THE XOGRAPH®: AN INVESTIGATION OF PARALLAX PANORAMAGRAMS AND EARLIER AUTOSTEREOSCOPIC METHODS

by

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ABSTRACT

The Xograph®: An Investigation of Parallax Panoramagrams and Earlier Autostereoscopic Techniques
Master of Arts, 2014
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Introduced by Cowles Communications and Visual Panographics in 1964, the xograph® or parallax panoramagram, was the first lenticular, autostereoscopic, photomechanical object created for the mass media. Publications such as *LOOK* magazine and *Venture: A Traveler's Guide* frequently distributed xographs® during the 1960s and 1970s, after which time, the xograph® began to disappear from mass publications.

The thesis provides a detailed account of the history of three-dimensional photographic techniques and places the xograph® within this history. It addresses the contributions and collaboration of Arthur Rothstein, Marvin Whatmore, Visual Panographics and Cowles Communications in the creation, production and dissemination of xographs®. The thesis then describes xograph® production process and the results of an electron microscopic analysis of an xograph® made to determine its physical properties . The conclusion offers suggestions for preservation guidelines for these fascinating objects.

ACKNOWLEDGEMENTS

This project would not have been possible without so many wonderful people and institutions.

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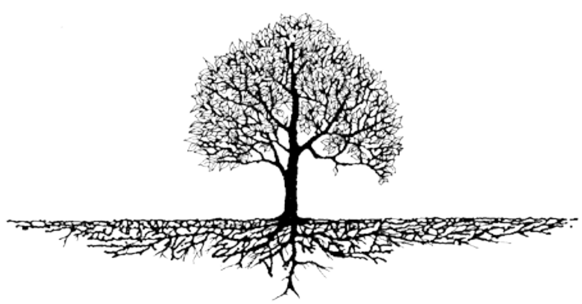
It is with deep and sincere gratitude that I thank my family and friends for their ongoing support through my academic adventure. Thank you to my parents, Fred, Nina, Alex, Momba, Chris, Quinn, the Ograms, and the Schembris. Your patience, confidence, and encouragement through this past year made this final project possible.

DEDICATION

"Photography came along to memorialize, to restate symbolically, the imperiled continuity and vanishing extendedness of family life."

- Susan Sontag, *On Photography*



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CHAPTER I: INTRODUCTION

Two peculiar photographic objects from a private collection came to my attention in October 2013. They were ridged, plastic photographs that when shifted slightly in the hand, gave the illusion of three-dimensional space and depth within the image. On the verso of these objects was the term "xograph®." Although I have seen three-dimensional images in a variety of forms, I was unfamiliar with this particular type of three-dimensional photograph, which produced such a subtle effect. Through preliminary research, I discovered how little has been written about the xograph®, its technical name being "parallax panoramagram." These objects are most commonly seen in the form of three-dimensional baseball cards and as the covers of popular magazines, such as *Elle* and *Venture*, from the late 1960s through the mid-1970s.

Xographs® were introduced to the public on 25 February 1964 by *LOOK* magazine, a publication produced by Cowles Communications Ltd.[1] The xographs,® commercially produced photomechanical objects, create the illusion of three-dimensional space in vivid colour on a plastic substrate with a linear textured surface. As the object does not require the use of optical eyewear or viewing device, it is classified as "autostereoscopic." The technology evolved from earlier stereoscopic experiments conducted by Frederic E. Ives first recorded in 1903,[2] and later improved by the work of his son, Herbert E. Ives.[3]

Interestingly, it is Frederic E. Ives who is credited with the invention of the halftone process, which allows for the simple reproduction of photographic images with

[1] Roland Edgar Wolseley, *Understanding Magazines* (Ames: Iowa State University Press, 1966), 247.
[2] F. E. Ives, Parallax Stereogram and Process of Making Same. US Patent 725567 A, filed September 25, 1902, and issued April 14, 1903.
[3] H. E. Ives, "Parallax Panoramagram Made With A Large Diameter Lens, " *Jor. Opt. Soc. Am.* 20 (1930): 333.

text for mass production through the process of lithography.[4] Prior to the halftone process, photographs and advertisements could not be combined with information and text successfully.

Autostereoscopic photography was not a new invention; however, prior to *LOOK* magazine's inclusion of an xograph®, the technology was always produced in very small quantities. From the explosion of the halftone process in the 1880's until *LOOK*'s 25 February 1964 number, mass publications and printing techniques that produced photographic material existed in a two-dimensional format. The February xograph® distributed in *LOOK* was the first autostereoscopic image that was successfully produced in the millions. Eight million identical xographs® were produced for the general public, exposing the three-dimensional photographic method to an audience much larger than had seen any previous autostereoscopic methods, and to the home of the ordinary consumer.[5]

Because this was the first autostereoscopic photograph available for individuals to possess, store, and collect, these objects need to be revisited. Collectors and researchers of the publications containing xographs® should be able to find more information on these three-dimensional objects, yet, little exists, and what does is largely inaccessible.

This thesis study was conducted to discover what this photomechanical process was, where it came from, and why it was so short-lived in the market of commercial printing. In addition, it is my hope that this thesis will aid institutions to identify xographs®, or, otherwise known as parallax panoramagrams, for easier research access in the future. There are currently no preservation recommendations for lenticular material

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[4] Mary Warner Marien, *Photography: A Cultural History*, 3rd ed. (London: Laurence King, 2010), 522.
[5] Arthur Rothstein, *Photojournalism: Pictures for Magazines and Newspaper*, 2nd ed. (New York: American Photographic Book Publishing, 1965), 202.

such as baseball cards or magazines featuring this three-dimensional image technique, no guides to proper storage and housing solutions for them. Due to the specific materiality and viewing requirements of these objects, tailored preservation recommendations could be beneficial for collectors, researchers, and institutions alike.

CHAPTER II: EARLIER THREE-DIMENSIONAL PHOTOGRAPHIC PROCESSES

The desire to produce a three-dimensional effect on a two-dimensional surface was evident in the very early days of photography. Stereographic daguerreotypes were produced and viewed through a stereoscope. Three-dimensionality was attempted and experimented with from the mid-eighteen hundreds through many methods and techniques leading up to the xograph®. This progression of three-dimensional photographic processes is important to understand how the xograph® came to be.

i. Stereography

The invention of stereographic viewing existed prior to the invention of photography, and then facilitated in early forms of photography such as daguerreotypes. It wasn't until the 1850s that publishing companies mass-produced the stereograph in the millions for consumers to collect and enjoy, and it remained popular into the 20th century. The possibility of mass production in the millions was made available with improvements of both camera technology and paper printing techniques.

The mass-produced stereographs were two seemingly identical photographs placed side by side on a card. The photographs were created using a camera that had side-by-side lenses to mimic the binocular viewing of a right and left eye. Thus, only a miniscule shift in position existed between the right and left exposures. Once printed, the images were placed on card for rigid support.

Stereographs required additional viewing equipment called a stereoscope for the three-dimensional illusion to be successful. A stereoscope could be handheld or function as a tabletop device. The stereo card was placed in the stereoscope, and the viewer looked through the eyepiece as the two images combined and produced the illusion of depth and three-dimensionality.[6]

However, this technology was not autostereoscopic, as it required an additional apparatus, the stereoscope, for the viewer to achieve the three dimensional effect.

[6] Marien, *Photography*, 80-81.

fig. 1: Cooley, Sam A. *Hospital no. 7, Beaufort, S.C., during Civil War.* c. 1861 – 1865. Library of Congress, Washington, D.C. Accessed May 3, 2014. 8.5 x 17.4 cm.

fig. 2: Holmes Stereoscope with a folding handle. George Eastman House: International Museum of Photography and Film, Rochester, New York.

ii. Frederic E. Ives (1856 – 1937) and the Parallax Stereogram

Frederic E. Ives was an American inventor who specialized in optical science and photographic innovation.[7] Among a number of his inventions, was the halftone process, which allowed for the simple reproduction of photographic images with text in print through the printing process of lithography.[8]

Ives' interest in three-dimensional photography was first noted with his invention known as the Kromskop, patented in 1894. The Kromskop was a tabletop-viewing device in which stereoscopic images could be viewed. His interest in three-dimensional photography expanded with his patent of the parallax stereogram, for which he received United States patents in 1903 and 1904.[9] Frederic E. Ives was awarded a medal for his innovative parallax stereogram after its debut at the 1902 by the Royal Photographic Society in England.[10] The technology was inspired through his work on the halftone screen and his study of dioptrics.[11] Frederic E. Ives wanted to produce a photograph that required no additional viewing apparatus to produce the illusion of the third dimension, and he referred to this method as "pseudoscopic" rather than "stereoscopic," meaning it produced the illusion of the third dimension without the necessity of optical eyewear or additional apparatus like that required for stereographs.[12]

The parallax stereogram required an in-screen camera, much like the later parallax panoramagram. The lenticular screen was placed carefully in front of a sensitized plate but without physical contact within the camera.[13] The use of a large diameter lens in the

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[7] Louis Walton Sipley, *A Half Century of Color* (New York: Macmillan Company, 1951), 193.
[8] Marien, *Photography*, 522.
[9] Sipley, *A Half Century of Color*, 193.
[10] Frederic E. Ives, "The Brigand," 1903.
[11] Ibid.
[12] F. E. Ives, Parallax Stereogram and Process of Making Same.
[13] Sipley, *A Half Century of Color*, 193.

camera was critical to the final product. Two small apertures were placed within the camera at the same distance as the pupil of a human's left and right eye. When the image was exposed and captured, the lenticular screen within the camera produced two images on a single negative: one from the left aperture, and one from the right. The screen placed within the camera was ridged, which, when the aperture opened, only permitted the exposure of one "eye"/lens on the plate, where the other "eye"/lens was shaded due to the angle of the lenticules of the interior screen. When the other aperture was exposed, the first was shaded, preventing over-exposure and interlacing the linear segments of the right and left aperture. A component to the process was appropriated for the later parallax panoramagram.[14]

When the parallax stereogram was processed, it was printed as a positive and then placed onto a glass support. A glass screen was added to the surface with opaque vertical lines that perfectly aligned with those on the glass photograph below. When held at the optimal distance (which, according to Ives, was approximately the focal length of the lens), the viewer's right and left eyes would see the vertical fragments of the image produced by its correlating aperture within the camera. Therefore, the right eye would see only the portion of the photograph produced by the right aperture, and the left eye would only see the portion of the photograph produced by the left aperture. With this perfect alignment and viewing distance, a three-dimensional effect was achieved with the naked eye.[15]

The George Eastman House holds three very early examples autostereoscopic photographs created by Frederic E. Ives, including one titled "The Brigand." The

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[14] Herbert E. Ives, "Parallax Panoramagram Made With A Large Diameter Lens," *Jor. Opt. Soc. Am.* 20 (1930).
[15] Sipley, *A Half Century of Color*, 193-195.

photograph is contained within a wooden frame to secure the two glass photographs and lenticular screen together in proper registration. Adhered to the bottom-centre of the frame, a small, typed label reads "Parallax Stereogram, patented April 14, 1903. Made by Ives Co., […] N.Y."

