temporal speed and material rushing growth are the prevailing attitudes of our age and unhurried attitudes seem to imply stagnation and inertia' (2009: 204). In his observation of humanity in the first decade of the twentieth century, Frascari made two further observations regarding its tendency to hastiness. The first of these is rather straightforward, in which hastiness manifests in the desire to advance more quickly through time. The second is reflected in 'growth' and its attendant concepts of development, expansion and progress. Through hastiness, growth is reduced to merely material terms, so that the immaterial terms of growth have been excised. In the context of architectural thinking, the immateriality of growth is seen in acts of creativity, discursion and reflection. As these acts are largely subjective, they appear to contribute less directly towards completion; thus, they denote indolence, unskilfulness and even absurdity in their actors.

In the same piece, Frascari noted: 'Computer technology speeds up tasks and, in theory at least, increases precision and photographic reality, but the drawings produce buildings that lack grip, lack traction in time' (2009: 204). To examine more closely the first part of Frascari's charge, the examples of digital perspectives and digital sketches may be considered. Frascari was correct in claiming that digital drawing is, through the control afforded to its makers, precise and, ultimately, often indistinguishable from photographs. Following this, Frascari posited that the meaningfulness of digital drawing, in its role towards the creation of built architecture, is proportionate to the meaningfulness of its relationship to time.

Frascari mentioned the 'photographic reality' of drawing. This is, in architectural representation, a challenging concept because the reality offered by perspectives, whether digital or analogue, is debatable. Robin Evans advocated that perspectives are untruthful, because, contrary to initial impressions, they provide 'no unique or privileged access to reality' (1995: 123). Perspectives and photographs, too, are never completely 'identical to human vision' (Fraser and Henmi 1994: 76). Indeed, accuracy belongs more appropriately to the realm of orthographic projections. This notion has its origins in the Renaissance, in which the *Letter to Leo X* (dating from approximately 1519, and attributed to Raphael, Baldassare Castiglione and Angelo Colocci) claimed that perspectives are distortive and misrepresentative, while orthographic projections convey 'the true dimensions of a building and the true relations between its parts' (van Eck 2002: 164). The letter further advocated that orthographic projections are in the repertoires of architects (Figure 1), while perspectives are in those of painters (Figure 2).

As a result, it is evident that perspectives should not be relied upon for their accuracy, but valued instead for their *painterliness*. The role of precision in perspectives is limited, insofar as their content, such as the architecture itself, must be recognized by their viewers. Perspectives are not 'pure geometrical constructions based on abstract systems of proportions, whose beauty is eternal and unchangeable' (van Eck 2002: 171), and any objective content is only ever fully conveyed through orthographic projections.

To speak of sketches, which are usually, but not always, located at the opposite end of perspectives in the design process, their purpose is consistently one of *thinking*. While sketches may be precise or imprecise (Smith 2005: 2), they are, by definition, produced with the intention of brevity. Thus, although it is apparent that the increased speed and accuracy of digitization generates poor outcomes for perspectives, it would seem that digitization is, for similar reasons,

actually beneficial for sketching. But in *Eleven Exercises in the Art of Architectural Drawing*, Frascari evaluated how digitization leads to a paucity of architectural thinking:

[Digitization] eliminates part of the original experience. No longer is there time for a mind to wander, no more a daydream appears during the rendering of the surface of a façade with whirling, scribbling, or cross-hatching shadow. The time to dream over a drawing has been efficiently, almost surgically, eliminated (2011: 153).

Therefore, while it is acceptable for each iteration of sketching to be carried out quickly, it must be remembered that the cumulative act of producing sketches should constitute, in fact, the act of thinking slowly.

Recalling that the split between perspectives and orthographic projections has determined that digitization is unsuitable for perspectives, it is worth noting that Evans conceded that the sketch does not fall easily into either category: ‘The sketch is a peculiar phenomenon. It is impossible to decide, except by dogmatic means, whether it is a projection or not’ (1989: 33). This denotes, once again, the usefulness of digital techniques for orthographic projections, and analogue techniques for other types of architectural drawing.

