AXONOMERTRY AND MODERN THOUGHT:
AN INVESTIGATION INTO ARCHITECTURAL SPACES AND ILLUSTRATIONS

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1. INTRODUCTION

This essay is ostensibly about a style of parallel line drawing. What the reader should shortly realize is that such a statement isn't enough. A style of drawing is a style of representing the world; in short, a method of thinking. Axonometric drawings are no exception. In order to illustrate this, first we must take a thorough look at this style's benefits and blind spots. With that detailed introduction, we can then properly look at how it's been applied as a tool for pre-modern, modern, and post-modern architectural explorations. Finally, with these examples, we can explore instantiations of architectural theory, and how their enhanced by axonometric drawings. It will be evident that axonometric is more than a type of drawing, it's a loaded method of thinking, which individual architectural ideologies have benefited from.

2. PROJECTIVE GEOMETRIES: AXONOMETRIC DRAWING VS. PERSPECTIVE DRAWING

Under the rubric of axonometric drawing contains isometric, diametric, planometric, oblique and parallel projection drawings.

Axons, like all architectural line drawings, are two drawing representations of a three dimensional scene. The convention shows the ve rticals and horizontals project to scale but diagonals, angles and curves distort, so that the whole appears inclined (Ramsey, 797). Importantly, parallel lines in axon remain parallel, unlike in perspective drawings where parallel lines tend toward a vanishing point. With no convergence, or diminution, all lines in axonometric drawings are to scale; no matter the direction they are drawn.

Irrespective of the age, certain observations about axonometric drawings are constant. Leonardo da Vinci had the habit of drawing in axon because it was better suited to represent the actual space of the object, rather than the object in space (Scolari, 73). In a similar vein, many have noted as Yve-Alain Bois does in 1981 that depth is rendered in a completely different way thru axons. With perspectives, infinity is rendered in a (vanishing) point and depth, with diminution there-to. But with axons, infinity is rendered with the parallel, and the eye seems to float untethered (Bois, 46).

The result is not a negation of depth, but a different expression of it. The eye is simultaneously equidistant from all objects in its field of view, rather than fixed like in a perspective. Further, the field is infinitely expandable.

Another observation common to axonometric drawings, that is rare in perspective, is a frequent multiplicity of readings. Examples of this are common to the old "Q-bert" playing field - from the original Atari games, to some Escher drawings, and to the Joseph Albers sculpture current crowning the Yale A+A Building main entrance. Each of these can be read with a visual switching, from either worms-eye to birds-eye or from projecting towards the viewer and then away from the viewer. The double reading further questions the position of the viewer.

In both drawings the viewer is conscious of the picture plane, but perspective drawings are more dependant on it, while the floating nature of axonometry denes it. This reveals that in perspective drawings the position of the viewer more heavily defines the shape of its representation. Axonometric drawings make no such assumption based on the position of the eye. Instead, axons represent objects as they relate to themselves. In this way, Johann Lambert has noted that axonometrics are object-oriented constructs, while perspectives tend to be subject-oriented constructs. (Schneider, 81)

Veins of these observations are common to literature on axons from all ages. As we will see later, other interpretations of axons illustrate how they were used at specific times in western architectural history.

3. BEFORE THE MODERN MOVEMENT, AXONOMETRIC DRAWING AND THE SCIENTISTS.

Axonometric's most immediate quality, of hyper-rationality, disposed it first to the scientists and engineers of pre-modern society. This palatable logic, crystallized in scale and measure, was taken advantage of by geometers as early as the 14th Century. Geometers, like Luca Pacioli and Niccolo Tartaglia, were using it for proofs in solid geometry in the first half of the 14th Century. After da Vinci used axons in his sketchbook to work out engineering problems, architects like de Marchi and Perret used axonometric drawings to illustrate technical solutions in fortification design (Scolari, 73)(Ill 1).

By the 18th and 19th Century, most technical engineering fields were using axonometric drawings to illustrate machinery. Both a design tool, and construction device, the highly rational aspects of axons provided two valuable functions. First, as a calculator, these drawings proved the demonstrated machines functioned before building them (Scolari, 73). The trained eye could dissect the functioning elements, and then could accurately calculate forces, volumes and lengths, by scaling off the drawing. Additionally, the constructor could use the same information about length, diameter, orientation, and sequence to construct prototypes (Ill 2 & 3). Only approximations would be possible with perspective drawings. For this reason, as early as the 17th Century, carpenters and machinists practiced axonometry as a method for planning projects (Bois, 42).