For a viewer to experience the desired three-dimensional effect, the parallax stereogram required a perfected alignment with the viewer's sightline, and had to be viewed at a close distance.[16] On "The Brigand"'s label is inscribed, "To obtain solid, life-like effect, hold in both hands at arm's length towards a window, or near-by artificial light, and with center opposite to eyes. Position is correct when only a single solid object is seen in bold relief. May be hung in a window and viewed as above."[17] Thus, Frederic E. Ives' parallax stereograms required backlighting for the image to be visible.

[16] Sipley, *A Half Century of Color*, 193-194.
[17] Frederic E. Ives, label, "The Brigand," George Eastman House: International Museum of Photography and Film, Rochester, New York. 1903.

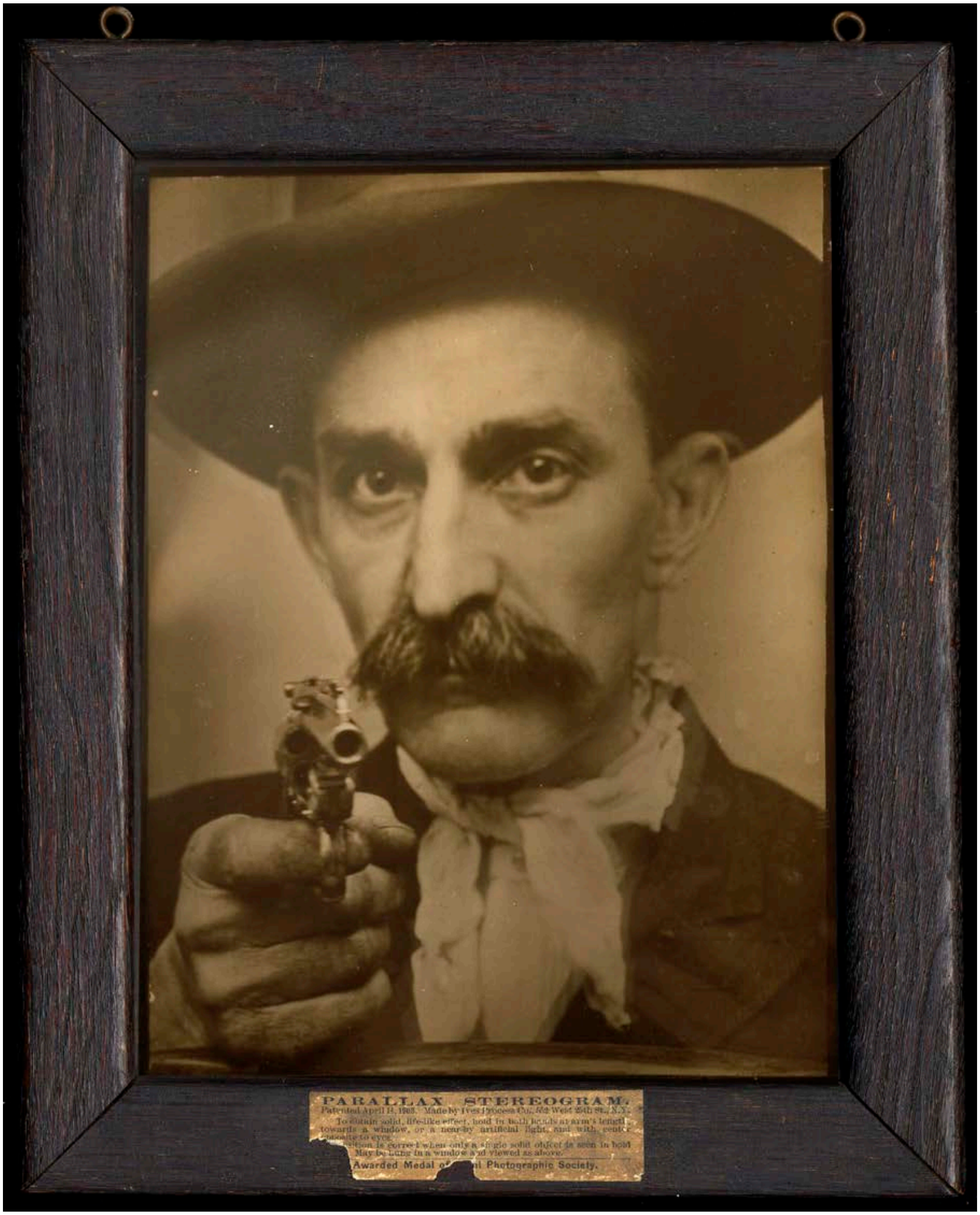

fig. 3: Ives, Frederic E. *The Brigand*. c. 1902. George Eastman House: International Museum of Photography and Film. 25.2 x 20.2 cm.

Ives foresaw the commercial potential for autostereoscopic photography. In 1901, he was quoted saying "there is nothing to prevent the production of these pictures in such large sizes that at the proper viewing distance the lines cannot be separately perceived, and in such large sizes they would prove interesting, and might have some vogue as window transparencies."[18] This is precisely the niche that companies such as VitaVision and Depth-O-Graph would fill in the world of advertising photography, which are discussed later.

iii. Herbert E. Ives (July 21, 1882 – November 13, 1953)

Herbert E. Ives was the equally innovative son of Frederic E. Ives and shared his father's passion for three-dimensional image making and experimentation.

Ives mostly expanded on the earlier work of his father, perfecting different lenticular screens. The younger Ives' also worked on producing a method to create parallax panoramagrams through projection for both still and moving images.[19]

Herbert E. Ives' lenticular object, *Vase*, housed at the George Eastman House: International Museum of Photography and Film, is cracked and fragile, but the legibility and effectiveness of the lenticular image is not affected. It is large, measuring to approximately 8x10 inches. Because it is a glass transparency, the object requires backlighting for optimal visibility, such as a light table or a window, like the earlier inventions of his father. On a hand-written label adhered to the glass surface signed

[18] Sipley, *A Half Century of Color*, 193.
[19] H. E. Ives, Making Stereoscopic Parallax Panoramagrams from Pseudoscopic Parallax Panoramagrams, US Patent 1,905,716, filed April 3, 1931, and issued April 25, 1933.

“H.E.I. October 16, 1930,” Herbert Ives wrote, “printed from large line negative by parall[ax] printing with linear light source giving print correctly seen through grating. ” [20]

fig. 4: Ives, Herbert E. *Vase*. October 16, 1930. George Eastman House: International Museum of Photography and Film. 30.5 x 25.4 cm.

[20] Herbert E. Ives, label ,“Vase,” October 16, 1930, George Eastman House: International Museum of Photography and Film, Rochester, New York.

iv. Depth-O-Graph (c.1931)

Ernest E. Draper built on the earlier technologies of Frederic and Herbert Ives, dispensing with the large-diameter lens with two apertures that was previously essential. Draper's camera was a modified view camera with a long-focus lens.[21] The camera was mounted to a base that rotated around a single anchor point directly across from the subject being photographed. The lens remained open while the camera arced approximately 11 degrees around the subject, exposure times lasted between 4 and 14 seconds, and were controlled by an electric motor for consistency. A lenticular screen inside the camera fragmented the composition before it reached the film.

[21] Sipley, *A Half Century of Color*, 196.

fig. 5: Depth-O-Graph transparency in lit viewer for advertising**.** ca. 1931. George Eastman House: International Museum of Photography and Film.

Depth-O-Graphs were typically recorded on glass transparencies, producing positive images. Although the Depth-O-Graph pre-dates the availability of large quantities of dye-coupler film, hand colouring was possible following development. Like the xograph®, the lens remained open while the camera arced around the subject to create a Depth-O-Graph.[22] The lens was left open to continuously recording multiple angles of the subject, which was critical for both the Depth-O-Graph and xograph® images and their unique and fluid legibility for the viewer.

According to Louis Sipley's *A Half-Century of Color*, Depth-O-Graphs were produced in both Canada and the United States. Fashioned to measure 11 x 14 inches, the objects were costly, fragile, and cumbersome to produce.[23]

Custom viewing apparatus was manufactured to add advertising text and physical protection to these objects. Companies would feature their logo or brand on the custom viewing apparatus and change the Depth-O-Graph insert to advertise campaigns and products. In 1988, the George Eastman House had an exhibition of advertising photography, sponsored by Eastman Kodak Company and the magazine *American Photographer*. Robert A. Sobieszek's accompanying catalogue, *The Art of Persuasion: A History of Advertising Photography*, featured a colour photograph of a metal stand, illuminated from within, with the text "PREVENT INFECTION" as part of the stand. This hand-coloured glass Depth-O-Graph showed a mother and child with a small bottle. Below the image, the product name is embossed, "MERCUROCHROME – AN H.W.S. & D. PRODUCT." [24] This type of stand allowed for interchangeable Depth-O-Graphs,

[22] Sipley, *A Half Century of Color*, 196.
[23] Ibid., 198.
[24] Robert A. Sobieszek, *The Art of Persuasion: A History of Advertising Photography* (New York: H.N. Abrams, Publishers, 1988), 78-79.

permitting companies to update their displayed advertising images while maintaining their brand.