As there is a dissonance between the heightened speed and precision offered by digitization on the one hand and the making of certain architectural drawings on the other, the solution is to mitigate these aspects of digital drawing to reclaim the inherent painterly qualities of perspectives and thoughtful qualities of sketches. These qualities collectively fall within *intangibility*, which is in opposition to the tangibility contained in orthographic projections. The criticality of intangibility resonates in pedagogical practices of architecture, which, commonly, ‘by overemphasising the detached and the rational, deny access to the atmospheric totality of mood’ (Teal 2010: 10). Intangibility in architectural drawing is made more legible by locating it in Frascari’s theory of cosmopoiesis.

Intangibility and cosmopoiesis in architectural drawing

The intangibility of architectural drawing is most obviously understood through the intangibility of architecture as built. This elusive notion was singularly described by Peter Zumthor as ‘atmosphere’, which he defined as being found in ‘things with such a beautiful, natural presence, things that move me every single time’ (2006: 11). It follows that some architectural drawings, if prepared to envision architecture, should be prescient of such intangibility, or, if intended to depict architecture that is already built, should aim to adequately capture its existing intangible qualities.

Intangibility in architectural drawings is seen further in how they are artefacts that encapsulate not only architecture, but wider cultural, political and social aspects as well (Collins et al. 2007: 93). And architectural drawings are often removed from many worldly constraints, so that they ‘better approach the purely aesthetic’, and compete with built architecture as instruments of architectural vision (Stevens 1998: 97). Finally, the ephemerality of drawing in all its forms is paradoxically one of its greatest strengths, as the ‘reduced materiality [of drawing] possesses a force that drives the imagination, which itself can overcome possible inhibitions’ (Bredenkamp 2004: 24).

Frascari described these phenomena more completely through his linking of the act of drawing in architecture to the act of *cosmopoiesis*. The meaning of cosmopoiesis is absent from a number of quotidian dictionaries but is usually defined as ‘world-making’. Frascari himself explained it in this manner: ‘Architectural drawings are representations that facilitate the understanding

of buildings, conditions, processes and events in human world-making, in other words they are the interactive and generative mapping of architectural cosmopoiesis' (2011: 2). While Frascari underscored the cosmopoietic acts of the maker, it must be mentioned that the viewer is not excluded from cosmopoiesis. Through interpretation, contemplation and deliberation, the viewer likewise engages in cosmopoiesis to become an equal participant in 'the interactive and generative mapping'. This affirms that architectural drawing is, for the maker and viewer, the site of representation and thinking.

In '*De beata architectura*', Frascari described cosmopoiesis by building on Nelson Goodman's idea of a 'world' as not only including its physical state, but being 'a sum of cultural artifacts, the systems of organization and meanings created by a group of people at any one time' (Frascari 2012b: 83). Frascari wrote: 'An architectural cosmopoiesis is the sum of the different ways that architects contribute to world order in their architectural conceiving' (2012b: 83). Thus, cosmopoiesis is the totality of means by which architects make worlds, and these worlds, in their polysemy, encompass tangible as much as intangible qualities.

As cosmopoiesis is a significant enabler of intangibility in architecture and architectural drawing, it stands, in pedagogical practices of architecture, as an important concept on which to focus. A step towards the inclusion of cosmopoiesis in the teaching and learning of architectural drawing is the identification of the key elements of cosmopoiesis in architectural drawing.

The elements of cosmopoiesis in architectural drawing

For Frascari, drawing in architecture is a *facture* because 'architects grew their own understandings of drawing as an independent facture with its own *graphesis*' (2009: 205, original emphasis). Bearing in mind Frascari's theory of cosmopoiesis, the facture of drawing in architecture is, more precisely, a cosmopoietic facture. The instinctiveness of *cosmopoietic facture* is shown in Frascari's reflection that '[h]umans instinctively long for physical and mental connections to a cosmopoiesis' (2012b: 85).

