

HISTORIOGRAPHIES OF TECHNOLOGY & ARCHITECTURE

The bibliographic citation for this paper is:

Fajl, Marcus. "The Visible Invisible: X-Rays and Claude Bragdon's Fourth Dimension." In *Proceedings of the 35th Annual Conference of the Society of Architectural Historians of Australia and New Zealand: 35, Historiographies of Technology and Architecture*, edited by Michael Dudding, Christopher McDonald, and Joanna Merwood-Salisbury, 157-173. Wellington, New Zealand: SAHANZ, 2018.

Historiographies of Technology and Architecture
Proceedings of the 35th Annual Conference of the Society of
Architectural Historians of Australia and New Zealand.
4-7 July 2018 at the Faculty of Architecture and Design,
Victoria University of Wellington, New Zealand.

Edited by Michael Dudding, Christopher McDonald,
and Joanna Merwood-Salisbury.
Published in Wellington, New Zealand by SAHANZ, 2018.
ISBN: 978-0-473-45713-6

Copyright of this volume belongs to SAHANZ; authors retain the copyright of the content of their individual papers. The authors have made every attempt to obtain written permission for the use of any copyright material in their papers. Interested parties may contact the editors.

The Visible Invisible: X-Rays and Claude Bragdon's Fourth Dimension

Marcus Fajl
University of Melbourne

Abstract

The discovery of the x-ray in 1895, which captured images of the unseen interiority of solid objects, quickly became the subject of intense popular fascination. This technology also became associated with occult phenomena, lending it significance to Theosophy. American architect Claude Bragdon subsequently adopted concepts inherited from x-ray technology into his architectural theories and drawings, which were based upon a singular foundation of Theosophical thought and an associated engagement with non-Euclidean geometry. This paper traces the intersections of x-ray technology and architectural practice across three of Bragdon's published works of architectural theory from 1913, 1915 and 1932; Bragdon's incorporation of a notion of 'x-ray vision' into architectural theory is isolated as the subject of historical interpretation. The earlier publications, which develop concepts and representational strategies focused on ornament and space evidence a conflicting Theosophical agenda resulting in compromised architectural theories that struggle to sustain consistent illustrated outcomes. The later publication reflects upon and revises earlier ideas, and abandons previous Theosophical notions of 'x-ray vision'. By developing illustrated outcomes and refocusing the written discussion upon relevant representational issues ignored in the earlier theories, this later publication evidences a more convincing engagement with the perceptual shifts and destabilising effect upon human vision associated with x-ray imaging; the most significant being Bragdon's adoption of axonometric as a conceptual and representational tool. By framing Bragdon's practice as primarily one of representation, and tracing this across his body of work, the paper finds resolution of several issues in his work by the 1930s, but also a graphic consistency sustained throughout his career. Refocusing his written theory away from Theosophical agendas towards the subjectivity of his representational methods is surmised as being the most important manifestation of the consequences of the x-ray upon his work. This is posited as a potentially viable avenue of further historical critique to address the exclusion of his practice within modernist historiography.

Introduction

The architectural practice of Claude Bragdon (1866-1946) was one component of a larger synthesis of creative practices and spiritual convictions. Based in Rochester, New York, he became committed to the notion of organic architecture emerging from Chicago initiated by Louis Sullivan. His published articles and lectures promoting and transforming Sullivan's ideas gained him a national audience amongst both architects and general readers. His fame was bolstered by the success of several architectural commissions in and around Rochester. Having abandoned architectural practice by 1923 to focus primarily on writing and stage design, he is mostly known for his publication of architectural theories with associated illustrations. Bragdon became committed to Theosophy and hyperspace philosophy, both of which associated the theoretical concept of four-dimensional geometry with a mystical significance. These esoteric spiritual and philosophical beliefs became a singular foundation for Bragdon's architectural theory, culminating in his most ambitious architectural manifesto *Projective Ornament* (1915) which argued for the development of modern architecture through the reform of ornament. By the mid-1930s, despite having earlier been recognised as a leading American modernist¹ his reliance on ornament was considered regressive, his work outdated and antithetical to the principles of the dominant International Style.² Almost entirely ignored by twentieth century critics and historians, his architectural theories and practice became forgotten figures in the conventional historiography of modern architecture.

Wilhelm Röntgen's discovery of the x-ray in 1895 suggested the limitations and subjectivity of human vision by producing images that reveal the interior of solid objects, rapidly becoming the subject of extensive popular fascination as a new visual medium, form of entertainment and display, and a source of literary speculation. X-ray technology was also immediately exploited by Theosophists and hyperspace philosophers as scientific 'proof' of paranormal and occult activity.³ Impacting upon a range of cultural, scientific and spiritual domains, x-ray technology became "an optical and philosophical revolution that swept the world at astonishing speed".⁴ Bragdon's spiritual and philosophical commitment to Theosophy and hyperspace philosophy lead to the notion of 'x-ray vision' becoming incorporated into his architectural theory. This manifest as specific visual outcomes within his drawings. This paper traces the resultant intersections between x-ray technology and Bragdon's architectural work, as evident in the written theory and illustrations across three publications of architectural theory and illustrations between 1913 and 1932. Bragdon's architectural theory synthesised his Theosophical beliefs into architectural theory, placing as much polemic import on his theoretical

sources as the theory itself. Bragdon's interconnected agenda - where architectural theory was both informed by, and used as a vehicle to promote Theosophical thought - forms the discursive framework through which the relevant historical junctures between technology and architecture are considered within this paper.