Depth-O-Graphs were used for commercial purposes only and were not available to the general public to collect and enjoy.

v. VitaVision (1940's)

The VitaVision Corporation was founded in the late 1940's by Louis Walton Sipley, who at the time was the Director of the American Museum of Photography in Philadelphia.[25] The American company produced autostereoscopic three-dimensional images for commercial advertising as large as a store window, as well as portraiture commissioned by the public. The mass manufacture of dye-coupler films, as well as the innovations in the manufacturing of plastic largely contributed to the success of the VitaVision Corporation.

What made VitaVision unique was its innovative three-dimensional portrait studios located in large department stores through the United States, allowing general consumers to get an autostereoscopic three-dimensional portrait produced in their likeness. The locations included R.H. Macy & Co in New York, Maison Blanche in New Orleans, Carson, Pirie, Scott & Co. in Chicago and Lit Brothers Department store in Philadelphia.

The April 1948 number of *Popular Photography* announced that Lit Brothers in Philadelphia were equipped with a three-dimensional portrait studio available to the public. Sitters were given a variety of pricing and style options when having their VitaVision portrait produced. For those with a limited budget, a black and white

[25] Walter Fischmann, "Stereo Studio Opened in Philadelphia." *Popular Photography*. (April 1948), 190.

lenticular portrait with a clarity of 64 lines to the inch could be had for as little as $6.95. For $34.95, a sitter could receive a full colour Kodachrome transparency portrait (Ektachrome and Ansco Color Film were also used, but minimally).[26] Although VitaVision had market presence in both commercial and portrait photography, it was the latter that was the more successful venture for the corporation.[27]

VitaVision portraits were produced using a full-sized transparency that was exposed twice. Within the camera, a lenticular screen "containing two apertures spaced at the pupillary distance"[28] between the right and left eye was placed behind the lens. The image was exposed once through the aperture mimicking the left eye. The studio camera was anchored to the floor, around which the camera arced. After the first exposure, the studio camera arced around the subject 15 degrees around the anchor, and an exposure was captured through the aperture, which mimicked the view from the right eye.[29]

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[26] Sipley, *A Half Century of Color*, 198.
[27] Ibid.
[28] Sobieszek, *The Art of Persuasion*, 101.
[29] Ibid.

fig. 6: VitaVision, three-dimensional colour portrait, c. 1947. George Eastman House: International Museum of Photography and Film, Rochester, New York. 26 x 21.5 cm.

After proper development of the transparency, a hard, plastic lenticular screen was adhered to the surface, which registered perfectly with the screen distortion created during exposure. The improvements in plastic manufacturing by the 1940s made this type of object more affordable for both the manufacturer and consumer.[30] In addition to making VitaVision lenticular photographs more accessible financially, the transition from glass to plastic substrates made the objects more durable. The final product produced a convincing portrait with a three-dimensional effect, mimicking the subtle difference of view between the right eye and the left.[31] Because the image was produced on a transparency, the final product required backlighting, ideally hung in a window or in front of an artificial light source for optimal legibility.

The VitaVision portrait studios were short-lived. Louis Sipley, the designer for the Philadelphia studio in Lit Brothers Department store, referred to the process as a "nine-day wonder"[32] and claimed the process was not ideal for portraiture, as it did not allow for successful retouching.[33] Other companies attempted to copy VitaVision's commercial model and product, such as Trivision and Akravue (see below),[34] but were faced with the same retouching problem that VitaVision encountered. In addition because Akravue's photographs were produced on transparency film within the camera, it limited the production to singular objects, making reproduction inconvenient. The inability to

[30] Sipley, *A Half Century of Color*, 198.
[31] Fischmann, "Stereo Studio Opened in Philadelphia," 190.
[32] Sipley, *A Half Century of Color*, 205.
[33] Ibid.
[34] Sipley, *A Half Century of Color*, 195. Akravue's studio set up was quite different from that of VitaVision's. As opposed to having the camera rotate around the subject, the camera remained stationary, and the photographic studio was constructed to rotate around the anchored camera

reproduce the objects in print further limited the success of the autostereoscopic technologies of the 1940s.[35]

fig. 7: Photograph of the studio at Lit Brothers Department store in Philadelphia, Pennsylvania. c. 1947 - 1948. George Eastman House: International Museum of Photography and Film.

[35] Ibid.

vi. Akravue by Bond Displays (c. 1947)

The Philadelphia company Bond Displays further advanced three-dimensional lenticular imaging for commercial advertising that became known as Akravue. Established by Richard Bond and designed by Harold A. Backus, the Bond Displays' design was, according to Louis Sipley, the "most commercially practical service" for producing three-dimensional images.[36] As opposed to the Depth-O-Graph studio set up, the Akravue camera remained stationary during exposure, while a moving stage rotated around the camera while the aperture was open. The moving set was completed by a lighting kit, and ranged in size from one to twenty feet in length. The set arced on four corner wheels on a track mounted to the floor to permit consistent exposure, focal length, and speed during exposure.[37]

[36] Sipley, *A Half Century of Color*, 199.
[37] Ibid.

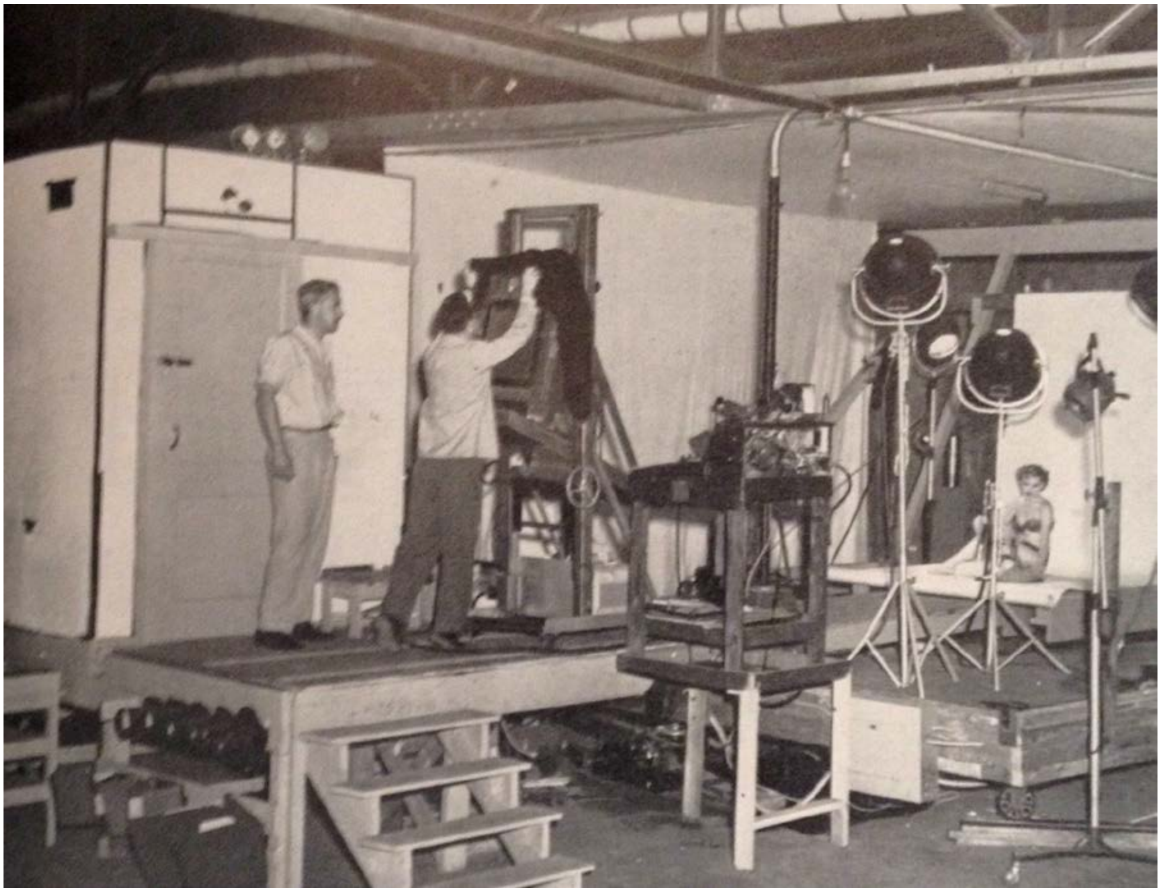

fig. 8: Akravue studio at Bond Displays. Stationary camera with rotating studio set. From Louis Sipley's _A Half Century of Color_, page 195.

Unlike Depth-O-Graphs or even VitaVision, Akravue never experimented with any lenticular substrate other than plastic. Akravue specialized in large-scale lenticular images for commercial purposes. Akravue produced colour transparencies using film brands such as Ektachrome, Ansco Colour, and DuPont Polymer. The plastic lenticular screen adhered to the image surface had 90 lines to the inch, a superior ratio than previous lenticular methods. Duplicates were more easily produced, and according to Sipley, were left as “the outstanding exponent” of three-dimensional imaging of the period. This was in part due to their superior laboratories, which were better suited to mass production and duplication of large transparencies for commercial advertising and use, as opposed to the facilities of Depth-O-Graph and VitaVision.[38]

[38] Sipley, *A Half Century of Color*, 204.

CHAPTER III: THE XOGRAPH®, ARTHUR ROTHSEIN, & COWLES COMMUNICATIONS

i. Arthur Rothstein (July 17, 1915 – November 11, 1985)

Arthur Rothstein was a well-known member of the FSA (Farm Security Administration), founded in 1935. Rothstein documented the hardships of the American people during the Great Depression of the 1930s. The FSA included such notable members as Dorothea Lange, Walker Evans and Marion Post-Wolcott, among others. Arthur Rothstein also authored a number of books on photographic topics, such as photojournalism, photographs for newspapers and magazines, and colour photography.[39]

Rothstein was the technical director of photography for *LOOK* from his initial hiring by Marvin Whatmore in 1950 to the magazine's final run in 1971. [40] Whatmore requested Rothstein specifically for the role of technical director of photography because of his long career in photojournalism and his interest in improving and expanding on photographic technologies in commercial printing.

As evident in his personal collection of photographic material housed at the Library of Congress, Rothstein had a vested interest in three-dimensional photography. Many of his experimental techniques, such as the integram, gained little success in the commercial market, but are impressive in both innovation and the success of the achieved three-dimensional effect.