To quickly reveal how many other engineering fields Axonometry was influencing, one can look at the example of T. Sopwith. In his 1838 treatise he illustrated the proper way to make calculations in, and properly draw complicated forms with isometric drawings. Then he applied the techniques to Mining, Surveying, Geology, Civil Engineering, building plans, machinery, and then with a certain charm, ornament, and landscape gardening (Sopwith, 104) (Ill 4).

In the same spirit, Esprit Jouffret used axonometric drawings to explore qualities of four-dimensional polyhedroids in 1903 (Evans, 60). With overlays on squares, calculations and visualizations could be made concerning otherwise unimaginable objects. (Ill. 5) Please refer to these drawings when we discuss the Hypercube, as this instance shows one threshold axons find into early-modern though. It was twenty years after this drawing that El Lissitzky and van Doesburg would re-encode this hyper-rationality of axons with new purpose.

4. PRECURSORS TO A NEW ARCHITECTURAL INVESTIGATION - CHOISY AND BRAGDON.

Two examples must be given to uncover how pre-modern architects approached Axonometry. Indirectly the examples will also betray a philosophy of space and Architecture.

Claude Bragdon, both a set designer and architect, wrote in 1926 an article entitled "Isometric Perspective" for Architectural Record. The text of the article is an appeal to practitioners everywhere to use this, quicker style to give more informative three-dimensional renderings.

> **"Many palatable shortcomings of our current American Architecture may be traced to the custom-now almost a settled habit-of designing in elevation instead of in perspective; buildings are *drawn* rather than *imagined*, as their general lack of *organic quality* clearly**

shows. Now designing in perspective forces the designer to *unitively*, to visualize clearly, but owing to his lack of easy familiarity with the perspective method, time pressure, or on account of shear intellectual indolence, this is all too often neglected... But there is a type of perspective - isometric, so called - which is rapid, direct, and simple, shows things truly and clearly, and requires no other paraphernalia than working drawings require...(Bragdon, 302)"

Incased in this argument is a simple appeal; innocuous on the first reading but, it remains very telling for our inquiry.

"Architecture, having preeminently to do with *solids*, the architect should think always in terms of three dimensions rather than two... (Bragdon, 301)"

In the "object-oriented" terms from Section 2, axonometric drawing highlights relations of objects to themselves (Ill 6), these comments are quite topical. This distinguishes an early 20th Century simpler preoccupation with solids that later proves to be restrictively narrow for Lissitzky or Eisenman.

August Choisy used axonometric drawing with the same logical first-step. His 1899 two-volume book, *Historie de l'Architecture*, had 1700 illustrations cataloguing technique of constructions. We have already seen that this is an ideal subject for axonometry. Choisy was a Rationalist. Reyner Banham describes Choisy's style of illustration as invariable thru the entire book (Banham, 24). In few places did Choisy actually deal with what the building looked like (a subjective agenda), but instead abstracted it construction and detailing (more object-favoring topics) in elegant worms-eye views that would influence generations to come (Banham, 25) (Ill 7).

5. INTO MODERN AXONOMETRICS: THE HYPER-CUBE, VAN DOESBURG AND EL LISSITZKY.

To detail how axons made the aesthetic cross-over to mature architectural investigations, one should now remember Esprit Jouffret's image of four-dimensional geometric solids. (Ill. 5). In 1904 Charles Howard Hinton published *The Fourth Dimension,* a book whose first leaf tried to display the four-dimensional phenomenon, the Hyper-cube (Hinton, Inleaf)(Ill. 8). With oblique axonometrics, Hinton color-coded the faces of two-dimensional representations of three-dimensional cubes to illustrate properties of the never-seen-before, wickedly complicated Hyper-cube. In Hinton's book the fourth dimension was a spatial one, and colors coded which of the 24 faces touched to fold eight cubes into one construct (Hinton, 142).

Years later, El Lissitzky and Evans manage with line-drawings in axon to more eloquently illustrate the same thing (Evans, 342). But not before Cornelis van Eesteren collaborated with Theo van Doesburg on a different interpretation of four-dimensional space. Using a color-manifold construct similar to Hinton's, van Eesteren created a series of similar axonometrics in 1921. When van Doesburg traced these color drawings that summer, he did so with a painterly agenda, thereby stripping the forms of architectural coding. These tracings, incorrect as technical drawings, became the basis for van Doesburg's "Counter-Constructions" and "Color-Constructions" of 1923 (Collaboration Re-examined, 110) (Ill. 9).