The Historiography of Modern Architecture, Claude Bragdon and the X-Ray

The impact of the x-ray upon modern architecture is an area of historical critique evidenced in several of Beatriz Colomina's writings,⁵ which argue that the logic of the x-ray informs an inverted body of modern architecture, where inside becomes outside via the use of glass as simulated transparency. Whilst acknowledging the findings of this existing critique, this paper necessarily takes a different approach. The focus is upon a singular and marginalised figure who developed a theory of modern architecture during an historical period (1913-15) when the technology of the x-ray was strongly associated with the Theosophical beliefs of paranormal activity which Bragdon incorporated into his architectural theories. This critique intends to reveal the ways in which Bragdon's spiritual association with the x-ray impacted upon his architecture. As historiography surrounding Bragdon is limited; this method intends to arrive at new ways of interpreting his practice which may address a sustained neglect of his significance in histories of modernism. Arguing for a developed historical repositioning of Bragdon is beyond the scope of this paper, which nevertheless concludes by identifying techniques developed by Bragdon in response to the x-ray that may offer connections to the later development of the modern movement with the potential of providing a further avenue of research reconnecting Bragdon's historical significance to a lineage of twentieth century architecture.

Pen and Ink Artist

One of Bragdon's greatest strengths was his drawing ability. *Projective Ornament* manifested in negligible built outcomes, and his drawings remain the sole source of evidence connecting his architectural theory with practice. In the 1890s his career as a graphic artist overshadowed his career as an architect.⁶ He designed high contrast pen and ink posters and book covers, an illustrative aesthetic required for the inexpensive reproductive processes of the times (Figures 1, 2 and 3). Through his graphic work, Bragdon studied principles of Japanese aesthetics such as counterbalanced composition and emphasising the abstracted qualities of line and form over a focus on realistic figurative depiction.⁷ These technical methods and compositional principles became integral to the design principles and representational methods within his pen and ink architectural illustrations employed later in his career central to his architectural projects.

These early illustrations foreground the significance of graphic communication to the later development of his architectural agenda.



Figure 1. Magazine Illustration, Claude Bragdon, late 1890s (Department of Rare Books and Special Collections, University of Rochester Library) **Figure 2.** The Rochester Post Express Poster, Claude Bragdon, 1895 (Department of Rare Books and Special Collections, University of Rochester Library). **Figure 3.** Poster for a Wilde Night, burlesquing the sensibility of Aubrey Beardsley's *Yellow Book*, Claude Bragdon, 1895. (Department of Rare Books and Special Collections, University of Rochester Library).

A Primer of Higher Space

Euclidean geometry had, since antiquity, formed the mathematical basis for describing objects in the world; this comprised a series of axioms which formed a logical geometric system. In the seventeenth century, the invention of analytic geometry transformed Euclidean principles into algebraic equations expressed as a co-ordinate system. The transformation of axiomatic logic into a symbolic and abstract system allowed mathematics to challenge the integrity of Euclid's system. By the mid-nineteenth century, Euclid's fifth postulate, concerned with parallelism, was interrogated by several mathematicians.⁸ Notions of n -dimensional space (or hyperspace) began to emerge, which posited that geometries with four or more dimensions were possible.

By the 1880s n -dimensional geometry became popularised, resulting in the emergence of hyperspace philosophy. Four-dimensional geometry, whilst theoretically feasible can only be imagined and represented, never built or experienced, as human perception is constrained to recognising space only in three dimensions. This aspect of hyperspace was exploited within the writings of Charles Hinton (1853-1907) which transformed this

mathematical theory into a philosophical framework. Hinton proposed that by learning to perceive, through the power of thought, spatial dimensions outside the constraints of one's sense perceptions, would lead to understanding a higher reality outside of the limitations of his concept of a materialist three-dimensional world, a process he called 'casting out the self'.⁹ For Hinton, four-dimensional perception was a mental, rather than visual exercise: "We can never see, for instance four-dimensional pictures with our bodily eyes, but we can with our mental and inner eye".¹⁰

Peter Ouspensky (1878-1947) built upon the work of Hinton by ascribing mystical associations to the concept of the fourth dimension as per his Theosophical and occult beliefs; proposing that the three-dimensional physical world was itself illusory and accessing higher dimensions would reveal transcendent psychic truths. He further postulated that perceiving ever-increasing spatial dimensionalities would result in increasingly higher transcendent revelations. An interest in Eastern religion led to developing Hinton's concept of 'casting out of the self' into a collective consciousness, whereby the revelations of dimensional transcendence revealed the illusion of selfhood and the reality of a universal humanity.¹¹

Bragdon was heavily influenced by Hinton and Ouspensky, establishing correspondence with both as he became more involved with organized Theosophy¹², building upon their foundational work to develop his own contribution to hyperspace philosophy. *A Primer of Higher Space* was published in 1913 and included thirty illustrated plates. Bragdon employed diagrams, drawn with orthographic projection to explain the transformations between 'lower space' geometries of the line, square and cube into the four-dimensional geometry of the tesseract, first proposed by Hinton (Figure 4). He proposed that our knowledge of space is incomplete and that spatial understanding requires further modification to be correctly known: 'What we think of space is probably only some part of space made perceptible'¹³.