[39] Arthur Rothstein, *Color Photography Now.* (New York: American Photographic Book Publishing, 1970).
[40] Anne Rothstein-Segan and Brodie Hefner, "Arthur Rothstein Archive," Arthur Rothstein Archive, Career, accessed May/June, 2014, http://arthurrothsteinarchive.com/.

ii. Arthur Rothstein & Cowles Communications

The American publishing company Cowles Communications Inc. published magazines as *LOOK*, and *Venture: A Traveler's Guide*. From 1949, Marvin Whatmore was the general manager of *LOOK* magazine[41] and was interested in bringing three-dimensional autostereoscopic technology to the world of mass printing. In 1950, Whatmore began to pursue his vision through resources made available by Cowles and more specifically the team at *LOOK* magazine.[42]

The publication was image-heavy and placed significance on the quality and uniqueness of the photographs it included.[43] Whatmore contacted Rothstein, a well-known photographer with an editorial approach and appreciation for mass publications, with hopes he could help introduce the third dimension to Cowles publication.

Whatmore's interest in advancing print photography, specifically colour, was well known. The introduction of three-dimensionality is what Whatmore envisioned as the next logical step in mass photomechanical reproduction. It took Whatmore's vision and Rothstein's expertise to perfect the balance between economic viability and visual quality for the xograph® to arrive on the market. Whatmore describes the xograph® as "a superior form of communication over color."[44]

Approximately thirteen years later, *LOOK* magazine produced eight million identical parallax panoramagrams for the general public to purchase and experience. Cowles Communications Inc. gave their small three-dimensional image the brand name

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41 Stewart Kranz, *Science & Technology in the Arts: A Tour through the Realm of Science/Art.* (New York: Van Nostrand Reinhold, 1974), 169.
42 "Another First," *LOOK*, February 25, 1964, 102.
43 Arthur Rothstein, *Photojournalism: Pictures for Magazines and Newspaper*, 2nd ed. (New York: American Photographic Book Publishing, 1965). 202.
44 Kranz, *Science & Technology in the Arts*, 169.

"xograph®."[45] The "x" was for parallax, which is found in all forms of photography, while "graph" was from the Latin word *graphicus*, meaning "to write."[46]

Autostereoscopic photography was not a new invention, but prior to *LOOK* magazine's inclusion of their xograph® lenticular images were always produced in extremely small quantities that were quite expensive to fabricate. The xograph® distributed in the 25 February 1964 number of *LOOK* was the first autostereoscopic image that was successfully produced in the millions, and thus exposed to an audience much larger than previous autostereoscopic methods.[47]

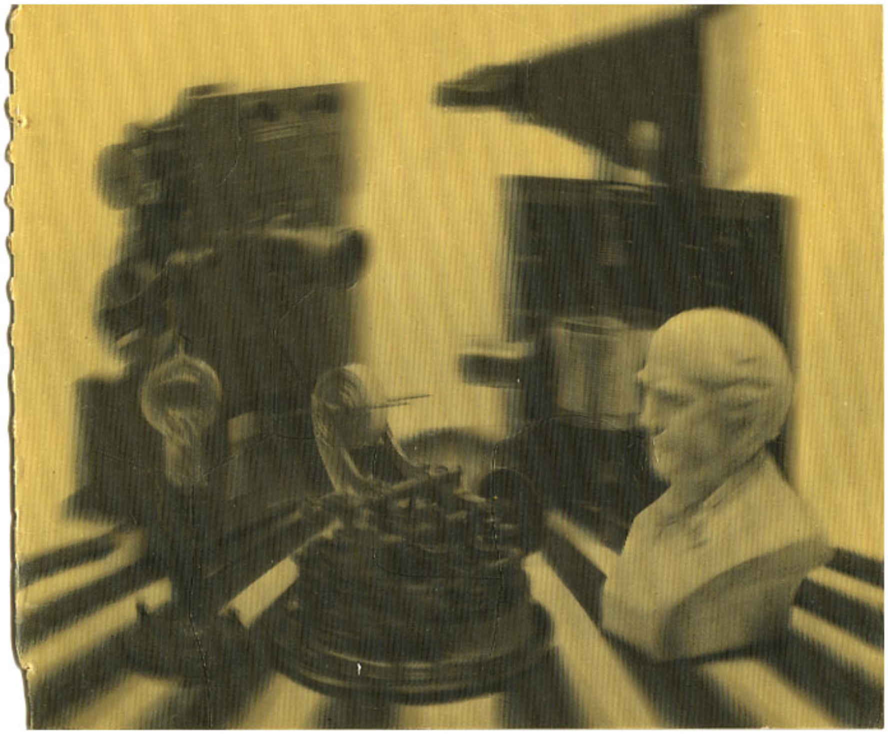
The xograph® was included as an insert between pages 102 and 103 in the object's debut appearance. The xograph® was black and white and measured 4 ¾ x 4 inches.[48] Articles on flanking pages 102 and 103 detailed this breakthrough in commercial magazine printing, crediting the process to Whatmore's vision, Rothstein's technical innovation, and the joint contributions of Eastman Chemical Products Inc. (an auxiliary of Eastman Kodak Co.), Harris-Intertype Corp. technology, and Cowles Communication's printing company Visual Panographics, based in New York City.[49] Visual Panographics were responsible for producing all xographs®, and held the trademark for the term "xograph®."[50]

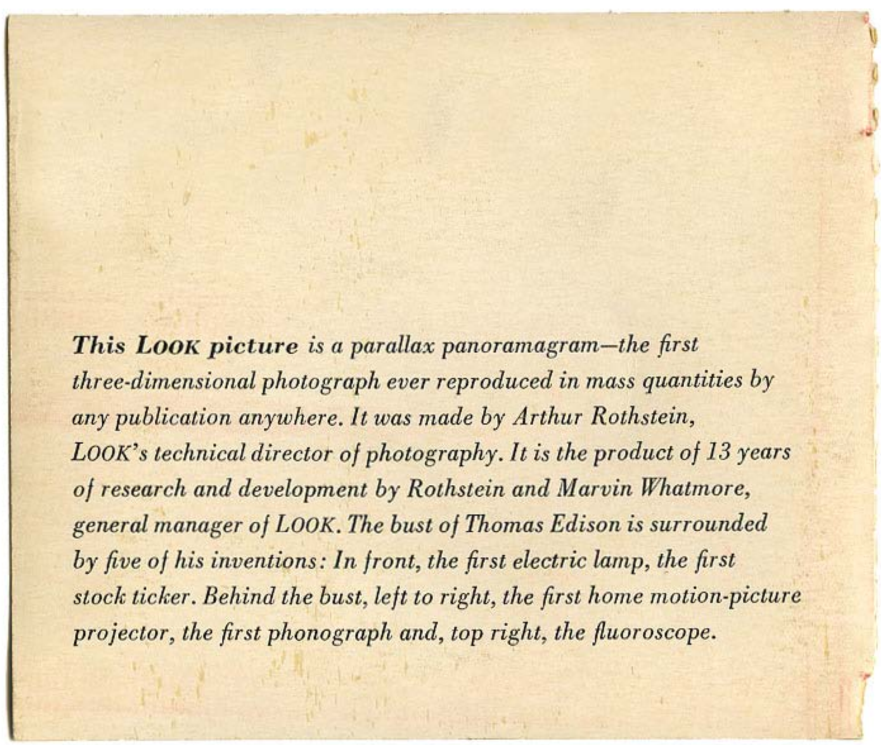
According to the article that accompanied the xograph's® commercial debut, the Harris-Intertype Corporation was responsible for custom engineering the mechanical printing technology that made the xograph® possible. Harris-Intertype Corp. was among

[45] Arthur Rothstein, *Photojournalism: Pictures for Magazines and Newspaper*, 2nd ed. (New York: American Photographic Book Publishing, 1965), 202.
[46] Kranz, *Science & Technology in the Arts,* 169.
[47] Ibid.
[48] Roland Edgar Wolseley, *Understanding Magazines* (Ames: Iowa State University Press, 1969), 247.
[49] "Another First," *Look*, February 25, 1964, 102.
[50] Visual Panographics, Inc. Xograph®. US Trademark 832,932, Issued August 1, 1967.

the leading printing equipment manufacturers in the United States, and at the time of the 25 February 1964 number of *LOOK*, Visual Panographics utilized the only printing press that could produce xographs®.[51]

[51] "Another First," *Look*, February 25, 1964, 102.





This LOOK picture *is a parallax panoramagram—the first three-dimensional photograph ever reproduced in mass quantities by any publication anywhere. It was made by Arthur Rothstein, LOOK's technical director of photography. It is the product of 13 years of research and development by Rothstein and Marvin Whatmore, general manager of LOOK. The bust of Thomas Edison is surrounded by five of his inventions: In front, the first electric lamp, the first stock ticker. Behind the bust, left to right, the first home motion-picture projector, the first phonograph and, top right, the fluoroscope.*

fig. 9 & 10: Scan of first xograph® run by *LOOK* magazine. February 25th, 1964. 4 ½ x 4 ½ inches. Recto (top) and verso (bottom).

iii. Xograph® by Cowles Communications

The xograph® process received a lot of attention from the press following its debut in *LOOK*. In the 7 March 1964 edition of the newspaper *Printing News*, the processes that produced the xographs® technology appears to have been greeted with enthusiasm by the graphic arts industry.[52]

The term "xograph®" was created by Whatmore and Rothstein, giving their technology a unique and appealing brand name.

The term is a difficult one to trace through both modern and past photographic histories and publications. The term appears frequently through the years the xograph® was being produced, mostly in the 1960s to the mid-1970s, but then begins to disappear from lenticular objects and mass publications.

[52] "Look's 3-D Process Gets Wide Interest In Graphics Field," *Printing News*, March 7, 1964.

CHAPTER IV: THE XOGRAPH® DISAPPEARS

The xograph® was used in a number of different forms, including postcards and sports cards. The term “xograph®” was printed on 1970s and early 1980s baseball cards, and these lenticular baseball cards can still be found for sale. Most notably, Kellogg’s produced xographic baseball cards that were included in their cereal products for consumers to collect.