The value of *marks* as a cosmopoietic element in architectural drawing is reckoned through their relationship to cosmopoietic facture. In being 'visual evidence of the application of tools to materials' (Mottram 2007: 196), marks become the tangible outcome of a facture that has since passed out of tangibility. Marks are given further significance through their intimacy with perception: 'The instinct to match shapes or marks, whether actual with actual, or actual with imagined, could be seen as one of those "hard-wired" aspects of the human perceptual system from the perspective of evolutionary biology' (Mottram 2007: 197). The instinctiveness of marks recalls the instinctiveness of cosmopoietic facture, and this implication of the biological emphasizes the instinctiveness of marks in making as much viewing. Marks are, altogether, the recording of corporeal gestures that were guided by the intangibility of cosmopoiesis.

Entourage in architectural drawing is defined as 'the environment and objects immediately surrounding a building' (Oles 1979: 269) and includes human figures, furniture, some meteorological conditions, vegetation and vehicles (Figure 3). The most fundamental functions of entourage are described as '[helping] to provide simple and clear indications of dimension in scaled orthographic drawings; in perspectives they contribute to the depiction of a proper sense of depth' (Anderson 2002: 238). Moreover, entourage suggests the potential uses of spaces, which is often accomplished through the inclusion of furniture and fittings.

Human entourage is a subset of entourage, which is, owing to the anthropocentricity of architecture, of special importance. This anthropocentricity is traceable to the mythical and

historical origins of architecture, and is, through the story of Diboutades, found even in the origins of drawing. Frascari named three functions of human entourage in architectural drawing, in which the first is to ‘help [...] imagine a three-dimensional future reality in a two-dimensional rendering’ (1987: 124). This function is the most deeply connected to cosmopoiesis because it encourages the viewer to, first, understand the cosmopoiesis of the maker of the drawing, and, second, engage in his or her own cosmopoiesis through the act of viewing. The cosmopoietic capacity of human entourage is also suggested through its potential for instigating dynamic interplay amongst the maker, viewer and drawing itself: ‘[I]n so far as drawing carries knowledge about the body such as its average size and abilities, it participates in the power relations through which different bodily capacities and experiences are given relative value’ (Fitzsimons 2010: 10).

Frascari wrote, in ‘An architectural good life can be built, explained and taught only through storytelling’, that architects employ *narrative*, or storytelling, ‘to give order and share their *cosmopoietic* experiences’ (2012a: 227, original emphasis). However, in ‘*De beata architectura*’, Frascari identified the narrative of architects as a cosmopoietic act in itself, and noted how it, fittingly, yields a multiplicity of interpretation: ‘Architectural storytelling [...] is a cosmopoiesis, a world-making where there is no neutral space between interpretations within which a confrontation can be conducted’ (2012b: 90). Therefore, the fundamental polysemy of cosmopoiesis, in conjunction with the cosmopoietic act of architectural narrative, allows for myriad interpretation. While these reflections are of architecture as a whole, Frascari did, elsewhere, link architectural drawing and narrative, suggesting that architectural drawing is the ‘result from different forms of storytelling based on sapient factures’ (2011: 10).

In addition, Frascari wrote that: ‘Architectural storytelling induces the listeners to dwell on architectural artefacts by allowing them to establish ways of living in common, in intellectual and spiritual communities in which there is confirmation for the story that constitutes one’s life’ (2012a: 227). As architectural narrative leads to the creation of wholly theoretical ‘intellectual and spiritual communities’; this argues further for narrative as a carrier of cosmopoiesis in architectural drawing.

Human entourage plays a role in the narrative of architectural drawing due to the viewer most frequently experiencing narrative through the projection of his or her ego onto the human entourage. As a result, human entourage enables the viewer to conceptualize his or her experiences of the architecture, through aspirations such as *as there’s a seat there, and I’d probably sit there if I could*, or to identify with one of the human figures. Frascari explained these acts of projection and conceptualization in this way: ‘The bodies, as scale figures, used in drawing become inferences that reveal, for instance, the close linkage between the regulation of life and the processing of images that is implicit in the sense of individual perspective’ (2011: 68). The delimitation of the key elements of cosmopoiesis in architectural drawing infers their latent vulnerability in digital drawing. This knowledge forms the basis of recommendations for preserving cosmopoiesis when teaching and learning architectural drawing in a digital environment.