Bragdon's text was accompanied by diagrams explaining how four-dimensional geometry may be described as two-dimensional representations (Figure 5). An illustration which connected clairvoyance with 'four-dimensional vision'¹⁴ was also included. The illustration compares an image of a human figure as seen by 'ordinary human sight' with a human figure 'as seen by clairvoyant (4-dimensional vision)'. It is rendered so that the skin is translucent, revealing the interior skeleton (Figure 6). The illustration does not mention the word 'x-ray', yet clearly borrows from the transparent rendering of solid objects associated with x-ray graphics. The x-ray was immediately exploited by Theosophists

who conflated radiographic technology with clairvoyant vision.¹⁵ Bragdon's illustration functions as Theosophical propaganda connecting x-ray technology with notions of the occult which held such currency at the time that when Röntgen first discovered the x-ray he initially kept his discovery secret, to avoid misconceptions of engagement with spiritualism or the occult.¹⁶ Elsewhere in *A Primer of Higher Space*, Bragdon employs the true notion of the fourth dimension, as a spatial dimension that can only be perceived mentally, never visually. The association of four-dimensional perception with clairvoyant vision akin to x-ray imagery contradicts an earlier assertion within the same publication that: "We must, however give up any attempt to picture to our imagination this four-dimensional space".¹⁷

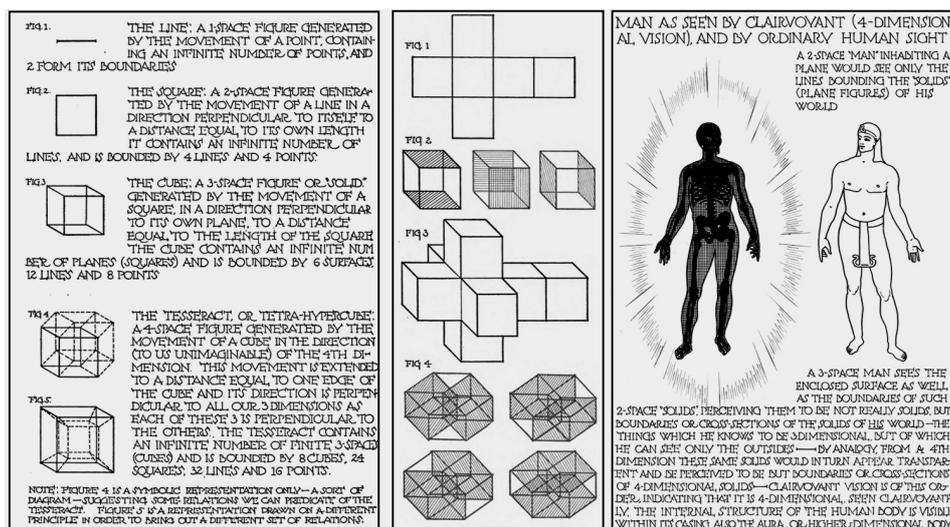


Figure 4. Transformation from line to tesseract in one, two, three and four dimensions, (*A Primer of Higher Space*, Claude Bragdon, 1913), **Figure 5.** Axonometric diagrams describing four-dimensional geometry, (*A Primer of Higher Space*, Claude Bragdon, 1913), **Figure 6.** Man, as Seen by Clairvoyant, (*A Primer of Higher Space*, Claude Bragdon 1913).

Man the Square, A Higher Space Parable

The use of 'lower-space' dimensional analogies to explain the concepts of higher-space dimensional perception was a narrative device common within hyperspace literature, first employed by Edwin Abbott in *Flatland: A Romance of many Dimensions* in 1884¹⁸. Bragdon included within this publication: *Man the Square, A Higher Space Parable*, an illustrated narrative which furthered this literary genre. The narrative describes a world where humans are cubes which rotate in space independently driven by the forces of individual personality, forming irregular cross-sections on a two-dimensional plane. The cubes can only understand themselves as dissimilar two-dimensional cross sections, remaining ignorant of the 'higher truth' of their three-dimensional unity.¹⁹ The notion of collective consciousness was thus supported by a parable relying on complex lower-

space analogies that could not have been clarified without Bragdon's accompanying graphic illustrations (Figure 7). *A Primer of Higher Space* and *Man the Square* became popular additions to hyperspace philosophy and literature; Bragdon's most significant contribution to these fields was due to his ability to clarify difficult geometric concepts via illustration.²⁰ The strength of Bragdon's graphic communication contributed to the significance of these publications serving as reference texts to understand the principles of four-dimensional geometry for the Avant Garde artists Marcel Duchamp and Kazimir Malevich.²¹

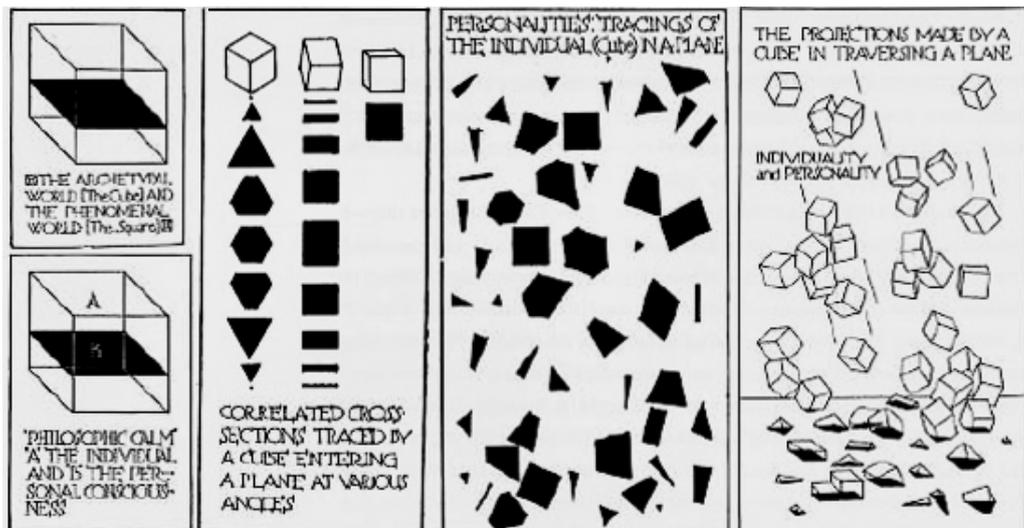


Figure 7. Bragdon's hyperspace illustrations (*Man the Square, A Higher Space Parable*, Claude Bragdon 1913).