The term “Super Xograph” later appears on lenticular baseball cards and postcards as well, but is not documented in any historical, scientific, or other publications whatsoever.

The mystery of all things “xograph®” is what makes this topic so interesting. I had sent an email inquiry to Eastman Chemical Company regarding this research topic, but Eastman Chemical Company refused to comment on the production of the necessary chemicals and materials for the objects. Yet Eastman Kodak Company used a three-dimensional, lenticular image on the cover of their 1969 annual report. Did Eastman Kodak want to take over the xographic market? Did they discontinue their relationship with Cowles Communications and Visual Panographics, thus constricting their production abilities by limiting their necessary supplies?

Perhaps the xograph® was not as commercially viable as the company had anticipated. Perhaps the “campy” aesthetic of the xograph® was only meant for fifteen minutes of fame, and consumer interest simply died out.

Through conducting the research for this thesis, I discovered that the trademark for “Xograph®,” originally filed 13 March 13 1964, had expired on 2 May 2008. The reasons why are not known, nor did the legal correspondents, law firm Richards, Harris, Medlock & Andrews, responsible for the trademark prior reply to my multiple information requests regarding the present status of “Xograph®” or reasons for the expiration of the trademark. The secrecy around the slow decline and disappearance of the xograph® leaves a lack of satisfaction, as if there is a secret or a larger reason for its disappearance.

CHAPTER V: LITERATURE SURVEY

The investigation for this thesis required research through a number of different avenues. Due to the short-lived popularity of the xograph® in commercial printing, little information exists on its presence outside of 1960s and 1970s publications. To understand how the xograph® was developed, an investigation of forms of autostereoscopic experiments and image-making techniques that existed before the xograph® was important. This included earlier patents and technologies that aided in the refinement that Visual Panographics and Cowles Communications achieved with the xograph®.

My research in the Arthur Rothstein Manuscript collection in February 2014 at the Library of Congress in Washington, D.C. provided insight into the vision that Cowles and Rothstein had for their xograph® in the world of mass printing and publication.

Very few contemporary sources, such as David E. Robert's 2002 *History of Lenticular and Related Autostereoscopic Methods*, contain any information on the xograph® beyond a brief mention as a fad technique produced by Rothstein and Cowles, and rarely ever referred to its technical name, parallax panoramagram. The technology has been harmonized with the term "holographic," which is incorrect. Indeed, I found that the use of the terms "xograph®" and "parallax panoramagram" varied from publication to publication, and often refers to the same technology.

An evaluation of histories of magazine and mass publications, technical photographic manuals and dictionaries, and histories of three-dimensional imaging follow in addition to the available literature regarding the history of three-dimensional imaging and stereoscopic photography. The latter section helps better contextualize parallax panoramagrams within this larger photographic tradition. Technical manuals and process descriptions are briefly explored in this survey. In addition, a review of historical patents, trademarks, and primary sources specific to this photographic method are included in the bibliography, but not discussed in detail in this chapter.

i. Magazines and Publication Histories

The 1966 edition of Roland E. Wolesley's *Understanding Magazines* included a tipped-in xographic print in full colour. The book discusses the introduction of parallax panoramagrams in mass-publications using the example of *LOOK*, a magazine published by Cowles Communications. Wolesley includes a simplified description of the process, but places emphasis on how the image visually appeared and was used at the time. He includes a photograph of Arthur Rothstein with his 3-D camera, largely regarded as the person responsible for the introduction of parallax panoramagrams to the general consumer, but little information on the specific technology and manufacturing is present. In the 1969 edition, although only three years later, significant revisions were made indicating that publications by Cowles Communications were not the only contenders in the use of parallax panoramagrams, and also indicated that other companies and corporations utilized similar technologies. This shift emphasized a dramatic turn in the use of this technology as more corporations, publications, and printing companies began to investigate the lucrative parallax panoramagram introduced by Cowles Communications. The fact that other companies started to use the technology speaks to its popularity and visual appeal at the time; the market no longer belonged solely to Cowles Communications and their publications.

Several publications by credited creator Arthur Rothstein emphasized the "xograph®" as the way of the future in commercial publications. This may have been due to his position as editor for *LOOK* magazine during its inception as a part of Cowles Communication. Although he included technical information on how xographs® were created, these descriptions were vague, with most of the emphasis placed on the significance of the xograph® as a breakthrough in photomechanical reproduction. In his book *Photojournalism: Pictures for Magazines and Newspaper*, Rothstein discusses the technical innovations being pursued to better improve the parallax panoramagram. Cowles Communications and Rothstein saw potential with the technology for uses such as "three-dimensional aerial and X-ray photography and lower costs through improved printing techniques," but these innovations are not discussed in any detail.[53]

In James Playsted Wood's *Magazines in the United States*, published in 1971, Wood indicates that Cowles Communications had experienced "a loss of $3,434,000," and further losses in the following year.[54]

ii. Photographic Manuals and Technical Dictionaries

Technological and photographic dictionaries and manuals from the period provide an understanding of the popularity of the technology from the 1960s onwards. The 1973 *Focal Dictionary of Photographic Technologies* outlines xography, parallax panoramagrams, lenticular imagery, and a number of critical terms necessary for the understanding of how these photographs were created. Simplified diagrams and

[53] Arthur Rothstein, *Photojournalism: Pictures for Magazines and Newspaper*. 2nd ed. (New York: American Photographic Book Publishing, 1965), 202.
[54] James Playsted Wood, *Magazines in the United States*. Third ed. (New York: Ronald Press Company, 1971), 436.

alphabetical order make the *Focal Dictionary of Photographic Technologies* easy to navigate and a critical reference when analyzing related patents.[55] The presence of parallax panoramagram technology during its production demonstrates its prominence and commercial promise within the photographic industry. Yet in similar publications and later editions of these publications mentioned above, the process has been removed or is not included.

Award winning photographer and photographic instructor John Hedgecoe's 1973 edition of *The Photographer's Handbook* includes xography with a straightforward definition and process explanation. It is placed within the larger umbrella of stereo photography, and also as a precursor to holography.[56] John Hedgecoe's 1982 *Advanced Photography* discusses the xograph® process as a "dimensional variation" technique,[57] yet the term is nowhere to be found in the extensive glossary at the back of the volume.

The Time-Life Corporation released the volume *Frontiers of Photography* as part of the "Life Library of Photography" series, composed of 17 volumes published in 1972. In this volume, the parallax panoramagram is explained by contrast with a vectograph stereo picture, which requires optical eyewear to achieve the desired technique. Visual diagrams are used to explain how a parallax panoramagram is designed to show three-dimensionality in the form of spatial depth as opposed to demonstrating motion. The discussion of the technology is concise and easily understood, yet no resources or footnotes are provided to find further information. The book directly relates parallax panoramagrams to the technology of holography, which, technically speaking, is

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[55] D. A. Spencer, *The Focal Dictionary of Photographic Technologies*, First ed. (London: Focal Press, 1973). 345.
[56] John Hedgecoe, *The Photographer's Handbook* (New York: Alfred A. Knopf, 1977), 180.
[57] John Hedgecoe, *John Hedgecoe's Advanced Photography* (New York: Simon and Schuster, 1982), 146-147.

incorrect.

Stewart Kranz's 1974 *Science & Technology in the Arts: A Tour Through the Realm of Science/Art* outlines the biographies of Marvin Whatmore and Arthur Rothstein as innovators of the xograph®. Kranz directly quotes the two, giving insight to their individual visions and hopes for their lenticular images in the world of mass printing. Rothstein's biography includes a basic description and diagram of the xograph® process. The volume is useful in terms of contextualizing Whatmore and Rothstein among other innovators included in the volume.

iii. Histories of Three-Dimensional Imagery

The literature covering autostereoscopic technology, specifically parallax panoramagrams, is rich in illustrations of how the object was made optically. However, no source provides information on specific chemical contents or materials used, and a cross-section diagram has yet to be created.[58]

In a 1930 essay, appearing in the Journal of the Optical Society of America, Herbert E. Ives himself explains three different methods for producing a parallax panoramagram, improving the technology through the use of a large diameter lens to make the image more easily viewed. The article also explains the optical science of viewing parallax panoramagrams, yet omits a structural cross-section of a final object.[59]

Louis Walton Sipley's 1951 *A Half Century of Color* includes historical accounts and descriptions of lenticular technologies predating the xograph® and their functions in the realms of advertising and marketing. Sipley's book includes many photographs of

[58] A cross-section image has been created for this thesis using a Scanning Electron Microscope (SEM).
[59] Herbert E. Ives, "Parallax Panoramagram Made With A Large Diameter Lens," 332.

these companies' studios, such as Akravue and VitaVision. The book contains a number of examples of earlier printing techniques that readers can handle and visually analyze, but none of these are lenticular technologies. The chronological progression of lenticular technologies in the first half of the twentieth century is a strong point of Sipley's book, while its lack of index made it difficult to navigate and revisit.

Takanori Okoshi's 1976 *Three-Dimensional Imaging Techniques* provides a highly technical and scientific approach to the creation of parallax panoramagrams, breaking down single-camera and multiple-camera methods. In addition to this process breakdown, the volume explained the flaws and drawbacks of the three-dimensional imaging technique, and presented possible reasons the technology slipped from popularity.[60] This volume is the most informative when considering the compositional breakdown of parallax panoramagrams in terms of chemical composition and inherent preservation concerns, but again is not complete. Okoshi also places this autostereoscopic technique as a prerequisite for holographic image-making, but indicates the two processes are distinct and separate.[61]

All of the resources that mention xographs® or the parallax panoramagram highlight the process as an up-and-coming and innovative technology for only a brief time period, after which, the authors note, they begin to disappear. IS THIS WHAT YOU MEAN? This disappearance of the xograph® is not explained in these sources. It may have been an issue with licensing and patents, or perhaps it was too costly for mass publications. It is also evident that while it is easy to find out how an xograph® or

[60] Takanori Ōkoshi, *Three-dimensional Imaging Techniques* (New York: Academic Press, 1976), 16-20.
[61] Sean F. Johnston's *Holographic Visions* follows the same suit, assigning autostereoscopic technology an integral position in the evolution of holographic imagery.

parallax panoramagram optically functions, its chemical composition and the materiality of the objects is not.

