Keystone's Meta-pictorial Stereoviews: Covert Transgressions within a Disciplinary Regime

I was intrigued by Eye-Training stereoviews the moment I first saw them. What do they mean, these surrealist juxtapositions of a mathematical sphere and photographic space (figure 1)? Here men seem to point to the apparition (perhaps it has just appeared?) or reach for it as it hovers, inaccessible, over a steep drop. This image is part of a sequence of images in which the sphere reigns over vast alpine spaces, descends into caverns, nestles into the petals of flowers and alights on the wings of butterflies. Is it a quest? What will the quest reveal? Figure 2, a 'jump fusion' stereogram, is equally perplexing. Why is pictorial space fragmented in this way? Why do the 'sensitive plants' so boldly ignore the boundaries of their picture frames? What space do they occupy when they emerge and what is its relationship with the spaces that remain behind the frames? Why is the encircling lettering carefully arranged so that words float out and hover at different depths independent of any writing surface?

Figure 1 – Keystone, c. 1940, AN56, *The Great Western Divide*, Gelatin silver print.

Figure 2 – Keystone, c. 1935, EC-46, *The Sensitive Plant*, Gelatin silver print.

I will argue that these are playful transgressions within a stern regime of ocular discipline. The eye-training stereoviews were part of a project to medicalize and normalize spatial seeing. On the surface that project seems to exemplify, in an unambiguous and explicit way, the influential claims of Jonathan Crary about stereoscopy's role in the standardization and mechanization of vision, rendering it rational and efficient within an increasingly global system of industrial mass production. But there is something going on within the stereoviews themselves that tells a different story. Many of them, visually, are direct descendants of early 19th-century stereoviews conceived on the model of the 'philosophical toy.' These were designed to stimulate critical thinking about how perception and optical deceptions worked and return agency and social power to the observer. Others embody some of the tropes of modernist art of the early 20th century, in particular its reflexive, 'meta-pictorial' logic.

By analyzing eye-training stereoviews within the context of the tradition of the philosophical toy and the innovations of avant garde art, I offer a corrective to some of the over-generalizations within the academic literature that situates popular visual media within the context of projects of social control. In this case study of a particular set of artefacts I explore themes both of resistance to as well as the failures of disciplinary projects of control. In the process I offer what I hope are insights of equal value into a little-appreciated body of images that challenge our conceptions about what it is to see stereoscopically and seduce us with optical experiences both pleasurable and beautiful.

I – The Therapeutic Stereoscope

The stereoscope began its career as a scientific instrument whose purpose was to abstract from natural vision and place under close examination one particular element of depth perception: binocular disparity. The first images produced for the stereoscope by Charles Wheatstone (1838) were designed to isolate binocular disparity to ensure that it and only it was the cause of the

spatial effect that the mind was able to invoke from the images. Wheatstone proved, contrary to received wisdom, that binocular disparity alone not only contributed to depth perception but gave it what many perceived to be its most vivid expression. There is nothing that pleases the mind so palpably with the fullness of spatiality as this blossoming into volume that the stereoscope revealed. These first schematic drawings (see Figure 3) were an unprecedented form of representation. They gave no hint of the spatial volume that they would generate once they were placed within the device and viewed stereoscopically. This transformation between inscrutable inscription on the stereocard and overwhelming spatiality became one the secret pleasures of stereoscopic art.
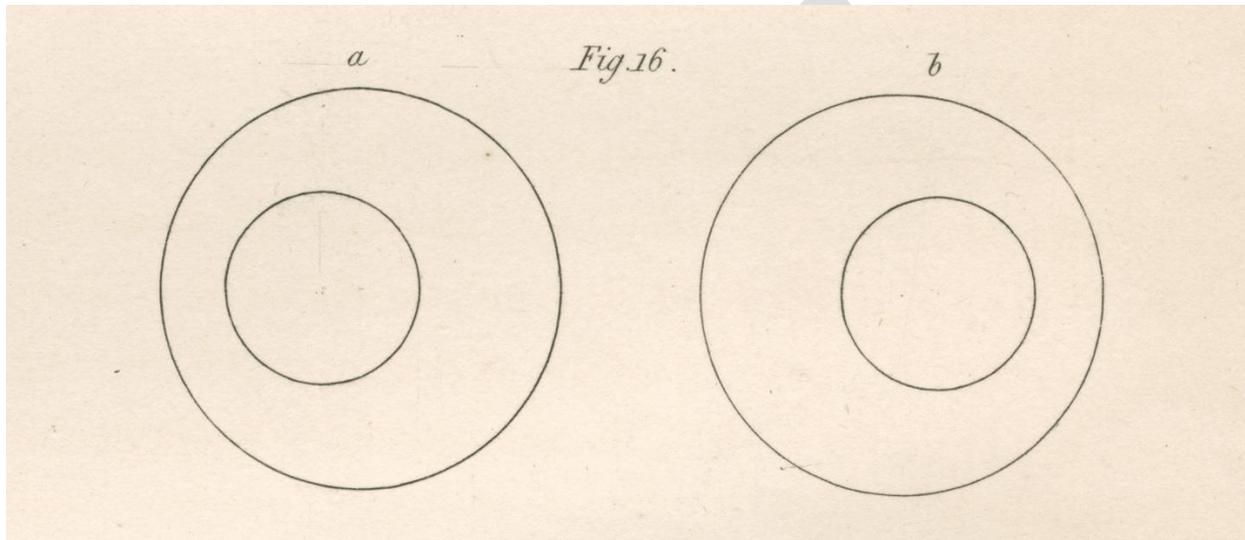

Figure 3 – Wheatstone (1838) figure 16.

The German physiologist, Emil Du Bois-Reymond, who observed the burgeoning craze for stereoscopic illusion in England in 1852, immediately saw its potential as a tool for medical therapy. 'In view of this game-playing activity in a country of practical people,' he wrote, 'it occurred to me how useful it may be to apply the stereoscope for the cure of strabismus…' (Remky 2002, 36). The stereoscope became a passion for some and a perplexity for others for whom the paired images invoked volumetric space only mildly, incoherently or not at all. Ubiquitous stereoscopy exposed new and possibly widespread problems with binocular spatial perception – strabismus, the inability to converge the eyes on a precise point, being one of them.

Du Bois-Reymond and William MacKenzie (1855) recognized in general terms that use of the stereoscope could exercise the user's capacity for binocular fusion. But people with deficiencies in binocular vision are typically unaware of what they lack. They have never seen stereoscopically and rely instead on monocular cues for reading space and volume from the world in front of them and from pictures such as those that they see in the stereoscope. Those, for example, with strabismus often have double vision so extreme that the brain compensates by suppressing the input from one of the eyes. Their subjective reports of their own perceptual experiences are unreliable. Émile Javal, in 1868, began to develop special diagnostic stereoviews that could force these stereoscopic deficiencies into the view of the medical practitioner. Faced with the following two stereoviews, one a stereoscopic view with disparity

and the other without, there is no way that the patient can distinguish them without the ability of fusion.
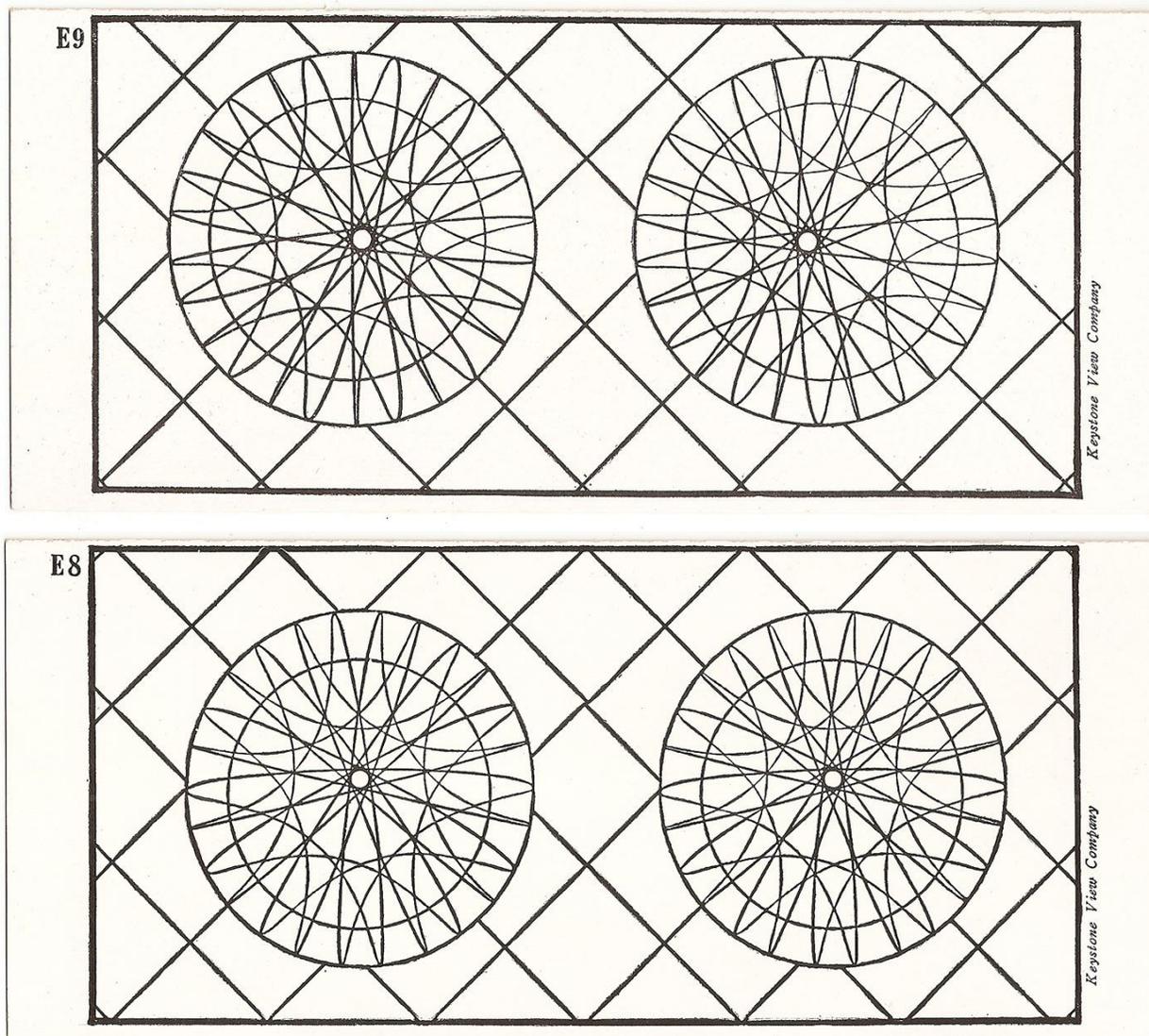