Projective Ornament

Prior to the 1930s, American architects of the progressive movement, including Bragdon, Irving K. Pond, Frank Lloyd Wright and George Maher viewed ornament as capable of being invested with meaning through reinvention intended to best serve the needs of modern American society. Bragdon published *Projective Ornament* in 1915, based upon the work begun in *A Primer of Higher Space*. Bragdon developed a theory of architectural and social reform through the agency of ornament based on his Theosophical conception of four-dimensional geometry. Believing that new construction methods would lead to an inevitable solution to modern architectural form, Bragdon focused on ornament as the subject of his concept of modern architecture.²² Bragdon admired Louis Sullivan's ornamental compositions based on vegetal motifs, but believed they relied too heavily on the subjective impulses of the individual. Believing that most Americans lived divorced from nature, his version of an authentic organic architecture was based not on the appearance of nature, but rather the geometric and mathematic logic underpinning the natural world.

Projective Ornament proposed a system of ornament comprised of motifs generated from two-dimensional axonometric representations of four-dimensional geometries. Bragdon proposed that learning to see in four dimensions would allow people to become free from the constraints of their own subjectivity and selfhood and realise that consciousness was not individual, but universal. Learning to see in four dimensions would thus lead to revealing the illusions of the three-dimensional world, including the falsehood of the self. The publication included diagrammatic explanations for generating decorative patterns based on four-dimensional geometry. These were illustrated in axonometric projection and based on three-dimensional solids and four-dimensional hypersolids as 'folded down' to form graphic patterns as well as two-dimensional axonometric representations of four-dimensional geometries. (Figure 8).

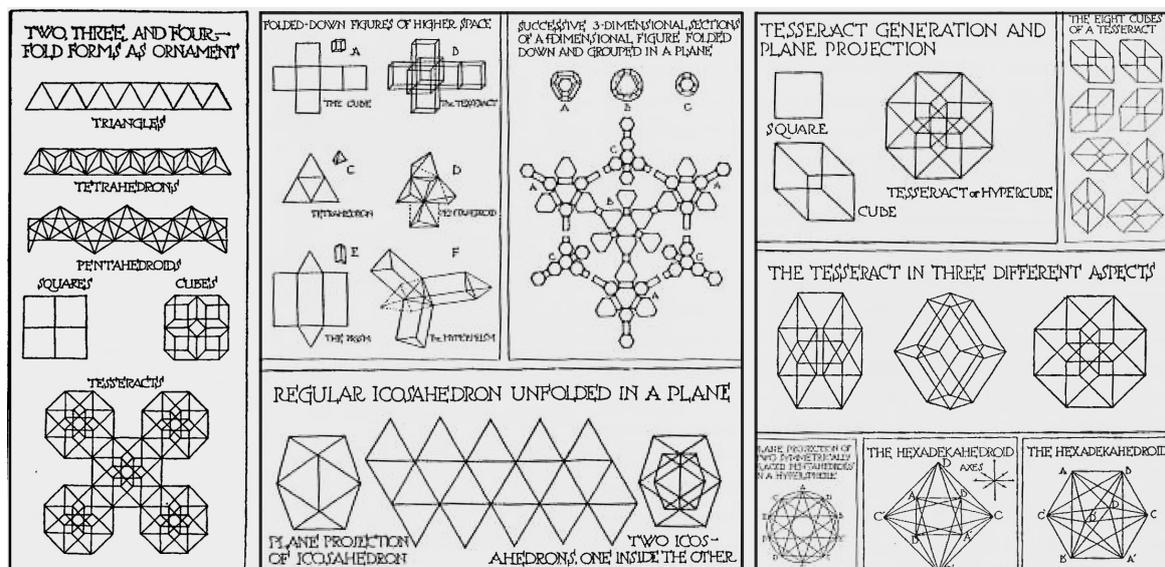


Figure 8. Diagrams illustrating processes for generating ornamental motifs based on four-dimensional geometry, (*Projective Ornament*, Claude Bragdon, 1915).

The implicit connection between four-dimensional perception and x-ray imagery made through the association of clairvoyance in *A Primer of Higher Space* is made explicit within *Projective Ornament*:

Were our sense mechanism truly three-dimensional, we should have X-ray vision and the surfaces of solids would offer no resistance to the touch. In dealing with four-dimensional space we are at liberty to imagine ourselves in full possession of this augmented power of sight and touch. The mind having ascended into the fourth dimension, there would follow a corresponding augmentation on the part of the senses...²³

Earlier in *Projective Ornament*, Bragdon remains true to original notions of the fourth spatial dimension being perceived mentally and not visually: 'But this thou must not think to find with eyes of body but of mind'.²⁴ The transcendental logic of hyperspace philosophy which considered the fourth dimension as a supra-sensory realm *beyond* vision is contradicted by the erroneous introduction of the concept of 'x-ray vision'. This fantastical notion is further extended by proposing an augmented sense of touch, capable of passing through solid objects, suggesting the human body itself could become invested with the 'supernatural' powers of x-ray technology. Bragdon's Theosophical convictions create theoretical contradictions by infecting the logic of heightened mental perception within hyperspace philosophy with invented supernatural powers of sight and touch. Bragdon's conflating of conceptions of x-ray technology as spiritual phenomena in the service of a Theosophical agenda creates contradictions and inconsistencies that dilute the rigour of his theory of modern architecture, yet his writing articulates Bragdon as an historical figure devoted equally to his spiritual beliefs and architectural convictions; rigidly determined to merge both into singular theoretical propositions.