Finally, Lenticular technology expert David E. Robert's 2003 *History of Lenticular and Related Autostereoscopic Methods*, dates his brief historical overview of technological advancements in autostereoscopic technology to 1692.[62] The book contains several diagrams demonstrating how this technology creates autostereoscopic images and the optical science behind the creation of these images.[63] There is no diagram featuring a cross-section of a final parallax panoramagram. The publication does not explain why the technology was phased out, and approaches the medium as if it were still quite popular, perhaps highlighting the author's approach as one driven by passion rather than reality. Although the piece itself is vague and simplistic, the bibliography is strong and provides further resources.

iv. Primary Sources

The technology began with the patents and inventions of Frederic Eugene Ives (1856 – 1937) and later his son Herbert Ives (1882 – 1953). Herbert Ives made major contributions to the field of optical science in addition to photographic processing. The technological evolution from the work of Ives to that of Arthur Rothstein and the introduction of parallax panoramagrams in the press reveals the complexity of the technology itself as does the navigation of the world of patents and trademarks. trademark "xograph®" was filed in 1964 by Visual Panographics, a company owned by Cowles Magazines and Broadcasting. Cowles produced publications such as *LOOK* and

[62] David E. Roberts, *History of Lenticular and Related Autostereoscopic Methods*, 2.
[63] Many of these diagrams are directly from the original patents from inventors such as H.E. Ives.

Venture, two of the first titles to produce parallax panoramagrams for general consumption.[64] Both magazines were pioneers in distributing autostereoscopic imagery to the general public. It was ultimately Cowles Communications and Visual Panographics that trademarked the term "xograph®."[65] I discovered that the trademark for the term "xograph®" was cancelled on 2 May, 2008.[66] Multiple attempts were made to contact the legal correspondents who are responsible for the trademark, but without any response. The mystery around the expiration of the trademark, as well as the slow decline and disappearance of the xograph® among publications is left unsolved.

CHAPTER VI: APPARATUS AND TECHNOLOGY

[64] Arthur Rothstein, often credited with the invention of the parallax panoramagram as used in the 1960's, was the director of photography for *Look* at the time.
[65] Roland Edgar Wolseley, *Understanding Magazines* (Ames: Iowa State University Press, 1966), 247-250.
[66] Visual Panographics, Inc. Xograph®. US Trademark 832,932, filed May 2, 2008.

The following is a compilation of the available information regarding the technical fabrication of the xograph®. It concentrates its production from its beginning within the camera, and moves on to the manufacturing and printing of the xograph®, and addresses the assembly and adherence of the lenticular screen. The small gaps in this section owe to the scarcity of information regarding the production of the xograph®.

i. Camera:

I made several attempts to track down the specific model of camera used to produce xographs,® but the search yielded no results. According to Arthur Rothstein, the camera used to produce xographs® was a large and cumbersome piece of equipment. Rothstein described the half-ton, single-lens camera as a "six-foot cube"[67] that had a focal range of three feet to infinity and allowed for a variety of lenses from telephoto to wide-lens.[68]

The exposures were lengthy due to the nature of how the images were captured in-camera to create the illusion of three-dimensionality of the final object. As Rothstein explained, the lens would have to remain open from between five and twenty seconds to allow the camera to arc around the subject during exposure. The film used measured up to 11 x 14 inches[69] and produced a single photograph as opposed to the parallax stereogram method.[70] What differentiated the parallax panoramagram from the parallax stereogram was that the latter was formed as a singular object within the camera, while the stereo effect of the former was created from two separate images after the film had

[67] Arthur Rothstein, *Photojournalism: Pictures for Magazines and Newspaper* (New York: American Photographic Book Pub., 1956), 202.
[68] Ibid.
[69] Ibid.
[70] Time-Life Books, ed., *Frontiers of Photography* (New York: Time-Life Books, 1972), 130.

been removed and processed.[71]

A screen containing 300 vertical slits was placed within the camera between the film and the lens. As the camera arced around the subject, these slits rendered the subject on the Ektachrome film, which, to the naked eye, appeared as a blurred image. The vertical slits caused the final exposure on the film to be distorted in parallel, vertical strips.[72] The calculations of focal length, camera distance, and the subject were calculated prior to shooting and depended on the subject. The camera may have been made to arc during exposure just a few inches, while in other cases it would require an arc of several feet.[73] Upon lamination with the lenticular screen, the fragmented image produced within the camera appeared with clarity and depth. The 300-slit screen used to capture the image onto film registered perfectly with the 300 embossed striations in the lenticular screen adhered during manufacturing.[74] Because the image was rendered on to separate viewing planes for the left eye and right eye through the lenticular screen, the image produced a three-dimensional effect when the viewer shifted the object in their hands.[75]

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[71] D. A. Spencer, *The Focal Dictionary of Photographic Technologies*, 432.
[72] Arthur Rothstein, *Photojournalism: Pictures for Magazines and Newspaper* (New York: American Photographic Book Pub., 1956), 202.
[73] Arthur Rothstein, Transcribed Lecture and Question Period Delivered at a Conference, 1966, MS, Research & Engineering Council of the Graphic Arts Industry.
[74] Time-Life Books, ed., *Frontiers of Photography* (New York: Time-Life Books, 1972), 130.
[75] Ibid.

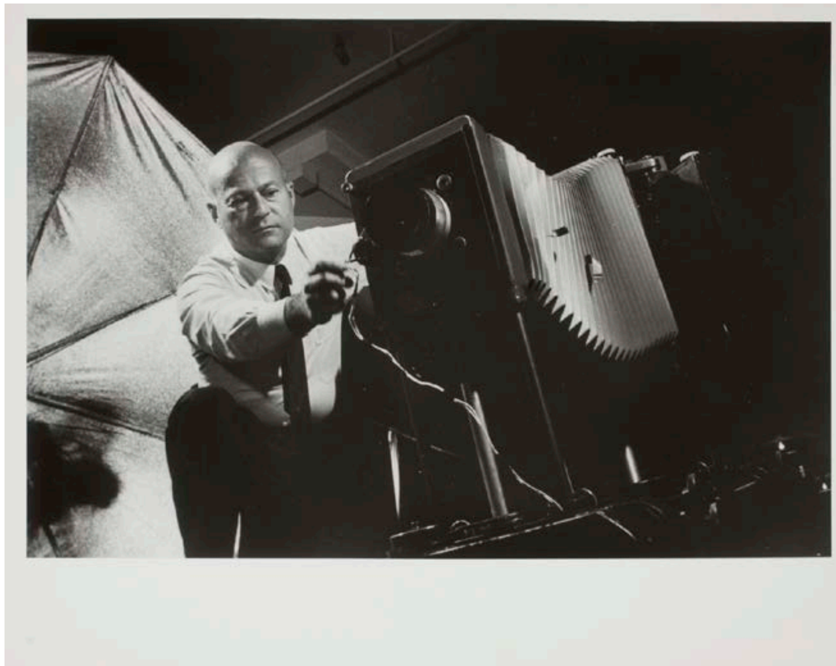

fig. 11 (top) & fig. 12 (bottom): Two photographs of Arthur Rothstein with the xograph® camera, c. 1964-1970. George Eastman House: International Museum of Photography and Film.

ii. Manufacturing:

The xograph® is a photomechanical object, created using the process known as offset lithography, although according to Rothstein, the company hoped to move towards the rotogravure printing method.[76]

The xograph® was successful in part due to the plastic used to create the lenticular screen adhered to the halftone printed image. Although autostereoscopic images were invented much earlier, modern plastic was not available, hindering the development and mass diffusion of these three-dimensional images. The plastic screen featured a cylindrically ridged lenticular pattern that registered perfectly with the distorted image produced by the screen within the camera during exposure.

After exposure, the film was processed (according to Rothstein, Kodak Ektachrome film was used)[77] and did not require any unconventional processing.[78] Following development, press plates were created for photomechanical production. Following printing, the plastic lenticular screen was adhered to the image at high speed and high heat.

During offset printing, a 300-line screen was used for four-colour separation (cyan, yellow, magenta, and black). The half-tone print had a very high dpi of 300,[79] ten times the normal printing requirement for the time.[80] In Rothstein's lecture reproduced as Appendix II, he states that the printed image was printed at 112 lines to the inch to ensure proper registration of the lenticular screen and lenticular photograph.[81] The relationship

[76] Arthur Rothstein, Transcribed Lecture, 1966.
[77] Ibid.
[78] Arthur Rothstein, *Photojournalism: Pictures for Magazines and Newspaper* (New York: American Photographic Book Pub., 1956), 202.
[79] Ibid.
[80] Ibid.
[81] Arthur Rothstein, Transcribed Lecture, 1966. 24.

between the thickness of paper and plastic lenticular screen was extremely specific to ensure the desirable flexibility and durability of the final product.

iii. Lenticular Screen:

Although I researched the materiality and composition of the lenticular plastic screen, my findings were often inconclusive or contradictory. According to Arthur Rothstein, the plastic used was a polypropylene substance that was "melted down" from crystal form and "applied just as ink would be applied onto the surface of the printed sheet."[82] Adorning the cover of the 1969 Eastman Kodak annual report is a three-dimensional parallax panoramagram, where the company describes this plastic as "a special Eastman acetate butyrate plastic of outstanding clarity."[83] In another source, Rothstein referred to the plastic used as "Epolene," which had suitable transparency, flexibility, and adhered well to paper.[84]

[82] Ibid.
[83] *Eastman Kodak Company Annual Report 1969*, report (Rochester, NY: Eastman Kodak Company, 1969), interior cover. My inquiry to Eastman Chemical Company on May 27th, 2014, was met with the following response: "Thank you for your inquiry. However it is Eastman's policy to not divulge information to universities beyond what is available on our website. This includes sampling and sales."
[84] Arthur Rothstein, *Photojournalism*, 202.