Figure 4 – Keystone, c. 1900, Geometric Solid with disparity and without disparity, E-8 and E-9 of the Wells Selection, lithograph.

Javal, Edmond Landlot (1886) and David Wells (1912) also became convinced that exercise, rather than or in addition to surgery and corrective lenses, could be used to retrain the eyes to overcome stereoscopic deficiencies. This was the premise on which the Keystone View Company's stereoscopic 'Eye Training and Eye Comfort' systems were based. W. Kroll, Carl Dahlfeld, Javal, and others all produced stereocards consisting, like Wheatstone's, of line drawings, but for the purposes of eye training. Wells in 1904 issued the first of many editions in a successful series of such cards including the 'best' of his predecessors', plus many of his own design. His commercial innovation was to make his cards compatible with an already-established instrument of mass entertainment – the Holmes stereoscope – and to require that each patient purchase his set of cards for home training (Wells 1912, 41).

While Wells made money only on royalties, Keystone sold both the cards and the accompanying stereoscopes with their signature precision scale along the adjustment bar. Their corporate success had up until this time been based on large boxed sets of standardized photo-realist stereoviews that claimed to transport viewers into perfect facsimiles of distant spaces. Line-drawing stereoviews produce spaces and volumes that are, and that always read as, pure artifice. Landolt was the first to combine simple artefactual spatial elements with photo-stereographic spaces (Wells 1912, 45). But the Keystone staff turned the technique into an art: their juxtapositions are astonishing, sometimes beautiful and perceptually troubling to the photographic realist elements that they are juxtaposed with.

In addition to diagnosing deficiencies in binocular vision, eye-training stereoviews were also designed to cure them. The first aim was to encourage binocular fixation – to get both eyes to see and combine the dual images of a single object. To this end the final form of the object should be known and expected. But within the expected there should be a little 'trick' inserted to guard against suppression. Javal and Wells liked to use images of words. In card C7 (figure 5) "ON" and "NE" should clearly merge as one (as "ONE"). The trick is the dots in the "N" – if the patient fails to see both of them, they are achieving coherence through suppression. Space here is a coherent text. The next step is to encourage fixation at different and increasingly widely separated angles of convergence. In card J1 (figure 6) the descending words narrate space. Linguistic meaning reinforces spatial meaning. Language here also offers a lesson in the 'language' of stereoscopic construction. Paired objects closer to the centre of the cards will 'read' as closer to the observer; paired objects further apart will read as further from the observer. This is a trick of construction that the Keystone artists delight in (see figures 2, 11, 18, 19). The letters in their text are made to dance at gratuitously odd levels and words veer off at arbitrary angles in space. The Keystone artists are writing stereoscopic space; the patients are being taught to read stereoscopic space.

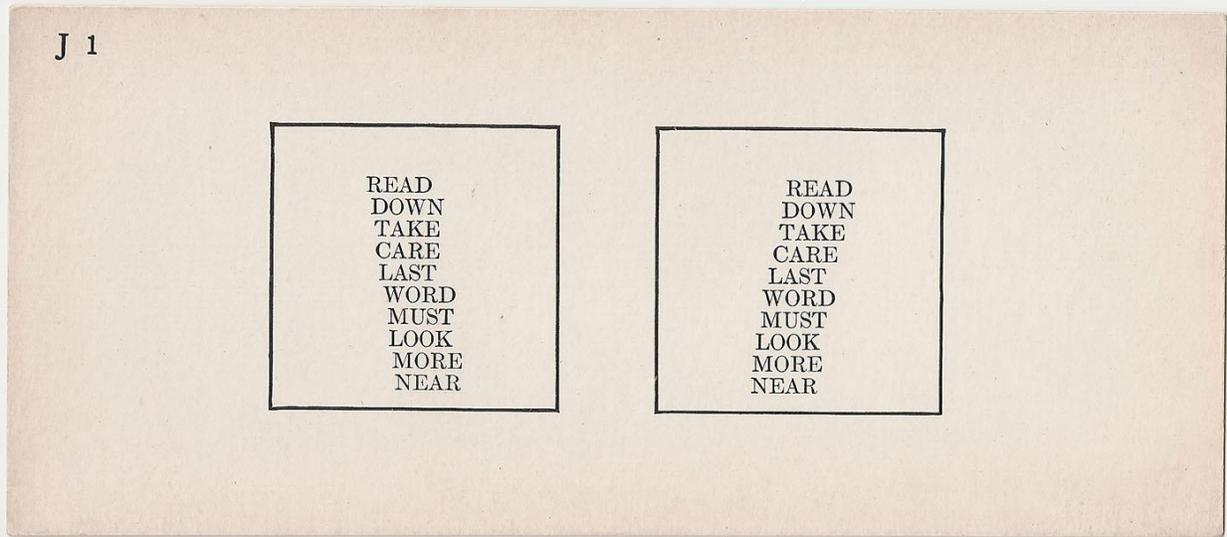
Figure 5 – Wells, c. 1935 [1904], C7, ONE, lithograph.

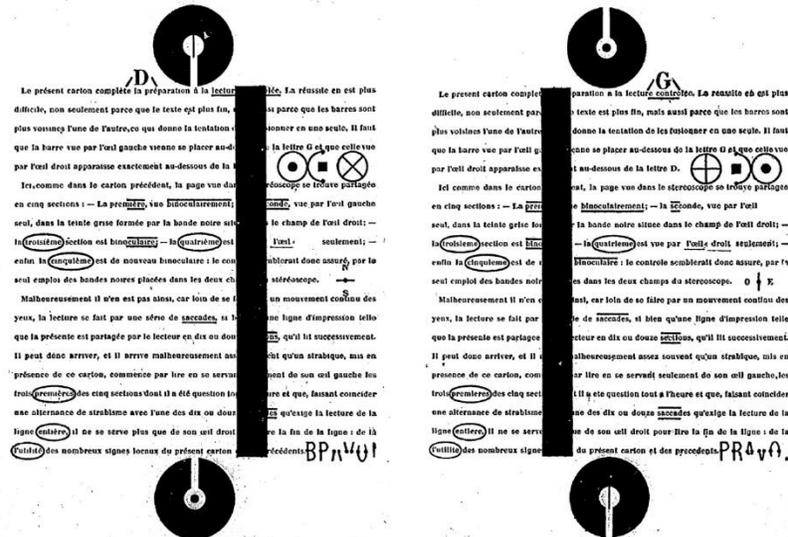Figure 6 – Wells, c. 1935 [1904], J1, Descending Text, lithograph.

Figure 7 – Javal, 1896, reproduction of card L3 (Javal 1896, 132-3).