Bragdon's willingness to merge imaginative fantasises of supernatural potential of the x-ray with hyperspace philosophy are also explicable within an historical setting that evidenced a sustained cultural fascination with the x-ray, still evident in 1915. The technology was considered as a new type of visual medium employed as part of a culture of technological display alongside the emergence of photography and cinema and significant to visual culture of the late nineteenth and early twentieth century.²⁵ Bragdon was an avid collector of x-ray photographs, considered as a type of experimental photography at the time. The visual possibilities that the technology suggested were also adopted by writers of hyperspace literature. After 1895, Hinton wrote science fiction that associated hyperspace with visual qualities inherited from x-ray imagery. H.G Wells (1866-1946) incorporated hyperspace associations of x-ray images and invisibility (but not x-ray vision itself) into his science fiction, relying upon Bragdon's authority as a hyperspace philosopher to validate his story ideas.²⁶ Bragdon's use of the term 'x-ray vision' and suggestion of other sensory augmentation, are linked to a cultural environment that 'envisioned a kind of Superhero 4-D Man, who could pass through walls and do similar amazing feats'²⁷ because of the speculative possibilities of the fourth dimension.²⁸

The concept of 'x-ray vision' as a feature of four-dimensional perception within *Projective Ornament* results in the adoption of a specific method of illustration (Figure 9). By

translating the optical effects of x-ray graphics into a line-drawing technique, Bragdon arrives at a method of 'attenuated' line work which is justified in the following way:

There is justification for the attenuation of all lines towards their centre. It is an obedience to the optical law that when the light is behind an object it so impinges upon the intercepting object as to produce the effect of a thinning towards the centre. Because in X-ray vision some substances are opaque and some are translucent, we are at liberty to attribute opacity to any part we please...We are also at liberty to stretch, twist or shear the figures in any manner we like.²⁹

Bragdon's insistence on sustaining x-ray vision as a concept which determines an illustrative method creates further problems in maintaining the theoretical integrity of *Projective Ornament*. Whilst the method of illustration seems analogous to the graphic qualities of the x-ray, the freedom of subjective impulse in applying this method, whereby line attenuation may be applied according to individual choice as well as allowing the user free licence to manipulate and distort prescribed geometric motifs in any manner seen fit runs counter to a foundational principle of *Projective Ornament*. Bragdon states that the Projective Ornament technique was a reaction against Sullivan's method of ornamental design as being overly dependent on individual choice, therefore resulting in successful outcomes when undertaken by a designer with Sullivan's mastery, yet inappropriate for a designer of lesser skill. Bragdon's ambition to reform ornament via an objective and universal system, equally accessible by any user was an attempt to create a democratised system which both reflected democratic principles underpinning American society as well as broader conceptions of universal consciousness as a manifestation of spiritual democracy. Allowing significant degrees of individual and subjective impulse is contrary to the purpose of a system intended to operate with universal and democratic objectivity.

Where individual geometric motifs are demonstrated, they are drawn with white ink on a black background, suggestive of a photographic negative (Figure 10). This gives the illustrations the strongest visual connection to the x-ray. This becomes lost within the illustrations which demonstrate the potential uses of Projective Ornament (Figures 11 and 12). Bragdon's graphic affectation might therefore be reconsidered in an alternate way: *Projective Ornament* was informed by an interest in merging a range of pre-modern Western and non-Western abstract decorative traditions into a singular transnational modern language.³⁰ This method of illustration transforms the geometric precision of the

axonometric motifs into a graphic language with associations across a range of pre-modern Eastern and Western ornamental tropes. This illustrative device was used across all representations; appropriating no single historical source directly, yet evoking associations with multiple decorative traditions simultaneously

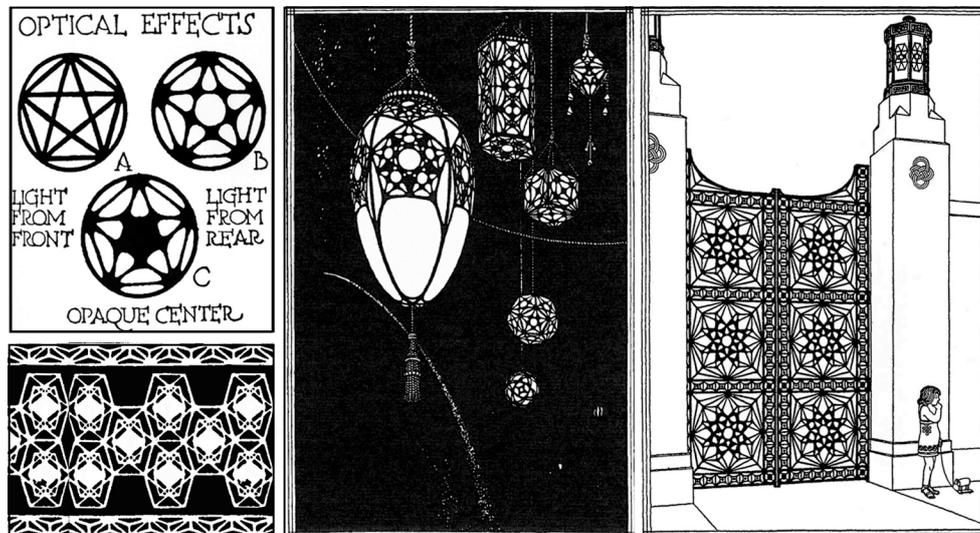


Figure 9 (top). Optical effects of 'x-ray vision' (*Projective Ornament*, Claude Bragdon, 1915). **Figure 10 (bottom).** Ornamental motif drawn as negative image, (*Projective Ornament*, Claude Bragdon, 1915). **Figure 11.** Illustrated example of possible application of Projective Ornament, (*Projective Ornament*, Claude Bragdon, 1915). **Figure 12.** Illustrated example of possible application of Projective Ornament, (*Projective Ornament*, Claude Bragdon, 1915).