Preserving cosmopoiesis in digital drawing

One effect of digitization is the loss of the drawing edge, which brings to bear ‘a smoothness and an uninterrupted flow in the plotting of space for planning’ and a sense that ‘no part of the space is beyond representing or viewing both simultaneously and instantly’ (Carless 2011: 151). As analogue drawing is limited by the dimensions of the drawing surface, the infinity of digital space and the ease with which it may be negotiated are ostensibly helpful for cosmopoietic thinking. But digitization also generally permits the architecture to be visualized in the

completeness of three dimensions and at full scale, in which ‘whole space is conceived of in its total (real) scale and drawings are printed off, or opened on-screen as fragments of the whole’ (Carless 2011: 151). Thus, the seeming benefits of an infinite digital environment disappear in light of Frascari’s adjurations against the ‘pseudo-completeness’ of digital techniques that ‘hides a loss of rigor’ (2011: 14).

Another ill effect of the completeness and efficiency of digitization on cosmopoiesis is evidenced in the creation of digital perspectives. As described above, when perspectives are required, the maker, much as a camera lens, selects particular views and produces two-dimensional representations. Aside from clearly showing the hastiness of which Frascari reproved, the method of capturing, rather than conceiving perspectives, negates the inherent requirement of perspectives for painterliness.

Furthermore, in non-digital methods, ‘the rectangular sheet of paper is an analogue of the window through which an object is seen’ (Ackerman 2000: 10). While it could be argued that the computer screen, in acting as a camera lens, is a similarly suitable window for perspectives, digital perspectives are still generated from a representation of ‘whole space’, and thus they have no real connection to edges of the screen. As a result, any painterly framing of perspectives is difficult. Moreover, the privileging of the viewer, as one of the defining characteristics of perspectives (Schneider 1981: 81), is effectively eroded without the presence of any edge or frame.

Frascari warned that digital drawing leads to ‘buildings that lack grip, lack traction in time’ (2009: 204). But it may be inferred that digital drawing, and not only the built architecture that results from it, is deficient. And a recasting of ‘grip’ and ‘traction’ suggests that the deficiency of digital drawing includes some physicality rather than pure temporality, as ‘grip’ and ‘traction’ imply the anthropogenic marks that are not seen in digital drawing: ‘Between the tooth of the paper and the guided pressure of the hand, the tool leaves a residue of graphite or pigment on the page’ (Lyn and Dulaney 2009: 23). In addition, marks are described as possessing ‘value by association’ because the viewer appreciates that ‘some talented person has made the marks’ (Mottram 2007: 196). This, alongside Frascari’s argument for ‘grip’ and ‘traction’, gives a reason for hand-made marks to be present in digital drawing.

One plausible method, towards achieving hand-made marks in digital drawing, would be through manipulating the appearance of marks in digital drawing to approach those in analogue drawing. But the uniformity in digital drawing cannot be overcome through this means: ‘If one asks why architects are usually offended by computer-generated lines or lettering that are made to look like hand drawing, it is not because of their visual appearance per se, but because of their facture’ (Emmons 2014: 554). Therefore, while digital marks may copy analogue marks, the incompatibility between their appearance and facture reveals their dishonesty, and the digitally manipulated marks fail to be true representations of their cosmopoietic facture. Consequently, the viewer is left underwhelmed by the discrepancy in, first, the method and its resultant marks, and, second, the paltriness of the method and its use by a hoped-for ‘talented person’. The collapse of the instinctiveness of marks, on behalf of the maker and viewer, results in the collapse of the cosmopoiesis of the drawing. Entourage in digital drawing is typically imported fully formed from elsewhere because it has been produced by someone other than the maker. And such digital entourage is usually introduced into the drawing towards its end, after the depiction of the architecture itself is fairly complete. Under these conditions, such digital entourage is devoid of any valuable relationship with the cosmopoiesis of the drawing. This contrasts with the entourage of analogue drawing, which is, particularly in perspectives, designed by the maker from the outset, and in sympathy with, or as a counterpoint to, the architecture and its surrounds.