These fixation exercises are designed to improve skills of binocular convergence, but not necessarily the interpretation of binocular disparity. Letters are flat and produce no binocular disparity. Only things that extend into the depth of the view produce disparate images on the retinae. Consider Wheatstone's (1838, 376) schematic of a 'line in the vertical plane, with its lower end inclined towards the observer' (figure 8). Most people can fix their eyes successively on the top or distant point of the line, the middle point (at the same apparent depth as the circular frame), and the bottom, or near point. The disparity is so great between the upper (further) and lower (closer) ends of the line that very few can make the whole thing cohere as a spatial form that doesn't threaten to split apart at the ends. Wheatstone could do it; his rival Brewster could not. The difference in their capabilities was in part responsible for a dispute as to whether disparate images were ever actually fused or whether we always build spatial objects sequentially though binocular convergence alone (Brewster 1844).
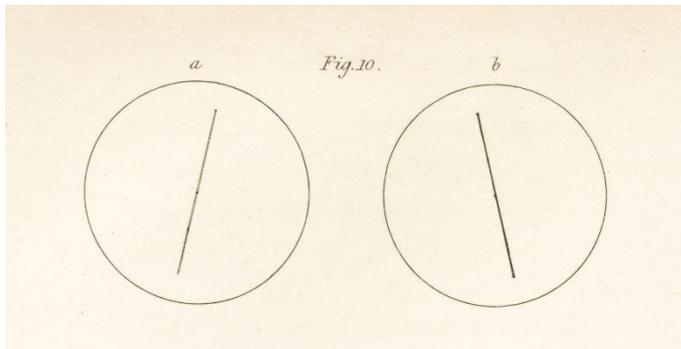
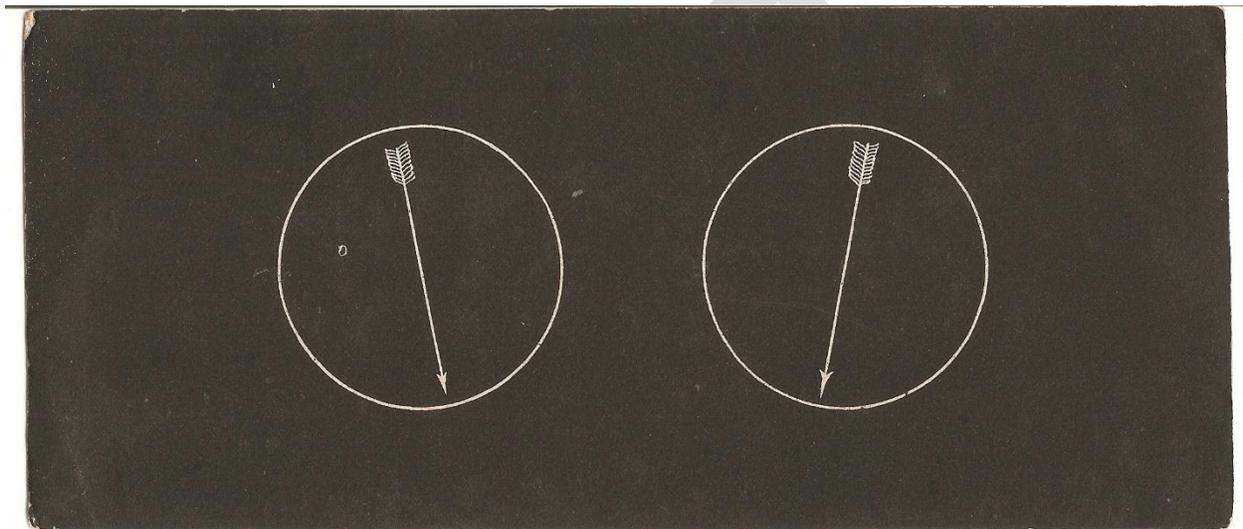Figure 8 – Wheatstone (1838) figure 10, [Wheatstone Line]

Figure 9 – Duboscq, c. 1850, *Untitled [Arrow]*, wood engraving on paper.

Figure 10 – Hale, c. 1900, *Untitled [Arrow]*, E7 in Wells' Selection.

A number of training stereoviews are variants of the Wheatstone line (Figures 10, 11, 19). The aim of training with *The Turn in the Road* (figure 11) is both to fix on the numbers along the receding line successively, but also to make as many as possible of the numbers cohere simultaneously. 'Fix' is not the right word to use here since it is optically impossible for the eyes to fix on the '1' and the '5,' or even the '2' and '4' simultaneously. That would be like simultaneously fixing on the words 'READ' and 'NEAR' in figure 6. These are fixations at different angles of convergence and the eyes can only be at one angle of convergence at a time. As the note 'to the doctor' in the Zeta series explains, the aim was to improve 'the depth and breadth of the horopter, or the fusion range.' (Keystone 1943, 5, 16) Keystone is invoking a kind of psychological horopter here. In the original mathematical meaning of the term the horopter has no depth. It is the surface consisting of all the points that the two eyes could fix on at a single angle of convergence. Anything that pierces the horopter, in the way that the line pierces the flat backdrop of the hills in this view, will have a tendency to double.
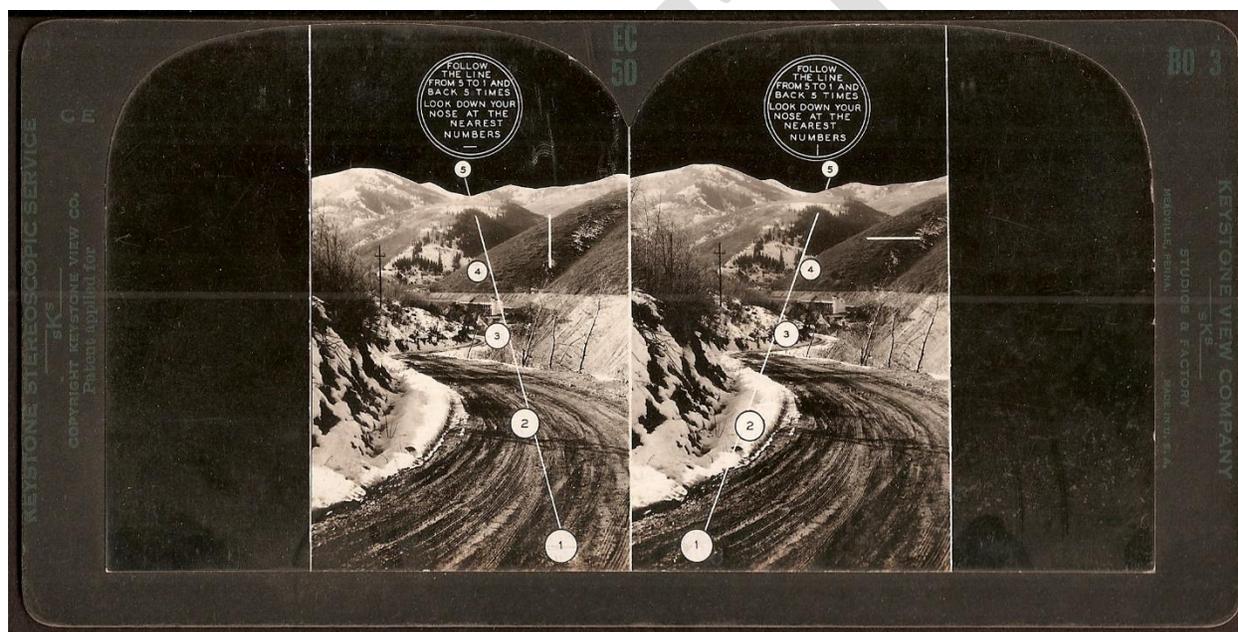

Figure 11 – Keystone, c. 1940, EC-50, *The Turn in the Road*, Gelatin silver print.

In reading binocular disparity the mind must impose coherence on an optically incoherent pair of retinal images. That was Wheatstone's most contentious conclusion – that we do not 'see' space as an optical input, but rather our minds impose spatial form. This has always been the anti-realist challenge at the core of stereoscopic representation. Keystone was both training the mechanical skills of binocular convergence and also the power of what we might call the spatial imagination – that ability that Wheatstone excelled in of imposing spatial form. They call this skill 'fusion'; I sometimes prefer the term 'suture' to describe it. Imagine sewing the two spaces in figure 11 together, the thread passing first through '1' and '1,' then through '2' and '2.' The sewing metaphor captures the way that we stitch and pull the fabric of space together even as it strains to break apart again. Try to fuse the line from 1 to 5 and you will see what I mean.

With the aim of exercising the muscles responsible for convergence, designers made many therapeutic stereoviews that are like jungle-gyms for the eyes. The accompanying guide

pamphlet tells the user that spatial fusion is an accomplishment and she is placed in circumstances where she can see the strain of suture as often as the success of fusion.   I will argue that there is a covert invitation here to explore Wheatstonian science, to try to figure out just what is going on when the mind wrestles visual inputs into a construct of space. The experience of effort and failure shows that perceiving space is not a passive 'seeing' – an 'out there' is not mirrored in our minds in the way that classic realism proposes.