The Frozen Fountain

In 1932, Bragdon published *The Frozen Fountain*, which revisited themes he had addressed in previous writings, including ornament. In relation to *Projective Ornament*, he states: "I now feel that my explanations were unclear and my illustrations not sufficiently convincing and the whole matter should be formulated anew."³¹ In this refigured ornament theory, the system as proposed in 1915 remains, however it is explained without the earlier proselytising Theosophical agenda, and the notion of 'x-ray vision' has been removed. The fourth dimension is described as a paradoxical world which is mathematically true, but impossible to visualise, other than through linear diagrams generated through orthographic projection.³² The illustrative method of linear attenuation from 1915 is maintained but not associated with theory; rather the manner of translating a line drawing into an illustrated ornamental motif is depicted graphically (Figure 14).

New illustrations of the design and application of ornament based on higher-space geometry are included (Figures 15 and 16). These illustrations are more detailed and

accomplished in terms of conception and execution than those published previously. Unlike similar drawings in *Projective Ornament* they are mostly rendered as white line work on black backgrounds. They employ the same types of geometric motifs evident in antecedent illustrations, but develop these into larger asymmetrical abstract, high-contrast compositions, echoing compositional and stylistic approaches from Bragdon's commercial artwork over three decades earlier (Figures 1, 2 and 3). These later compositional and graphic iterations evidence more graphic resemblance to the visual language of x-ray imagery than earlier drawings.

Examining these revised drawings alongside an x-ray of seashells, kept by Bragdon as part of a larger collection of x-ray images (Figure 17), reveals visual similarities, which in turn allow interpretations locating more significant theoretical intersections between x-ray technology and Bragdon's architectural practice: Bragdon's x-ray reveals an otherwise imperceptible geometric substructure of nature; rendering the surfaces of seashells as transparent allows invisible geometric relationships to become visible. This resonates with Bragdon's geometric concept of nature, as signified through a mathematical, rather than figurative depiction of nature. Furthermore, the x-rays clear refutation of the authenticity of external appearances infers that visual perception is limited³³, correlating with Bragdon's earlier contention that 'What we think of space is probably only some part of space made perceptible'³⁴.

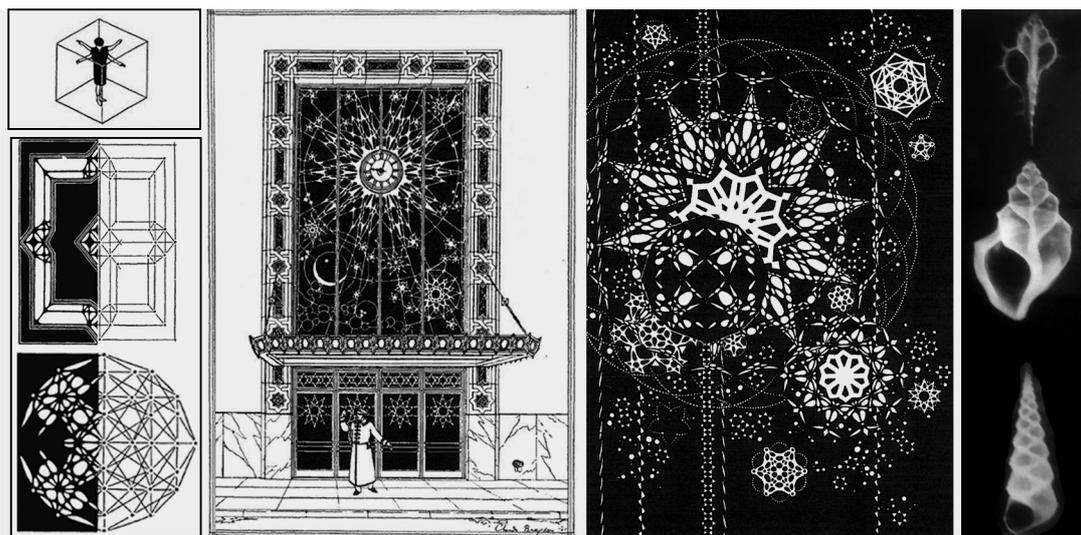


Figure 13. (top) Human form rendered as axonometric projection. (*The Frozen Fountain*, Claude Bragdon, 1932). **Figure 14. (bottom)** Ornamental designs based on four-dimensional geometries and their derivations, (*The Frozen Fountain*, Claude Bragdon, 1932). **Figure 15 and Figure 16.** Bragdon's revised illustrations depicting *Projective Ornament*, (*The Frozen Fountain*, Claude Bragdon, 1932). **Figure 17.** X-ray image of seashells collected by Claude Bragdon, 1910 (Department of Rare Books and Special Collections, University of Rochester Library).

Axonometric Projection

The Frozen Fountain contains a chapter discussing axonometric projection, a representational method central to Bragdon's architectural strategy since at least 1913, yet not included in his writings until 1932. He describes axonometric projection³⁵ as a method of representation which "truly renders the mental image – the thing seen by the mind's eye".³⁶ Bragdon's association of the mental 'vision' of the axonometric evidence a reengagement with the true principles of hyperspace philosophy, and thus integrate the conceptual significance of axonometry throughout his practice. Bragdon's earlier publications from 1913 and 1915 employ two, three, and four-dimensional geometric motifs throughout to illustrate central concepts. *The Frozen Fountain* revises this with a depiction of a human figure within an axonometric cube, (Figure 13). The shift from a focus upon these geometric motifs to the means of their representation, indicates that axonometric projection became central to his reconsideration of his body of work.

Bragdon's development of a methodology entailing the use of axonometric projection as a representational device central to a theoretical agenda held important theoretical significance. Since the Renaissance, perspective projection, relying on notions of 'systematic space' to emulate the optics of vision had been the privileged method of three-dimensional representation.³⁷ The emergence of x-ray technology challenged assumptions about the primacy of human vision, disturbing assumptions of the reality of perception and the nature of transparency and opacity. Bragdon's adoption of axonometry acknowledged that perspectival representation no longer depicted a singular reality of vision, and his choice of the axonometric, a "perceptively ambiguous",³⁸ mode of representation reflected the destabilising effect upon vision suggested by an emergent technology. Moreover, Bragdon's choice of rendering his axonometric motifs without shading or depth heightened a sense of spatial ambiguity whilst responding directly to the transparency of the x-ray image.