In 'The body and architecture in the drawings of Carlo Scarpa', Frascari despaired of the use of human entourage 'generally favoured by architectural students' in which such representations 'present only stereotypes, that have lost any ontological dimension' (1987: 124). Although such thoughtless conception is plausibly found across both analogue and digital drawing, it is arguably more prevalent in digital drawing because of the ease with which digital human entourage is imported. There is also criticism by others of the use of human entourage in digital drawing in terms of the function of human entourage in narrative. The precision of digitization means that the human entourage may well be 'accurate depictions of human beings', but due to the remoteness of their production, in relation to the maker and the context of the drawing, 'they rarely seem to have much to do with the buildings or spaces depicted, much less the narratives that might take place in them' (Anderson 2002: 238).

But digitization does hold positive outcomes for the cosmopoiesis of architectural drawing. Bryan Cantley, when reflecting on the effects of digitization on his own work, observed: 'Perhaps the biggest impact of technology in my drawing is the ability to render conditions of transformation, phase shifting, entropy and revolution [...] I realised that the act of recording could become live and not as dependent on chronology' (2013: 39) (Figures 4 and 5). Digitization, therefore, has useful applications for narrative, by depicting, for example, the architecture through its many iterations of design or stages of construction, or the impact of shifts in climate or user activity on the architecture. The ability of digitization to effectively show time provides an intriguing rejoinder to the shortcoming of digitization in needlessly accelerating tasks. And in its potential to capture live acts, digitization may relieve the dishonesty in digital copies of analogue marks through recording the creation of a digital drawing as it takes place.

Conclusion

When considered alongside the theories of Frascari, digital drawing demonstrates limitations chiefly in its extremeness of speed and precision. These limitations have negative implications for the cosmopoiesis of drawing, as experienced by the maker and the viewer. In diminishing the cosmopoietic act, digitization compromises any painterliness in the composition and hinders the imagination. Thus, digitization should be avoided in the formative stages of design thinking but is more appropriate for orthographic projections that necessitate accuracy. And digital perspectives, if preferred over analogue perspectives, should be created with an understanding of, and compensation for, their loss of edge and frame. The lack of marks in digital drawing may initially appear to be easily mitigated through copying analogue marks, and yet thought must be given to the offensive nature of such imitation. Therefore, emulating analogue elements through digital techniques should be avoided, and the fractures of elements, whether digital or analogue in origin, should be respected. Digital entourage, meanwhile, should be carefully selected and placed, to show consideration for the architecture and its context. A more considered approach to digital entourage will, in turn, give greater relevance to the narrative of the drawing. But digitization is, in other ways, beneficial for narrative because the incorporation of temporal shifts allows digital drawing to provide viewers with a unique experience of the architecture and its changes over time.

In architectural pedagogy, a complete return to analogue drawing is neither feasible nor necessary because what is required is an awareness of the main areas in which digital drawing is most likely to fail, so that digital drawing retains the cosmopoietic qualities that characterize some examples of analogue drawing. An understanding of the cosmopoiesis of architectural drawing is vital to transcending the apparent incompatibility of intangibility and digitization.