As van Doesburg explored this quasi-axonometric space, he was only concerned with color and affect, abstracting the investigation from program, gravity and form. In this way, axonometric space was reinvented as a tool for a different kind architectural exploration: Yve-Alain Bois considers these investigations as the first time axons were used in the service of aesthetic aims, rather than practical ones (Evans, 338). Couched in the universal observations

from Section 2, the following Van Doesburg quotes from "The Axonometric Project." unmistakably locks him in patterns of axonometric thinking.

> **"Van Doesburg stated that 'the new architecture is formless': alien to a priori schemes, it 'doesn't recognize the fundamental and unchanging patterns'; the new architecture shuns symmetry and the frontal approach 'developing it's many-sided plastic nature in space,' and therefore does not distinguish a 'front' (façade) from a 'behind,' the 'right' from the 'left' and, if possible, not even 'up' from 'down'; architecture as a whole is made up of related parts which 'permits of representation (in the form of a separate 'picture' or 'sculpture')"(Reichlin, 83).**

Co-tangentially from the Hyper-cube, and inspired from the above investigations was El Lissitzky's *Proun Space*. Immanent here is the notion that starting in the middle of the 19th Century, Euclid's laws were been taken from their foundations. Coupled with that undermining was Einstein's work on space-time, another four-dimensional concept still grappling for proper graphic representation (Henderson, 296). Work of mathematicians like Gauss and Reimann, and specifically with Lobachevskii's lecture to the University of Kazan in 1826, noted that Euclid's Fifth Postulate was malleable without damage to the rest of his geometry. This postulate was replaced to say an infinite number of parallels can exist to a line at a given point (Corrada, 377). Entirely new spaces were possible; functions in a revised algebra could describe perspectival space, and others (Corrada, 379). Lissitzky's "A.[rt] and Pangeomtry" of 1924 acknowledges "Lobachevskii has already exploded the absoluteness of Euclidean space…" and writings like this and *Prouns* detail how he saw his invented drawing as a way of (re)constructing the world around him (Henderson, 295).

Attempting to come to terms with these new realizations, combined with the imagery of Theo van Doesburg's new illustration of the Hyper-cube (Ill 10) , El Lissitzky produced *The Proun Room* (Evans, 343)(Ill. 11). This new type of drawing, derived from the axon, required the viewer to imagine himself inside a fictional room, looking at several different directions at once. The representation is impossible to construct in three dimensional space, yet El Lissitzky gives the viewer enough information, with sculptures wrapping around corners of the room, to reconstruct the space in their mind. Mathematical reference to the hyper-cube had given way, but locked on the two- dimensional surface of the paper, was a new exploration of architectural space (Evans 344).

In this time, the inherent rationality of axonometric drawings lent themselves to early investigations of new mathematical concepts. By offering this crutch of rationality, it was with axonometric drawings that Modern Architects required something new from. It also became a way of organizing planes in space, of color, and of new mathematical explorations, all of which contributed to new aesthetic aims.

6. PRACTICING A MODERN ARCHITECTURE THRU AXONOMETRIC'S FIRST INCARNATION.

We've now charted how El Lissitsky helped encode the axonometric drawing for high-order architectural investigations. What follows is a quick look at how other Modern architects framed their explorations with this newly re-energized style.

Two examples will serve to demonstrate new aesthetic experience of architecture, and new ways of designing. Herbert Beyer's axonometric study of the new director's office for the Bauhaus at Weimar.(Ills. 12&13) The planes, window detailing, the support rods for the shelves

and all the designed furniture are quite at home in axonometric space. They are conceived of with its rationality, and carry that feeling into the built work.

Next, Alberto Sartoris' "My Ideal Home" (Ill. 14) project tries not to represent what the massive object would feel like in reality. Instead, it presents solids standing proud to each other, with balcony conditions that simultaneously skew off the grid and kiss the building in a way entirely lost if rendered in perspective (Reichlin, 89). These were subtle investigations of Kandinski's theories to make harmony objective (Gonzalez, 230).

7. EISENMAN AND HEJDUK'S POST-MODERN AXONOMETRIC: A SECOND INCARNATION.

To conclude these examples of axonometric drawing as axonometric thinking, we will look at a rebirth of the drawing style in the early 1970's. This quote from Bruno Reichlin in 1979 best describes the operations of our focus at the time.

> **"The 'subject' (the 'topic') of the modern structure of architecture consists rather of the procedures and the system of rules that an evermore specialized profession imposes on [an] external reality…" (Reichlin, 87).**

More directly to the "subject" this new incarnation of the axonometric drawing put the drawing style and the geometries it represented on center stage. Once recognized, the finished three-dimensional product was the repository of the design operations exercised on it. In post-modernity, Architectural objects began to be subjected to transformations related to axonometric drawing. The rational nature of axons had fully blossomed into an analytic tool, and sometimes the "architecture" happened on the paper, not in the building (Eisenman, Review). In this way John Hejduk and Peter Eisenman's work show the highest self-consciousness of how operating in axonometric space effects the work.