Yve-Alain Bois article outlining the history of the axonometric acknowledges Bragdon as the first twentieth century architect to employ the axonometric and to discuss its representational value. He dismisses the historical significance of this fact, as in his view, Bragdon's work bore no epistemological relation to the modern architectural movement (inaccurately describing Bragdon's work as Art Deco). Bois instead identifies the 'modern revival of axonometry' as 'precisely October to November of 1923' with the De Stijl exhibition of drawings by Theo van Doesburg and Cornelis van Eesteren.³⁹ Bois' account is oblivious to the fact that van Doesburg's work issued from an interest in the fourth dimension sustained throughout his career.⁴⁰ Recent scholarship has drawn parallels

between van Doesburg and Bragdon, despite the apparently disparate manifestations of their work.⁴¹ The misunderstandings within Bois' critique indicates a lack of knowledge of Bragdon's work; his assertion that Bragdon was a master of Art Deco suggests a stylistic assumption based on visual observation in the absence of historical and theoretical source material.

Desley Luscombe's analysis of Gerrit Rietveld's axonometric drawings of the Schroeder House describe graphic techniques employed by Rietveld to represent an interest in the fourth dimension as space via graphic devices intended to represent existent, yet invisible spatial qualities, and also as space-time, by employing a system of colouration intended to invoke a temporal quality within the drawing.⁴² Luscombe traces Rietveld's theoretical sources, identifying influences in common with Bragdon, such as Charles Hinton.⁴³ Rietveld produced a 'wireframe' axonometric drawing, rendered as transparent through an absence of shading to indicate solidity, which is described as 'revealing a viewing subjects 'x-ray vision'⁴⁴; echoing a representational method and perceptual concept employed by Bragdon in 1915.

Conclusion

Bragdon's theoretical engagement with the impact of x-ray technology, from the period of 1913 to 1915, within *A Primer of Higher Space* and *Projective Ornament* is compromised by inconsistencies and contradictions resulting from his determination to theorise architecture in accordance with his Theosophical beliefs; this results in a dilution of the coherency of his architectural theories. Bragdon's architecture was one element of several creative practices informed by his spiritual convictions; this creates an inherent sense of ambiguity in assessing these publications, whereby it is possible to interpret them either as Theosophical ideas portrayed through the medium of architecture, or an architectural theory informed by Theosophy. *Projective Ornament* is unique as a manifesto, as it functioned as a freely accessible instructional manual, with ownership of highly developed design strategies relinquished to the public. This democratic dispersal reflected a genuine interest in the advancement of social cohesion, and a spiritual concept of a democracy whereby consciousness was not individual, but universal; values promoted in the rhetoric of *Projective Ornament*, and reflected in his actions.

The revisions of his writings and drawings within *The Frozen Fountain* from 1932, locate meaningful intersections between the perceptual shifts associated with x-ray technology, and the development of Bragdon's architectural agenda. These manifest as legible theoretical, visual and representational outcomes; the most significant of these is his use

of the axonometric. Bragdon refocuses his theory away from the symbolic language of his drawings, towards the subjective effects of his representational methods; the shift this represents in his own thinking is perhaps the most sophisticated manifestation of the impact of the x-ray upon his body of work. His illustrations are highly accomplished, clarifying a connection between the x-ray and his architectural practice without need for textual justification. The silence of the text, in this regard, gives voice to the illustrations.

The previous section of this paper compares similarities with Bragdon's practice and the work of later Avant Garde architects included within the modernist canon. These projects dealt with conceptual and representational themes foreshadowed by Bragdon's earlier work. The axonometric later became universally adopted as a key representational motif within modernism; an historical development also prefigured by Bragdon. Despite Bois' assertion that Bragdon's early engagement with the axonometric held no historical import as it was disconnected from the later development of the modern movement, Bragdon's use of the axonometric as a representational device employed to support a conceptual agenda related to notions of space was an innovation that resonated throughout the development of modern architecture.

Bois' objection to considering Bragdon's relevance is justified according to stylistic difference. His work contravened nearly all principles of the International Style, most notably his focus upon, rather than rejection of ornament. This method of qualitative assessment accounts for the devaluation of Bragdon's architecture. Whilst Bragdon's work on hyperspace was influential upon the modern art movement⁴⁵, historical accounts describe a negligible influence upon modern architecture. Bragdon's pioneering use of the axonometric is the richest outcome of his engagement with x-ray technology, and his absence from the modernist canon is the most substantial historiographical concern. A further historical investigation into the representational and conceptual impact upon the history of modernism resulting from Bragdon's early use of the axonometric would therefore indicate a method of critique with potential to reposition his significance as an influential early modern architect, and transcend the limitations of stylistic difference which have contributed to his absence from modernist historiography.