II – The Medicalization of Rational Recreation

Many of the images in the eye training sets have a genealogy that traces back to the stereoscope's early life as a device for 'rational recreation.' In the 1830s the meaning of this term had begun to shift to encompass what Peter Bailey (1978) calls a middle-class 'concern to police the amusements of the poor' (16).   The stereoscope, long out of reach of the poor and working classes, was integrated into an older tradition exemplified in the writings of William Hooper (1774) and John Paris (1827) in which the playful exploration of 'philosophical toys' was meant to encourage the kind of critical reflection and discovery that led to mastery of the world. The two 'rational recreations' do not succeed one another in response to uniform needs of emergent industrial capitalism, but rather prepare people destined to be masters of the industrial machine differently from those destined to be its servants. Social class makes a difference; even in the rationalization of spatial perception, it is more empowering to be the one doing the analysis and designing the technologies of control than being the one who is only subject to those technologies of control.

The first commercial set of stereoviews ever produced – wood engravings of geometric figures by Jules Duboscq – and David Brewster's (1856) critical commentary upon them located stereoscopy firmly within the earlier, critical tradition of rational recreation. They invited the user to deconstruct the mechanisms by which we construct the spatial 'real' (Bantjes 2018). Duboscq included a version of the Wheatstone line (figure 9). He also generated a number of complex geometric spheres, using descriptive geometry to calculate the precise rotation of the stereoscopic pair. The first Keystone sphere, included in Wells' selection (figure 12), was designed by a pair of mathematicians as part of their effort to popularize the appreciation for elliptical functions. Their aim was that the user understand the mathematics of construction. The Keystone copy is designed rather to deceive the user (Figure 4). Keystone's mysterious sphere (Figure 1) remains for the viewer an unexplained object of wonder.
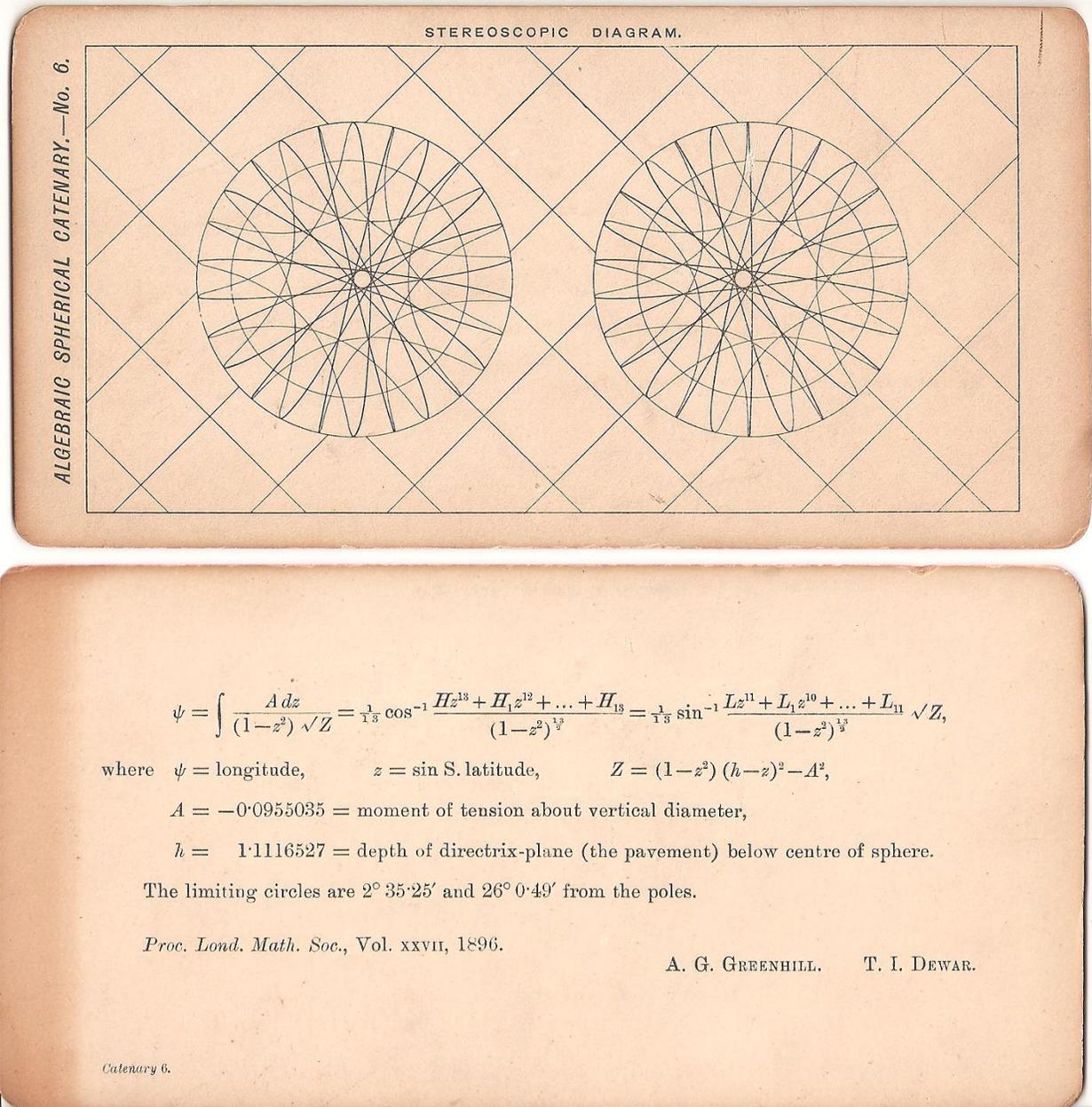
Figure 12 – Greenhill and Dewar, 1896, *Algebraic Spherical Catenary No. 6* with construction method on the back, lithograph.

The fragmented letters that when fused spell "Bravo!" in Javal's card (figure 7) have precedents both in phenkistiscope disks (figure 13) and thaumatropes of the 1830s (figure 14). In the Javal case, "Bravo!" is a reward for successfully following instructions; in the thaumatrope it is an experiment into the principle of the persistence of vision. Consider another very common thaumatrope image of a bird and a cage that Wells includes in his selection (figure 16). This is one of John Paris's (1827) original designs for his invention. The spirit in which he intended it to be used was one of dialogic inquiry. He depicts children of the landed gentry – Tom and Luisa at Overton Lodge – whose curiosity leads an investigation into the scientific meaning of the device. While the adults are better informed, the role they play is not so much instructors as

co-investigators. The thaumatrope was a device to encourage children to think for themselves about how perception works and the technological deceptions that the eye can fall prey to. In a context of increasingly technologically-mediated perception, their critical skills armed them against the deceptions of new media. Their understanding of the scientific principles positioned them to be the engineers of the technological sensorium, not the hapless subjects of its effects.

Figure 13 – Simon Stampfer, c. 1833, 'The Stroboscope or Magic Disc. No. 7.' Published by Mathias Trentsensky, Vienna, AP-94-196, *Cinémathèque Française*.
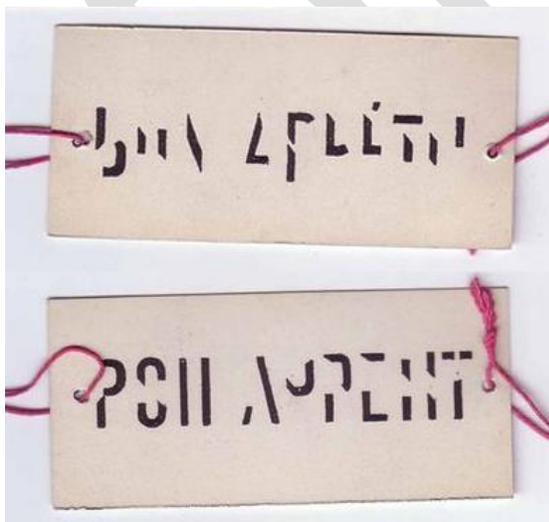

Figure 14 – Charles Watilliaux, c. 1880, Thaumatrope, Collection of François Binétruy.
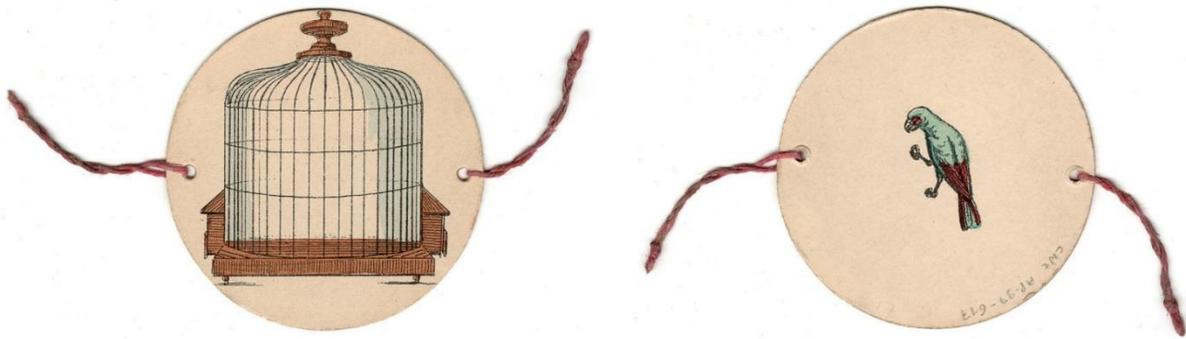
Figure 15 – Anon. 1850,Thaumatrope of Bird and Cage, Centre national du cinéma et de l'image animée, Paris.