CHAPTER VII: ANALYSIS OF XOGRAPH® WITH A SCANNING ELECTRON MICROSCOPE (SEM)

To my knowledge, no one has yet undertaken a visual analysis of an xograph® on a microscopic level. Previous to this publication , a visual analysis of an xograph® on a microscopic level had yet to be published. In doing so, It was my goal to see in the resulting images whether or not the pigment on the paper substrate was being absorbed into the plastic lenticular layer, or whether the plastic WAS stable, without any leaking. This information, together with that in the previous section describing the production process of xographs® is used to create preservation strategies and help in predicting the possible ways and means of the deterioration of these objects as they age. I hope that on the basis of the outcomes of the analysis, others will conduct future research on the preservation of objects such as these, and use this chapter as a visual aid to understanding the technical process of these lenticular objects.

As I conducted the research for this thesis I found that no one had yet analyzed the layer structure and chemical composition of xographs®.

However, this chapter aims to provide an example only and does not claim to apply to the layer structures of all lenticular photographic material or even parallax panoramagrams for that matter.

On 19 June 2014, I conducted an analysis of the May 1969 cover of *Venture* magazine[85] with the use of a scanning electron microscope (SEM microscope). I preformed the tests at The Hospital for Sick Children (SickKids) in Toronto, Canada. With the assistance of fellow Masters candidate Samantha Ackerley and her father, Dr. Cameron Ackerley, a renowned electron microscopist, I was able to attain chemical

[85] See fig. 13

analyses and cross section images were produced to help better understand xographs®.

I hoped to produce a chemical analysis of the plastic lenticular layer, but it was not possible at the time of this test. Through research, I hypothesized that the lenticular layer is a cellulose butyrate acetate substance.[86] The chemical analysis was not specific enough to be conclusive.

i. Scanning Electron Microscope (SEM)

A scanning electron microscope shoots a concentrated beam of electrons at a sample of the xograph®, from which detailed microscopic images of the solid specimen are produced. This electron beam then produces readings from the atoms refracted off the sample, creating topographic reports that allow us to better understand the surface structure of the object. In addition, spot samples were taken and analyzed to retrieve the specific chemical composition of the paper and plastic layers of the xograph®.

[86] *Eastman Kodak Company Annual Report 1969*, report (Rochester, NY: Eastman Kodak Company, 1969), interior cover.

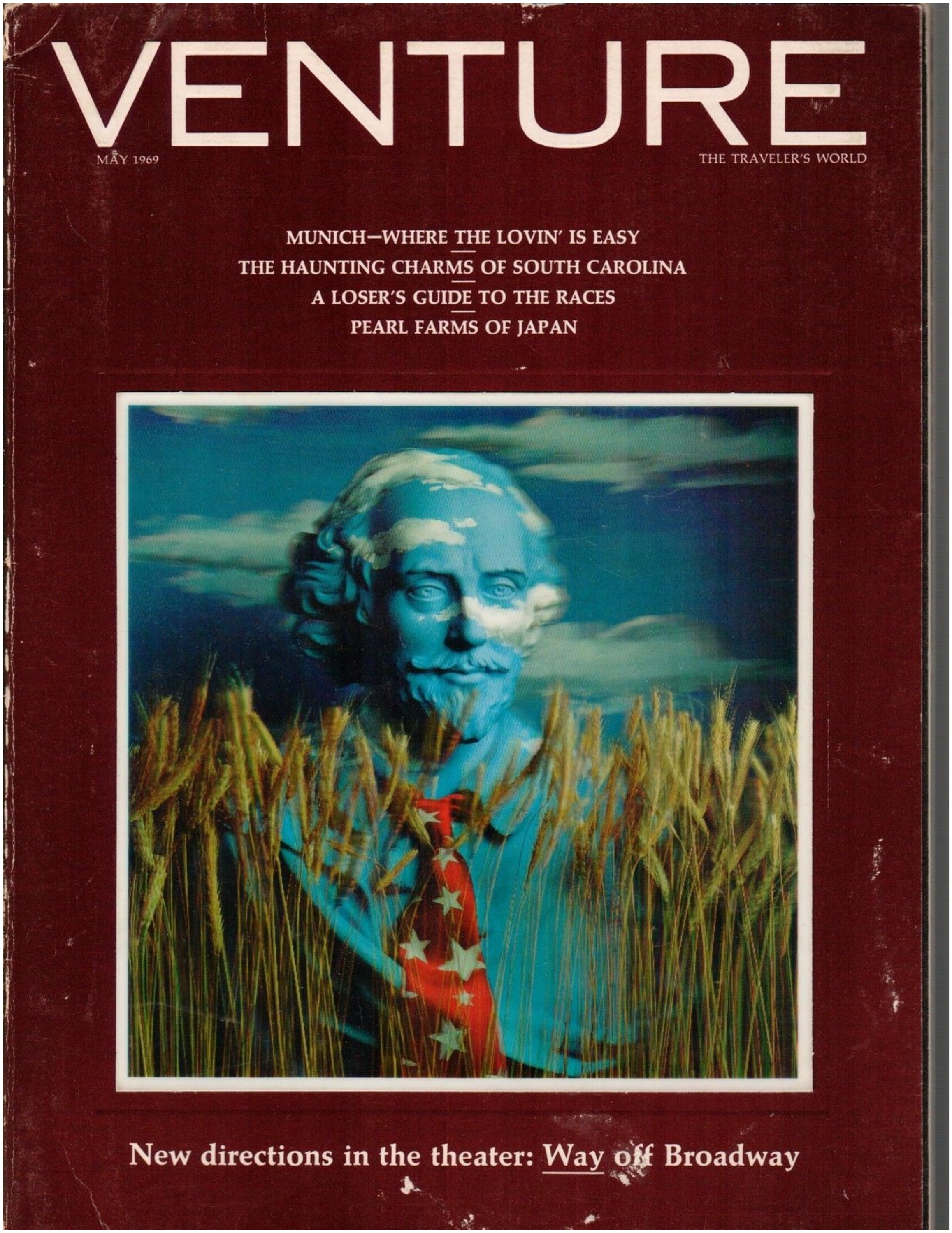

Fig. 13: Visual Panographics, Inc., 1967, *Venture: A Traveler's World*, assembled by Bob Sullivan (New York: Cowles Communications, May 1967), front cover. Cover: 21.3cm x 28.05cm. Xograph®: 15.9cm x 15.9cm.

Several tiny samples of the xograph® on the cover of the May 1967 number of *LOOK* magazine were taken and adhered with carbon tape to a specimen stub designed to be inserted into the scanning electron microscope for evaluation. While the carbon tape can produce slightly higher carbon readings when analyzing the chemical composition of the xograph® sample, the carbon tape typically does not interfere with the final data produced by the microscope. The specimen stub, which measures approximately 13mm in diameter, was sputter-coated with gold palladium alloy to make the specimen electrically conductive before the readings were taken. This prevented an electrostatic charge, grounding the samples to produce more accurate data.

The samples were divided into two types. The first were three cross-sections each containing the paper, pigment, and plastic layers. The samples were laid on their side, allowing the paper, pigment, and plastic layer of each sample to be exposed to the electron beam. This allowed the microscope to produce a reading of all three layers by navigating the electron beam. I conducted this test to assist in evaluating any seeping or leaking pigment in the plastic lenticular layer. The uniformity of the lenticules was also made clear in the cross-section images.

I conducted spot samples on three separate portions of the *Venture* xograph® cover, each containing a different pigment. To achieve this data, the lenticular layer was carefully removed with a scalpel from the paper and pigment layers, and the pigment layer was placed on the specimen stub to face the electron beam. Samples of the xograph® in red, blue, yellow, and red/brown were analyzed with the hopes of discovering variations in the chemistry used.

According to Rothstein, the paper used to create the xographs® by Visual

Panographics Inc. was Kromekote paper, which was highly reflective and permitted strong adherence of the lenticular screen onto the paper.[87]

[87] Arthur Rothstein, Transcribed Lecture, 1966. 23.

ii. Cross Section Images

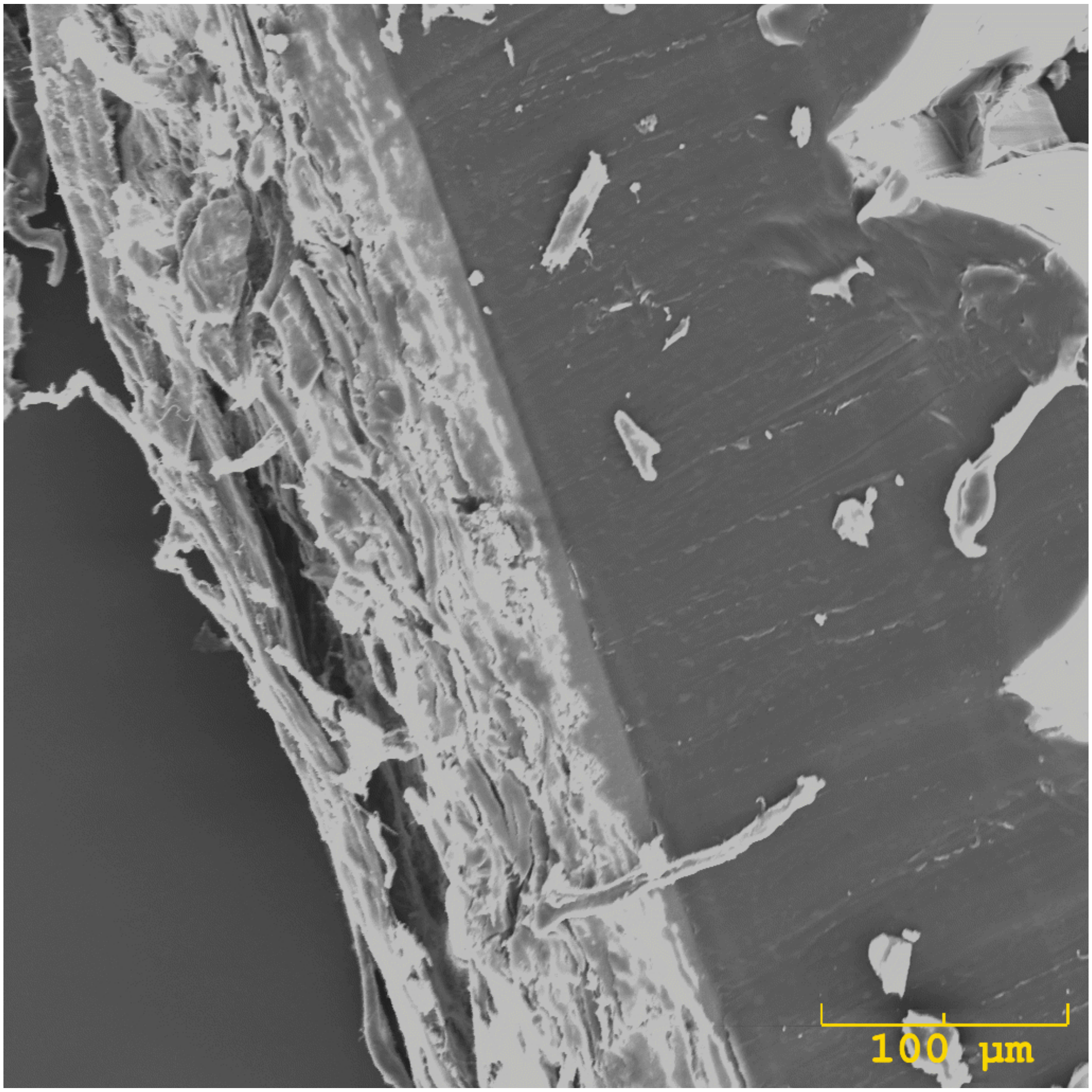

fig. 14: Secondary Electron Image of xograph® cross section:100 micron scale, 230x magnification.