The space had to be axonometric. These men are updating and later abandoning the proportional systems designers like Le Corbusier used strictly in elevation. A flip thru "Regulating Lines" in *Towards a new Architecture* will reveal the ordering for his (own house and studio) "a House", and his (Jeanneret-Raaf House)"Two Houses at Auteuil" was done completely in elevation. In their work from the 70's, Men like Hejduk and Eisenman needed to take the conceptual step to the side that axons all to illustrate their ideas.

To give and example, one need only glance at the drawings Eisenman produced for House VII, displayed last year in our own gallery. With analysis of his house in terms of lines, planes, and volumes spread over the twelve steps necessary to understand the house the drawing(s) read more like a film-strip. The observer is allowed views of forms, walls, and columns colliding in a series that could be run forward of back to illustrate the house. With the arrival of Deconstruction, it was necessary to show the audience of the work how one arrived at the solution. Elevations were woefull inadequate for illustrating that formal play.

Hejduk's Diamond House (Ill. 15) makes a further bold leap by putting a social agenda for architecture completely on the back burner. Instead the subject of his work was the operations, or process that occurred in axonometric space onto the Diamond house. Bringing the multiple interpretations of an axonometric drawing into review.

Totally obliterated is logic behind the simple "solids" quote offered in Section 4 of this essay. These men's work was as much about void as solid, and more about process than effect.

In an even more obvious example, Peter Eisenman deformed a three-dimensional nine-square grids in order to create a house House El Even Odd. (Ills. 16&17) One might describe the distortions as perspectival, ironically, but religiously respecting laws of axonomtry, and an axonometric view-plane. In a Daidelos article from 1981, Bernard Schneider directly questions the accuracy of his operations. Specifically, he calls such operations arbitrary and contradictory. Who-ever is right, the fact that the following statement was made justifies the claim of this paper, axonometric drawings predicate axonometric thought.

> **"House El Even Odd is and axonometric object… It explores the conditions of representation reading and architecture. As such, it is concerned with the limits of the disciple of Architecture. (Reichlin, 60)(Ill. 20)"**

8. Conclusion: Theory and Axons: Reinforcing thru drawing.

It is the position of this essay is that the theory and drawing enjoy a symbiotic relationship. The preceding words could not show axonometric drawings divorced of motivation, and in the same way, this quick overview of theories explored in the class could not be fully exercised without drawings. Thus, the few examples I point out here are attacking the same issue of "what can axonometric mean?" from the opposite side.

The subject of Hejduk and Eisenman's investigation was the nature in which objects related to themselves. Eisenman boldly claimed this was a frontier of Architecture (Reichlin, 60). Given that premise and what we've seen contrasting perspective and axonometric space in section two, there is an inevitability to these men's use of axonometry.

Eisenman claims much of the architectural way he sees the world is heavily influenced by Colin Rowe, eluding several times in his Yale classes to the tortuous summer in Europe the two shared. As such a strong influence, it comes as no surprise that Rowe's writings convey a philosophy that would favor the strengths of axonometric analysis. In "The Mathematics of the Ideal Villa" he specifically contrasts Le Corburier's mathematic harmonies with Palladio's in order to highlight their different systems or "rules."(Rowe, 14) This is the playground of the axonometric. Eisenman and Hejduk used axonometry to express these rules all thru the 70s.

Contrast this sentiment with Semper's Space*, Time and Architecture*, and you realize how large the gap in this thinking has gotten. Semper's conception of Space-time also is easily illustrated with axons, but for almost completely different reasons. He rests the method of spatial relationships the cubists developed with the genesis of Space-time.(Semper, 434) Like the Purest agenda of the 20's, both were interested in presenting simultaneous representations of objects to preserve "the characteristic and invariant constant of the object" (Reichlin, 66). Perspective projections, lacking the mind's-eye that axons do, are not as well disposed for this. When Semper speaks of the stairs on the Eiffel tower and space-time, he qualifies them as a place where the observer must project himself thru, in order to fully grasp (Semper, 436). It's axonometrics that can begin to afford the viewer a uniformly biased point of observation to not hinder this exercise.

A style of drawing is a style of representing the world; as said before, the choices one makes when they draw betrays their method of thinking. Axonometry started as a much simpler representation system, but matured into a rule-set for architectural investigations. In short, and in counter-balance to the Renaissance fixation on perspective, axomonmetry has guided and convinced people's perceptions of space for over 400 years.

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