Figure 16 – W. Kroll, c. 1904, A1 in Wells' Selection.

The late 19th-century re-framing within a medical, therapeutic model removes agency and technical competency from the subject and reinvests it in the medical professional. Users are explicitly positioned as 'patients' and their competency in matters of their own vision is placed in doubt. The Keystone sets are 'sold only on prescription.' Users are cautioned not to explore the cards at will, but to strictly adhere to the regime 'prescribed' by their doctor. They are expected to follow instructions and record their progress on a grid supplied within the eye-training booklets. The patient returns these results to the doctor who alone is qualified to interpret them, and who amends the prescription based on their professional judgement.

No longer does the user explore the mechanisms of spatial perception and its causes of failure. That is the exclusive preserve of the medical professional. The job of the patient is to become 'normal' by a standard of normalcy set by the physician. 'Normalcy' here is not the

determination of a value-free science; it is rather a class-specific adaptation to a particular regime of social power. Wells (1925) conceives of his intended patients in class terms, writing that normal binocular fusion is of the greatest value 'to chauffeurs, engineers and street car motormen.' These workers are the organic links in a global machine system of interconnected exchanges of people and commodities that relies on increasing speed, precision and standardization. There is only one, maximally efficient way for the railway engineer to perceive space.

Keystone also represents the value of eye training in terms of work efficiency and the normalization of 'incorrect visual habits' (Keystone 1943, 4). They too imagine working-class occupations: garment workers and the clerical workers that Harry Braverman (1975) calls the 'white collar proletariat' essential to the growing corporate bureaucracies of monopoly capital. Eye training increases the efficiency of 'long hours of near-point work on fine detail, such as reading, writing, sewing.' Many of Keystone's cards are explicitly directed to airplane pilots, who might be added Wells' list of those needing binocular efficiency to steer moving machines (see also 'Keystone' 1938, 18). Figure 17, an earlier version of which appears in the Wells selection, is a 1930s German training stereoview to help pilots assess the spatial location of bombing targets.
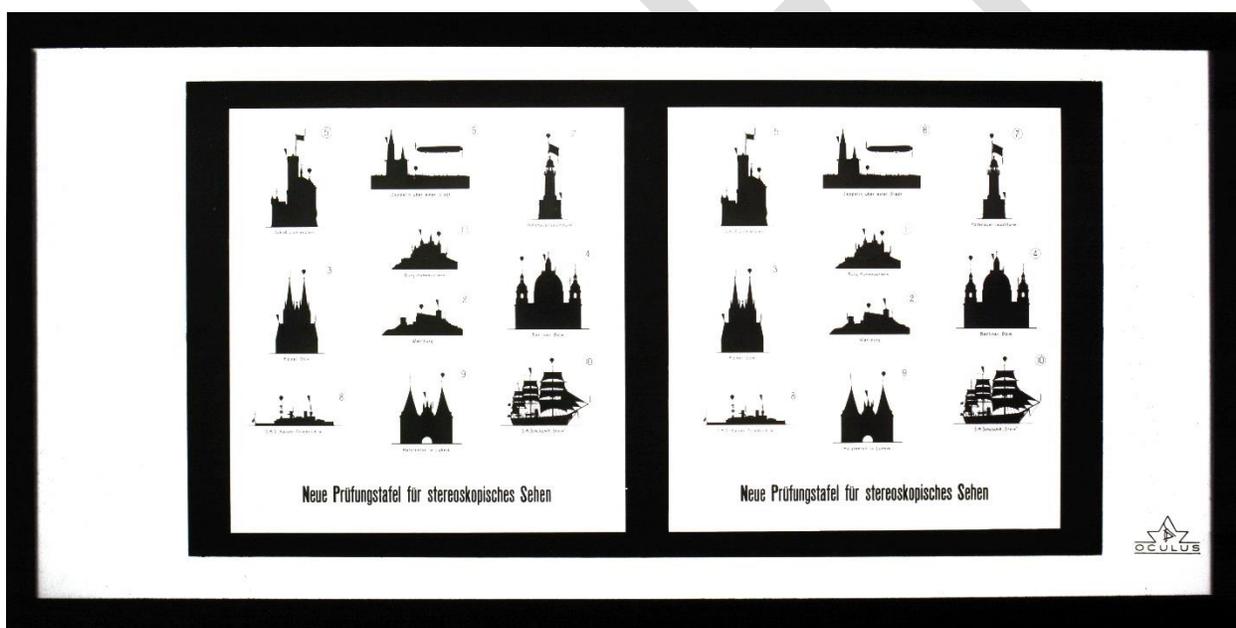

Figure 17 – Oculus, c. 1935, Neue Prufungstafel, Albumen on glass.

Framed as medical therapy, stereoscopy can be understood as Crary (1992, 85, 112) understands it in general, that is, as annexed to projects of Taylorization and work discipline: dispossessing visual competency from the individual subject and embedding it in alien systems of technical expertise and machine domination. Taylorization was typically imposed on workers through external coercion (Braverman). The literature on medicalization reveals the more Foucauldian logic by which this 'biopower' is softened and legitimized. Medicalization veils class aims behind the value-free language of science. The patient becomes the subject of medical 'care' in which she learns to take as much an interest as does her physician and the medical and scientific academies, hospitals and asylums that guarantee biopower. In the present case, that is, she takes

the eye-training stereoscope and cards home and attempts to normalize herself through what she is led to understand is 'self-improvement.'

Peter Brownlee (2008, 2019) has demonstrated that the care of the eyes was promoted as part of a 19th-century American discourse on self care and self improvement. Under the influence of Crary, he understands eye care to be required by new social conditions and to be a generalized manifestation of biopower. In the case of stereoscopic eye-training, medical professionals were divided on its value (Lang 2008, 93). Indeed, by the 1920s, according to Roper-Hall (2002, 261), 'enthusiasm for fusion training with various stereoscopes had waned, mainly due to its time-consuming nature and unpredictable outcome.' It was not economically viable for ophthalmologists to spend the long hours with their patients supervising eye-training exercises, and they were unable to motivate people to keep up the exercises on their own at home. There was, and still is, no evidence to suggest that home-based eye-training was effective (Wells 1940; Helveston 2005). The aim of eye training may have been a Foucauldian 'autonomization' of power, or self-discipline, but its success was doubtful. As is often the case with medicalization, the claims of its proponents – and here I mean Javal and his followers in the Stereophthalmic Department – cannot be taken at face value as somehow founded on medical science rather than on ideological anxieties or purely economic interests.

The economic bet that Keystone made in the 1930s was that they could solve the problem of patient compliance or at least offer a system that would persuade ophthalmologists and optometrists that this problem could be solved. Keystone (1937) assures us that each of its new editions of the eye training system 'includes the latest findings from the Keystone Bureau of Research.' However, the researchers who worked for that department were not eye specialists but rather industrial engineers.[1] Reuel A. Sherman, Director of the Stereophthalmic Department in the 1930s and the man with the strongest claim to ophthalmological expertise, had no medical credentials, having dropped out of university after a year and joined Keystone as a stereoview salesman ('Keystone' 1938, 18; 'Pioneer' 1985, 25). It was a marketing imperative that drove Keystone's medicalization project.

This case study of therapeutic stereography challenges some of the theoretical assumptions of Crary and 'control' theorists (Roberts 2014) more generally regarding the enlistment of optical new media in projects of domination. First, I draw attention to the possibility that projects of domination can fail. Second, I resist a kind of 'paradigm blindness' that sees only homogeneous power effects within rigidly-conceived Foucauldian 'epistemes' (see also Plunkett 2013; Schröter 2014; Bantjes 2015). By reintroducing a sensitivity to social class, I aim to show how power and its effects are differentiated within historical periods. Stereoscopy was meant to have very different meanings and social effects for Tom and Louisa than for Wells' chauffeur. Tom and Louisa's interaction with new media will give them agency and epistemic superiority. The chauffeur is meant to be a docile body. They are free to join the ranks of professionals who administer docile bodies. Class-specific domination has been a constant throughout the history of optical new media. In ignoring it, both Crary and Foucault undertheorize resistance generally.

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[1] Patents that were registered to the Keystone View Company in this period all dealt with eye training which seems to indicate that the Bureau of Research was not distinct from the Stereophthalmic Department. The inventors whose credentials can be traced have engineering, not medical expertise.

My focus in the next section will be on a form of resistance to ocular normalization that operates within and against the grain of eye-training stereoscopy.