Endnotes

- ¹ Sheldon Cheney, *The New World Architecture* (New York: Longmans Green, 2013),
- ² Linda Dalrymple Henderson, *The Fourth Dimension and Non-Euclidean Geometry in Modern Art* (Cambridge: MIT Press, 2013), 1.
- ³ Linda Dalrymple Henderson, 'X Rays and the Quest for Invisible Reality in the Art of Kupka, Duchamp, and the Cubists', *Art Journal*, 47,4 (1988) 323-340, 324.
- ⁴ Beatriz Colomina, 'X-Screens: Röntgen Architecture' *e-flux journal* 66 (2015) 1-13, 7
- ⁵ See Colomina, 'X-Screens: Röntgen Architecture', Beatriz Colomina, *X-ray Architecture: Illness as Metaphor*, *Positions*, 1 (2008) 30-35 and Beatriz Colomina, 'Skinless Architecture' *Thesis, Wissenschaftliche Zeitschrift der Bauhaus-Universität Weimar*, (2016) 123-124. These essays form the basis of Colomina's forthcoming book, *X-Ray Architecture*, to be released in June 2018
- ⁶ Jonathon Massey, *Crystal and Arabesque: Claude Bragdon, Ornament, and Architecture*, (Pittsburgh: University of Pittsburgh, 2009), 36.
- ⁷ Massey, *Crystal and Arabesque: Claude Bragdon, Ornament, and Architecture*, 34.
- ⁸ Henderson, *The Fourth Dimension and Non-Euclidean Geometry in Modern Art*, 105.
- ⁹ Linda Dalrymple Henderson, 'The Image and Imagination of the Fourth Dimension in Twentieth Century Art and Culture', *Configurations*, 17, 1-2 (2009), 131-160, 139.
- ¹⁰ Charles Howard Hinton, *A New Era of Thought* (London: Swan Sonnenschein & Co., 1888), 86.
- ¹¹ Peter D. Ouspensky *Tertium Organum: The Third Canon of Thought, a Key to the Enigmas of the World* (Rochester, New York: Manas Press, 1920)
- ¹² Massey, *Crystal and Arabesque: Claude Bragdon, Ornament, and Architecture*, 133.
- ¹³ Claude Fayette Bragdon, *A Primer of Higher Space: the fourth dimension; to which is added Man the square: a higher space parable* (Rochester, New York: Manas Press, 1912) 12.
- ¹⁴ Massey, *Crystal and Arabesque: Claude Bragdon, Ornament, and Modern Architecture*, 160.
- ¹⁵ C.W Leadbetter, *Clairvoyance* (Theosophical Publishing House, London, 1899) 11-12.
- ¹⁶ Throesch, *Before Einstein: The Fourth Dimension in Fin-de-Siècle Literature and Culture*, 8
- ¹⁷ Bragdon, *A Primer of Higher Space: the fourth dimension*, 16.
- ¹⁸ See: Edwin Abbott Abbott *Flatland, a Romance of Many Dimensions* (London: Seeley & Co, 1884)
- ¹⁹ Bragdon, *A Primer of Higher Space: the fourth dimension*, 19.
- ²⁰ Henderson, *The Fourth Dimension and Non-Euclidean Geometry in Modern Art*, 316.
- ²¹ Henderson, *The Fourth Dimension and Non-Euclidean Geometry in Modern Art*, 316.
- ²² Claude Fayette Bragdon, *Projective Ornament* (Rochester, New York: Manas Press, 1915) 2.
- ²³ Bragdon, *Projective Ornament*, 33.
- ²⁴ Bragdon, *Projective Ornament*, 11.
- ²⁵ Simone Natale, 'The Invisible Made Visible: X-rays as attraction and visual medium at the end of the nineteenth century', *Media History*, 17,4 (2011) 345-358.
- ²⁶ Throesch, *Before Einstein: The Fourth Dimension in Fin-de-Siècle Literature and Culture*, 140.
- ²⁷ Tony Robbin, *Shadows of Reality: The Fourth Dimension in Relativity, Cubism, and Modern Thought* (Cambridge: Yale University Press, 2013), 19.
- ²⁸ Robbin, *Shadows of Reality: The Fourth Dimension in Relativity, Cubism, and Modern Thought*, 19.
- ²⁹ Bragdon, *Projective Ornament*, 33.
- ³⁰ Massey, *Crystal and Arabesque: Claude Bragdon, Ornament, and Modern Architecture*, 163.
- ³¹ Claude Fayette Bragdon, *The Frozen Fountain, being essays on architecture and the art of design in space* (New York: Alfred A. Knopf, 1932) 73.
- ³² Bragdon, *The Frozen Fountain*, 95.
- ³³ Corey Keller, 'The Naked Truth or the Shadow of Doubt? X-Rays and the Problematic of Transparency', *Invisible Culture*, 7 (2004) accessed February 22, 2018, http://www.rochester.edu/in_visible_culture/Issue_7/title7.html
- ³⁴ Bragdon, *A Primer of Higher Space: the fourth dimension; to which is added Man the square: a higher space parable*, 12.
- ³⁵ Bragdon uses the term 'isometric perspective', a term effectively synonymous with 'axonometric projection'.
- ³⁶ Bragdon, *The Frozen Fountain*, 95.
- ³⁷ Erwin Panofsky, *Perspective as Symbolic Form* (New York: Zone Books, 2013), 49.
- ³⁸ Yve-Alain Bois 'Metamorphosis of Axonometry', *Daidalos*, 1, (1981) 40-60, 40.
- ³⁹ Bois 'Metamorphosis of Axonometry', 42.
- ⁴⁰ Henderson, *The Fourth Dimension and Non-Euclidean Geometry in Modern Art*, 462.

⁴¹Christina Malathouni, 'Architecture is the pattern of human mind in space: Claude F. Bragdon and the spatial concept of architecture', *The Journal of Architecture*, 18,4 (2013) 553-569

⁴²Desley Luscombe, 'Illustrating architecture: the spatio- temporal dimension of Gerrit Rietveld's representations of the Schröder House', *The Journal of Architecture*, 18,1 (2012) 25-56.

⁴³Luscombe, 'Illustrating architecture: the spatio- temporal dimension of Gerrit Rietveld's representations of the Schröder House', 42.

⁴⁴Luscombe, 'Illustrating architecture: the spatio- temporal dimension of Gerrit Rietveld's representations of the Schröder House', 27.

⁴⁵Henderson, *The Fourth Dimension and Non-Euclidean Geometry in Modern Art*.