References

- Ackerman, J. S. (2000), 'Introduction: The conventions and rhetoric of architectural drawing', in J. S. Ackerman and W. Jung (eds), *Conventions of Architectural Drawing: Representation and Misrepresentation*, Cambridge, MA: Harvard University, pp. 9-36.
- Anderson, A. T. (2002), 'On the human figure in architectural representation', *Journal of Architectural Education*, 55:4, pp. 238-46.
- Bredenkamp, H. (2004), 'Frank Gehry and the art of drawing', in M. Rappolt and R. Violette (eds), *Gehry Draws*, Cambridge, MA: MIT Press and Violette Editions, pp. 10-28.
- Bruegmann, R. (1989), 'The pencil and the electronic sketchboard: Architectural representation and the computer', in E. Blau and E. Kaufman (eds), *Architecture and Its Image: Four Centuries of Architectural Representation: Works from the Collection of the Canadian Centre for Architecture*, Montreal: Canadian Centre for Architecture and MIT Press, pp. 138-55.
- Cantley, B. (2013), 'Two sides of the page: The antifact and the artefact', *Architectural Design*, 83:5, pp. 36-43.
- Carless, T. (2011), 'A new visibility: The productive space of drawing', *Spaces and Flows: An International Journal of Urban and ExtraUrban Studies*, 1:1, pp. 141-55.
- Collins, J., Collins, S. and Garnaut, C. (2007), 'Behind the image: Assessing architectural drawings as cultural records', *Archives & Manuscripts*, 35:2, pp. 86-107.
- Emmons, P. (2014), 'Demiurgic lines: Line-making and the architectural imagination', *Journal of Architecture*, 19:4, pp. 536-59.
- Evans, R. (1989), 'Architectural projection', in E. Blau and E. Kaufman (eds), *Architecture and its Image: Four Centuries of Architectural Representation: Works from the Collection of the Canadian Centre for Architecture*, Montreal: Canadian Centre for Architecture and MIT Press, pp. 18-35.
- Evans, R. (1995), *The Projective Cast: Architecture and its Three Geometries*, Cambridge, MA: MIT Press.
- Fitzsimons, J. K. (2010), 'The body drawn between knowledge and desire', *Footprint*, 4:2, pp. 9-28.
- Frascari, M. (1987), 'The body and architecture in the drawings of Carlo Scarpa', *RES: Anthropology and Aesthetics*, 14, pp. 123-42.
- Frascari, M. (2009), 'Lines as architectural thinking', *Architectural Theory Review*, 14:3, pp. 200-12.
- Frascari, M. (2011), *Eleven Exercises in the Art of Architectural Drawing: Slow Food for the Architect's Imagination*, Abingdon and New York: Routledge.
- Frascari, M. (2012a), 'An architectural good life can be built, explained and taught only through storytelling', in A. Sharr (ed.), *Reading Architecture and Culture: Researching Buildings, Spaces and Documents*, London and New York: Routledge, pp. 224-34.
- Frascari, M. (2012b), 'De beata architectura: Places for thinking', in P. Emmons, J. Hendrix and J. Lomholt (eds), *The Cultural Role of Architecture: Contemporary and Historical Perspectives*, London: Routledge, pp. 83-92.

- Fraser, I. and Henmi, R. (1994), *Envisioning Architecture: An Analysis of Drawing*, New York: Van Nostrand Reinhold.
- Kara, L. (2015), 'A critical look at the digital technologies in architectural education: When, where, and how?', *Procedia: Social and Behavioural Sciences*, 176, pp. 526-30.
- Lyn, F. and Dulaney, R. (2009), 'A case for drawing', *ARCC Journal*, 6:1, pp. 23-30.
- Mottram, J. (2007), 'Marks in space: Thinking about drawing', in M. Frascari, J. Hale and B. Starkey (eds), *From Models to Drawings: Imagination and Representation in Architecture*, London and New York: Routledge, pp. 193-200.
- Oles, P. S. (1979), *Architectural Illustration: The Value Delineation Process*, New York: Van Nostrand Reinhold.
- Schneider, B. (1981), 'Perspective refers to the viewer, axonometry refers to the object', *Daidalos*, 1:1, pp. 81-95.
- Smith, K. S. (2005), *Architects' Drawings: A Selection of Sketches by World Famous Architects Through History*, Amsterdam: Elsevier and Architectural Press.
- Stevens, G. (1998), *The Favored Circle: The Social Foundations of Architectural Distinction*, Cambridge, MA: MIT Press.
- Teal, R. (2010), 'Dismantling the built drawing: Working with mood in architectural design', *International Journal of Art & Design Education*, 29:1, pp. 8-16.
- Van Eck, C. (2002), 'Verbal and visual abstraction: The role of pictorial techniques of representation in Renaissance architectural theory', in C. Anderson (ed.), *The Built Surface: Architectural and the Pictorial Arts from Antiquity to the Enlightenment*, Aldershot, Hampshire and Burlington, VT: Ashgate, pp. 162-79.
- Wallis, J., Hong, Z., Rahmann, H. and Sieweke, J. (2014), 'Pedagogical foundations: Deploying digital techniques in design/research practice', *Journal of Landscape Architecture*, 9:3, pp. 72-83.
- Zumthor, P. (2006), *Atmosphere: Architectural Environments, Surrounding Objects*, Basel: Birkhäuser.