III – The Covert Modernist Aesthetic

The Keystone Bureau of Research appears to have been staffed by people who genuinely loved 3D and were having fun dreaming up stereoscopic spaces that were challenging to the eyes and stimulating to the imagination. Some of their creative impulses had the same subversive qualities of works of avant-garde modern art of the 1920s and 30s. They were as much interested in the pleasure of seeing as in therapy. As evidence of this claim I point to the aesthetic excess within and across the images, well beyond any diagnostic and therapeutic requirements. As evidence that the work operates against the grain of ocular normalization I show what radical departures many of the images are from 'normalized' spatial representation. Some of those departures draw on modernist experiments in abstraction in painting and photography of the same period. Some are pure explorations of the space-making character of stereoscopy that has its roots in the tradition of rational recreation and in the creative stereoviews of Dubosq and Claude-Marie Ferrier (Bantjes 2018)
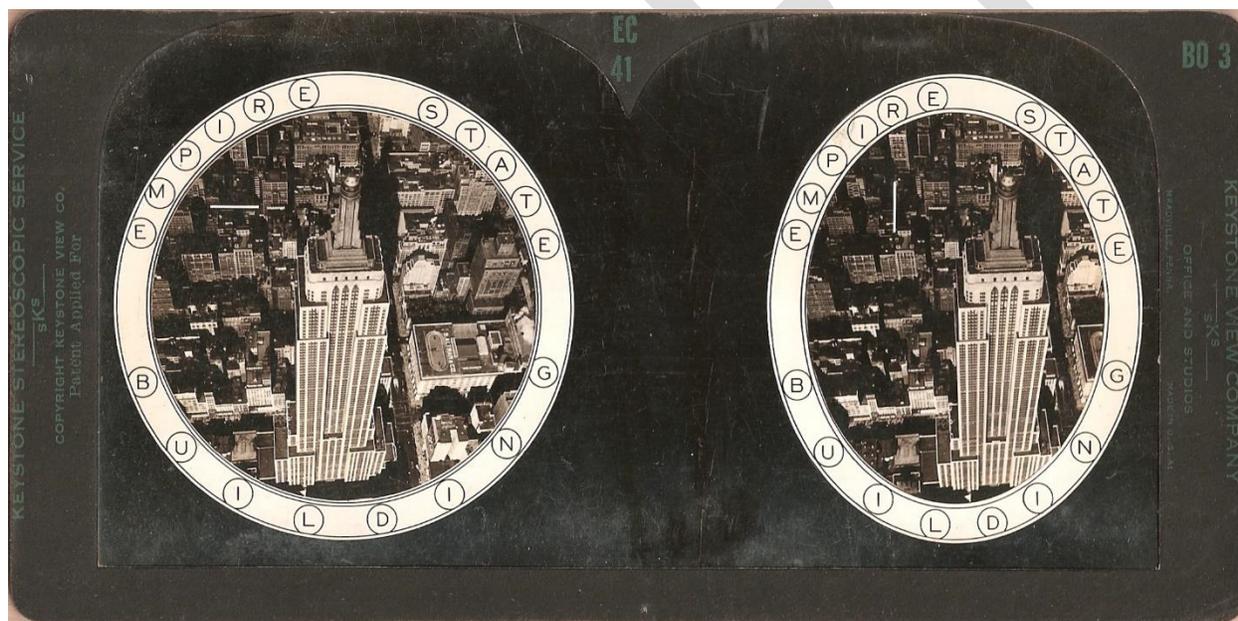

Figure 18 – Keystone, c. 1940, EC-41, *Empire State Building*, Gelatin silver print.

The *Empire State Building* (figure 18) is a bold statement of two representational heresies. Throughout the 19th century the reigning convention in both painting and photography was to keep architectural subjects firmly on the ground and level to the horizon so that vertical lines always remained parallel (Bantjes 2014). Where cameras had to tilt upwards to capture the full extent of tall structures, techniques of 'perspective control' were employed to twist converging parallel lines back into parallel. This convention continued to apply to commercial photography through the first half of the 20th century. Only the Cubist- and Constructivist-inspired avant-garde, including László Moholy-Nagy, Edward Steichen and Berenice Abbott, began experimenting with dramatic off-horizontal angles, mostly in the 1930s. Their example would have been very fresh by the time this image was taken, circa 1940. This stunning off-world take

would have been doubly astonishing since so few would yet have had the experience of air travel.

The more revolutionary heresy is what the image does to the picture frame and to the very idea of 'a picture.' It is stereoscopically angled so that there is a vertiginous drop *downward* between the right and left edges of the frame. To get 'into the picture' and feel its space as the eye-training guide recommends, it feels like you have to fall twenty stories and then enter the radically tilted frame from the side. The letters of the words 'Empire State Building' are embedded in the frame as though they were billiard balls rolling in a channel. As the eyes follow the circle it twists and bends and the 'balls' seem to shift around concertina-like within it. This dynamic structure would be incapable of supporting a glass or any planar surface, so we are not presented with some novel picture plane at a 45-degree angle. The viewer is dropped into a disorienting parody of conventions of representation. Two things are clear: while palpably spatial this is not 'real,' and this is not 'normal.'

Many of the stereoviews are arenas in which representational conventions collide. Some, like Javal's (figure 7) combining text, symbol and image suspended off the page, are like Dadaist poetry. Others share an affinity with post-Dada photomontage, whose 'nonlinear structure and multiple speech-forms,' according to Roberts (2010, 187) 'become a kind of template of urban and modern discontinuity, contingency and fracturedness.' They also offer a kind of localized intertext, where the representational meanings of each element are 'commented upon' by the others and subtly transformed so that there is no central, homogeneous meaning. This destabilization of meaning is evident in the *Empire State Building* as well as *Boulder Dam*. Is this (figure 19) a contest between the stereo-photographer and the graphic artist to see who can more powerfully evoke space? (The graphic artist wins.) Is it a sober lesson in geography? If so, why is it undermined by the spatial antics of the letters that can't seem to settle down or adhere to the representational surfaces of their labels? These playful details are rarely commented upon in the guide booklets and not recorded in the therapeutic progress sheets.
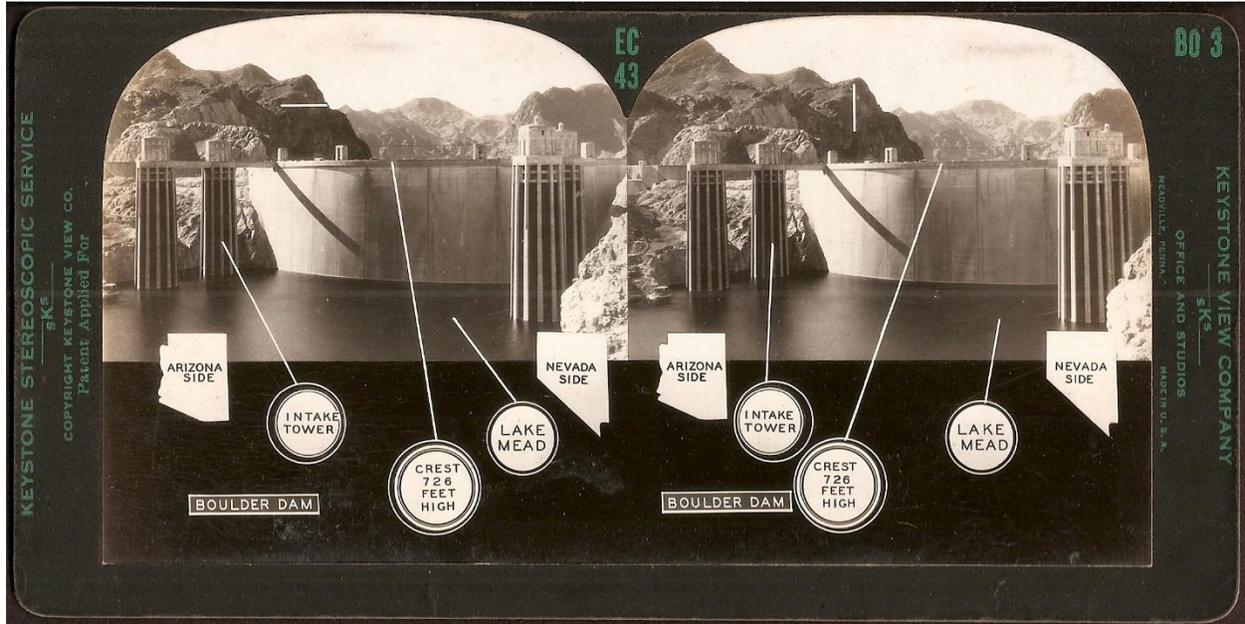
Figure 19 –Keystone, c. 1940, EC-43, *Boulder Dam*, Gelatin silver print.

Always at issue in these representational mashups is the homogeneity of space. Jump-fusion stereoviews are the most challenging in this regard. They assert incommensurate spaces that are made to 'comment' upon one another and interact in impossible ways that can never be reconciled into any one, homogeneous spatial illusion. Consider again the *Sensitive Plant* (Figure 2). First, the text makes a temporal claim in a form of 'concrete poetry' about how the sensitive plant responds when touched. The words 'folds its leaves' in the second (lower) state are folded in space. The letters of the words 'when touched' lead the eyes inward from the tip of the protruding bud down to the level of the circular frame. We are being led both by the meaning and the representational artefacts of language to reach out and touch. Language makes its own space here irrespective of any surface or frame.

Frame violations, where some object or part of the scene reaches out into the viewer's side of the frame, are common tropes in Keystone therapeutic views. In their standard boxed sets of 'tours of the world' Keystone respects the representational convention that picture-space opens up only behind the picture frame. Here the artists carefully manage overlaps so that the sensitive plants reach not only 'upwards' but outwards, well beyond the frames' perimeters. The result is that each state of the plant occupies an origin space (behind its circle) and a common space simultaneously. The common space pulls the lower frame well forward of the upper. As a consequence, the space that it contains and the plant within it shrinks relative to the upper – this despite the fact that the two plants are identical in size on the flat photographic card. The two origin spaces, one shrunken and brought in front of the other, are completely incoherent. The fact that they are continuous with the common space produces a fully non-homogeneous space. While the common space initially reads as the shiny black photographic ground, the makers have contrived to place the upper frames behind that surface, and the lower frames well in front of that surface. Which photograph of the plant is then in the photograph and which is outside it? And

when it stands outside photographic space, what is the relationship between this non-photographic space and the multiple spaces within the view? Here again the artists are posing the question of what it means to be a picture or what it means for a representational medium to represent.

Figure 20 – Keystone, c. 1940, AN-39, *Jump-Fusion*, Gelatin silver print.

Other jump-fusion stereoviews link square frames to make common incoherent geometric figures (see figure 20). These photomontages destabilize our conception of space in the same way that cubist collages do, except here the incommensurate fragments blossom into full spatial plausibility even as their spatial claims are called into question by other fragments. Keystone calls these 'jump fusion' exercises because our eyes are meant to leap from one spatial construction to the other. In a flash we make space one way and then jump to another, fracturing the first in the process. The user here is enjoined to make space in different ways from the same representational artefact.

Keystone often chooses photographic compositions that combine extreme foreground objects and depths in order to provide the maximum exercise for the eyes. To these they often overlay alphanumeric 'stations' that extend the depth well beyond the photographic (see figures 11, 19, 21) and can also be used to prescribe different paths through the hybrid space. In the case of *The Nation's Capitol*, reading provides a path through space. In a rare invitation to creativity, the guide booklet asks viewers to make up their own word combinations from the surrounding letters (Keystone 1940, 7). In 'writing' words this way their eyes will criss-cross space and 'draw' geometric figures. Gavin Adams, in a recent paper in which he thinks about these cards in relation to the art of Marcel Duchamp, cannot resist the impulse to depict the implied figures, to 'amend' and re-frame the Keystone views as his own Duchampian ready-mades (Figure 22). I will venture that Adams' is better than Duchamp's stereoscopic ready-made, *Stéréoscopie a la Main*.
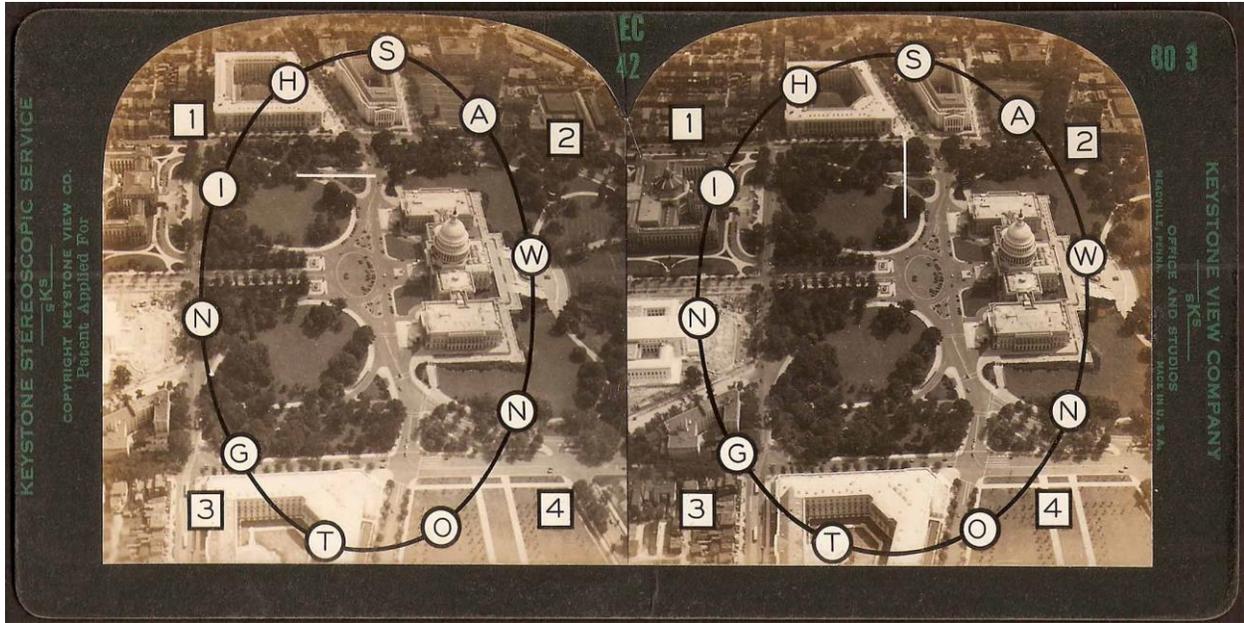
Figure 21 – Keystone, c. 1940, EC-42, *The Nation's Capitol*, Gelatin silver print.
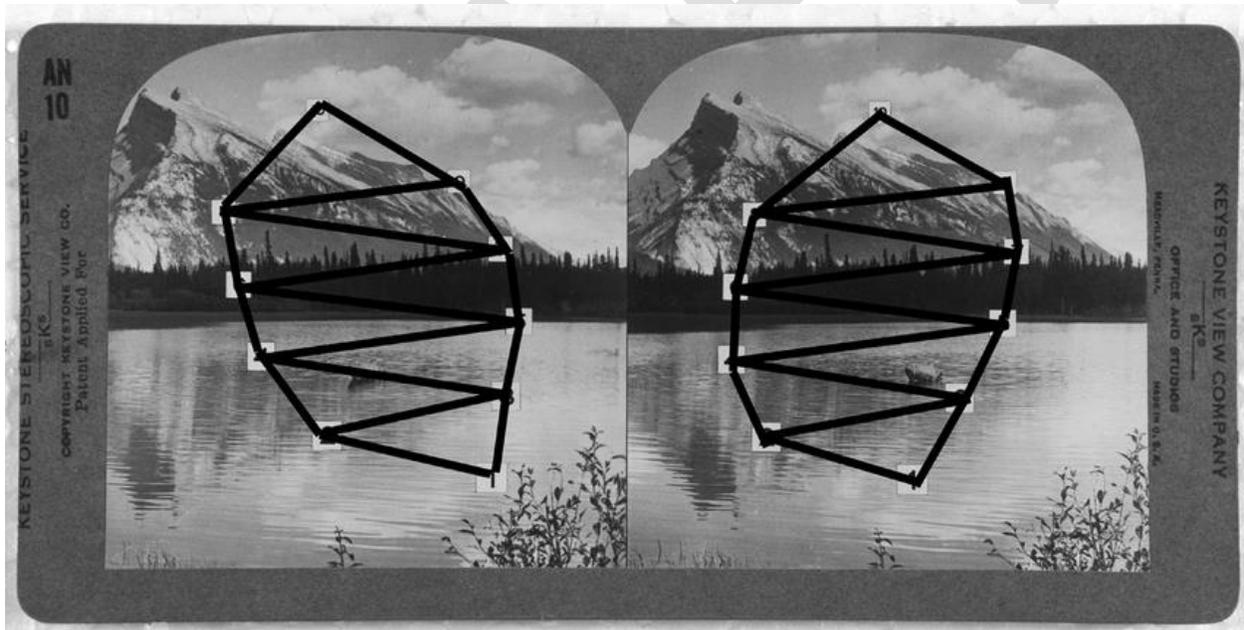

Figure 22 – Gavin Adams (2015), Rectified Keystone Card.

In figures 23 and 24 I have reproduced two of a series of four views that are the start to the 'Beta' series. The series of four progresses from a 'normal' stereoscopic rendering, where the two cameras are spaced as far apart as the human eyes, to an extreme 'hyperstereo' where the cameras are placed perhaps a metre apart. In using hyperstereo, the makers are flouting another naturalistic convention, like the parallel verticals, that was hotly debated in the 19th century (Bantjes 2016). Here they do something even more interesting which is to ask the viewer to stack the cards in the viewing clip and view them successively to watch as the structure of space changes. The effect is similar to what one would see through a telestereoscope as the viewing

mirrors gradually move apart. The operation produces a visual paradox: fixed distances seem to lengthen and the spatial separation between objects intensifies more than their distance apart would merit. It is as though objects do not move away from one another, but their volumes intensify, and more intervening space accumulates between them. The manual measures the viewer's 'progress' by how well they can construct not 'normal' space, but rather these more challenging hyperspaces. This progression of images is perhaps the clearest of the Keystone artists' covert challenges to the overall disciplinary project – to the expectation that, for the railway engineer, there was a single standard for the construction of space.

Figure 23 – Keystone, 1937, EC-101, Gelatin silver print.

Figure 24 – Keystone, 1937, EC-102, Gelatin silver print.

These cards are also inscribed with numeric stations at widely varying depths, and the prescribed exercises demand long jumps between them, forward and back into the scene. In the extreme hyperstereo version it is impossible to make these jumps without actually seeing the other numbered cards and the rest of the scene split apart and double. The exercise brings into view the incoherence of the binocular spatial field. The booklets occasionally draw attention to this doubling and flag it as normal. In other words, fusion is only ever partial and breaks down at some difficult to determine limit beyond the horopter. Doubling is an everyday feature of natural vision that had intrigued theorists of perception since the 18th century (Bantjes 2015). The very fact that we 'normally' suppress awareness of it tells us a great deal about the mental legerdemain involved in perception. Indeed, the question of why anything at all coheres across the horopter is one that led Wheatstone to his important discoveries.

How can we explain this blossoming of invention and playful meta-critique within a firm up until this time known for its sober realism? We can identify a probable author for some of these experiments. Keystone photographer George (Georkee) Lewis majored in art at university, was a gifted draughtsman, and as some of his known photographs and the letters he sent to his sister when on assignment in Europe attest, someone with a playful and irreverent eye (Lewis 1983; Stebbing 2018). Company president, B. L. Singley, valued Lewis's creativity enough to defend his autonomy against Keystone's perhaps aptly named 'negative committee.' Lewis's encounter with modernism might have come from many sources: his European tour; his friendship with Carl Sandburg; his contact with the innovative aerial photographer Sherman Fairchild. Sandburg no doubt introduced him to the photographic work of his brother-in-law, Edward Steichen, and may have communicated to Lewis his conviction that the genius of an artist in a commercial setting could flourish just as easily as that of Michelangelo under his wealthy patrons (Lears 1994, 340). Steichen's and Fairchild's photographs of skyscrapers taken with dramatic off-horizontal tilts are both now in the collection of the Museum of Modern Art. Lewis's, arguably more radically modernist *Empire State Building* perhaps should be alongside them were it not for the low-brow stigma of the stereoscopic format and the obscure circulation of eye-training views.

The institutional motivation for Keystone to tolerate the unconventional was an economic gamble. Faced with declining sales and competition from the more imaginative, narrative medium of cinema in the1930s, Keystone was casting about for new markets. The therapeutic line offered more reliable sales, tied as it was to the authority of physicians to 'prescribe' it. Singley may have become convinced that reintroducing what Du Bois-Reymond had called the spirit of 'game-playing' to stereoscopy might solve the problem of patient compliance and lure ophthalmologists, along with their patients, back to the stereoscope. There may have been a further hope that by training the fusion capabilities of the population, they were training a renewed passion for 3D. Given what I have demonstrated about the spatial inventiveness of these stereoviews I think it is plausible to imagine Singley giving Lewis a free hand to be playful, and to showcase the particularly stereoscopic delights that makes those who can fully appreciate them almost fanatical about the medium.

IV – Discussion and Conclusion

Throughout the previous section I have flagged the covert ways in which eye-training stereoviews challenged realist assumptions about representation and 'normal' perception. The overarching theme is that the representational artefact is not a passive 'copy' of the real that can be seen correctly only one way; but is rather an active and sometimes arbitrary construction first of the person who makes the artefact, and second, of the viewer who works to re-construct its spatial meanings, and who may do so in more than one way. I have shown how two longstanding conventions of visual representation were explicitly overturned. The first was that we depict the architectural world with a level horizon and suppress upward-converging verticals (e.g. figure 18). The second was that a picture is a representational surface and that picture-space opens out behind that surface (Greenberg 1940, 34) (e.g. figures 2, 4, 20). The idea that there are multiple ways of constructing an external 'real' space is best exemplified by the hyperstereo sequence that highlights an elasticity in the Z-axis of perceptual space. The textual elements of therapeutic stereoviews imply that space can be both 'written' and 'read' in creative ways. The idea that there are multiple ways to read space is further demonstrated in stereoviews in which incommensurate spaces are placed in incoherent continuity with one another (e.g. figures 2, 20)

Realism has also been understood in terms of what Theodore Adorno calls the 'occultation of production' (Crary 1992, 132). What he means is that a version of the real is manufactured, often in a way that suits particular class interests, but that the traces of that manufacture are carefully effaced from the representational artefact so that it can masquerade as an expression of universal, objective truth. In their world tours, Keystone sought to induce in the viewer this sort of uncritical immersion in the representation, and for her to 'lose all consciousness of [her] immediate bodily surroundings and to gain …a distinct state of consciousness or experience of the location in the place represented.' (Holmes 1935, 4) The representational artefact and the mechanics of representation vanish in this waking dream-state. The first stereoviews, made in the spirit of rational recreation, turned attention back upon the representational artefact in order to make people think, and to ask questions that would lead them to the science of perception and the engineering of optical mediations.

The eye-training stereoview systems were designed to reveal the mechanisms of spatial perception and the secrets of stereoscopic illusion only to the experts and to leave patients in the dark. However, covert features of the system, including the very premise that people had to be trained to construct space stereoscopically, worked against this design. Attention was drawn persistently back to constructedness and the acts of construction. This kind of reflexivity, a turning back towards the medium of depiction and what it means to depict, was a feature of modern art of the early 20th century (Greenberg). Stephen Bann (1980) calls this turn 'meta-linguistic' as though depiction were a language. Victor Stoichita (1997) uses the term 'meta-pictorial.' Of the many devices of meta-pictorial art, Stoichita is particularly interested in frames within frames – a scene within a scene framed by an archway, a curtain, its rail painted as though above the painted surface. 'All picture frames', he writes (55), 'establish the identity of the fiction. To give a painting a painted frame, in addition to its actual frame, indicates that the fiction has been raised by the power of 2.' The multiple frames in a view like *The Sensitive Plant*, those that I have pointed out plus the arched frames of the photo and the ever-present

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frame of the card-holder and stereoscope eye-pieces, raise awareness of the fiction to the power of 3.

Crary finds stereoviews dull and uninspiring and represents the act of viewing them in sequence as deskilled assembly-line work: 'each time, the mass-produced and monotonous cards are transubstantiated into a compulsory and seductive vision of the "real."' (132) This assessment, indeed, his entire analysis applies to the Keystone tours of the world, but not to the remarkable modernist experiments that I have showcased here. Nor does it apply to the brain teasers that were made for 19th-century rational recreation. The impulse to rationalize, deskill and minutely control human behaviour has been a constant in capitalist societies; however, its logic of application has not been uniform. The profit imperative consistently favoured Taylorization for industrial and clerical labour. That has included the rationalization of vision and attention as well as attempts to normalize spatial perception in conformity with the realist model. But perfect binocular depth perception is not essential for most occupations. In cases where it was –piloting fast-moving machines by eye for example – it was more 'efficient' to select those with natural abilities rather than train the deficient. In fact, at the onset of WWII, Keystone shifted to producing binocular acuity tests for pilots and anti-aircraft rangefinders.

The dull, artificial spatial realism that Crary laments was never universally required by the capitalist social formations of the 19th or early 20th centuries. It was useful for certain occupations and as a 'naturalizing' strategy for ideological narratives (Bantjes 2021). But its opposite – an aesthetic meta-critique – has always been co-present with it. Taste for modernism has been a marker of cultural capital that sets apart that class of people who are immune from Taylorist work-discipline and are free to think, critique, create and innovate. This is an important class difference. While we should be sceptical about how socially revolutionary the modernist impulse was, there is something potentially subversive whenever any privilege normally reserved for the elites, such as this capacity for meta-critique of visual culture, is offered to their subordinates.

The fact that Lewis, or perhaps other frustrated artists in the Stereophthalmic Department, embedded commentary on the art-house potential of stereoviews in medical training kits tells us something about resistance to disciplinary projects of dull conformity. However, the training kits that I acquired for this research tell a story of double failure. The enclosed progress reports show that no-one completed even the first set of exercises, never mind the prescribed repetitions. They tire of the dreary discipline. Equally uninspired by modernist brilliance, they return the stereoscope, cards and instruction booklets to their boxes and leave them in the attic for 80 years until their descendants put them up for sale on eBay. The happy collector acquires for next to nothing a pristine set of period experiments in stereoscopic innovation that *do* help us reflect on our space-making capabilities, and (perhaps I should take responsibility for re-presenting them here as ready-mades) introduce us to astonishing and beautiful new ways of seeing.

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