Plastic lenticular screen visible as well as paper fibres. The pigment layer is less visible, but the loose density and fibrous structure of the paper substrate is clear.

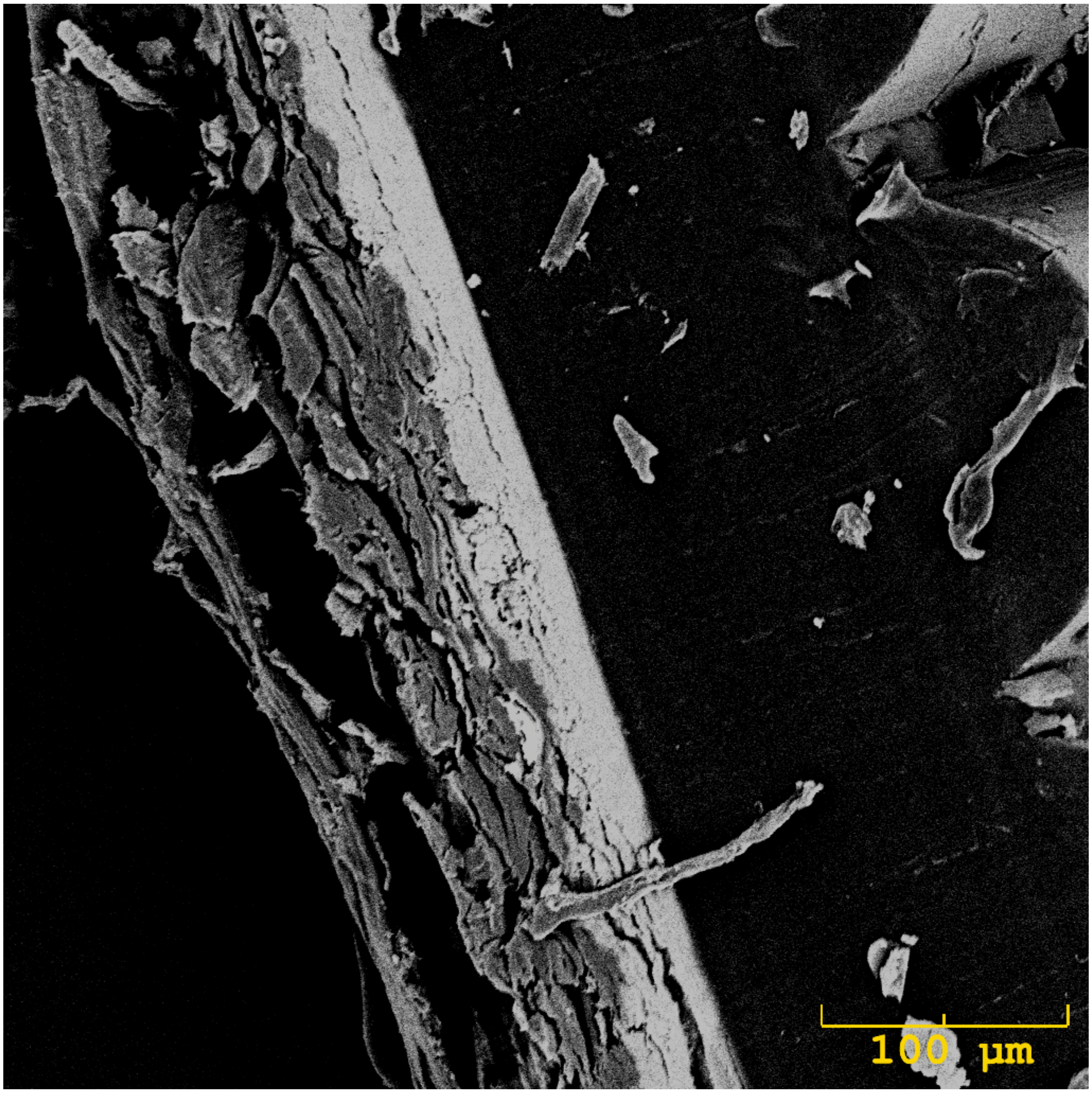

fig.15: Backscatter electron image of xograph® cross-section: 100 micron scale, 230x magnification

The backscatter image of the same sample demonstrates the atomic contrast between the paper substrate, pigment layer, and the lenticular plastic coating. The clean definition between the lenticular layer and pigment layer (the white strip in the middle) shows there is no seeping or bleeding of pigment into the plastic layer nor vice versa.

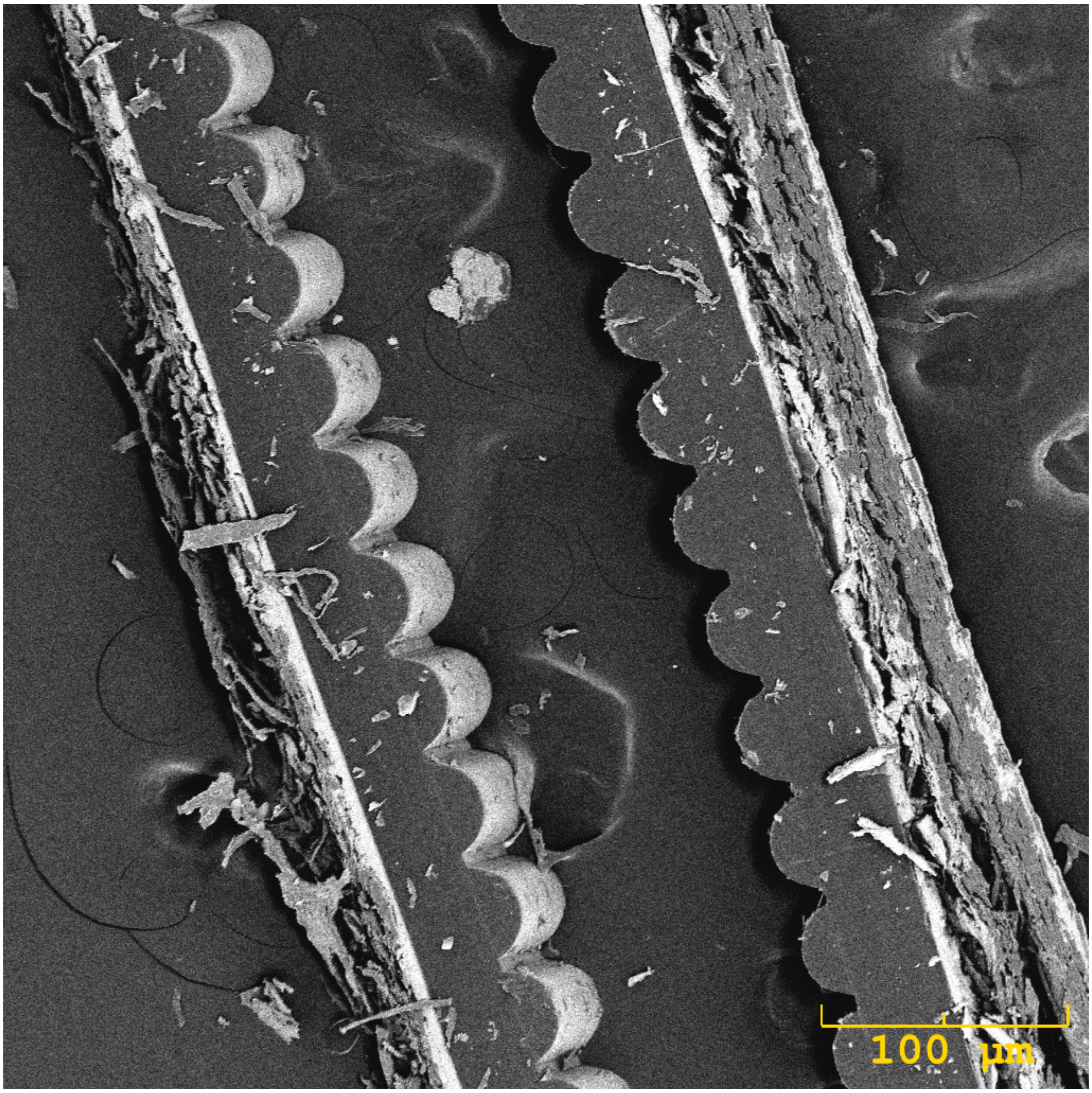

fig. 16: Low powered backscattered image of two cross sections. 43x magnification.

The cross section on the right has a complete paper layer, and reveals a pigment layer on the verso (which would be the inside cover). The cross section on the right has had this verso pigment layer carefully removed, resulting in fragmenting of the paper substrate. Both objects demonstrate that the pigment layer has not bled or seeped into the plastic lenticular layer. The image was formed at 43x magnification to clearly demonstrate the lenticules.

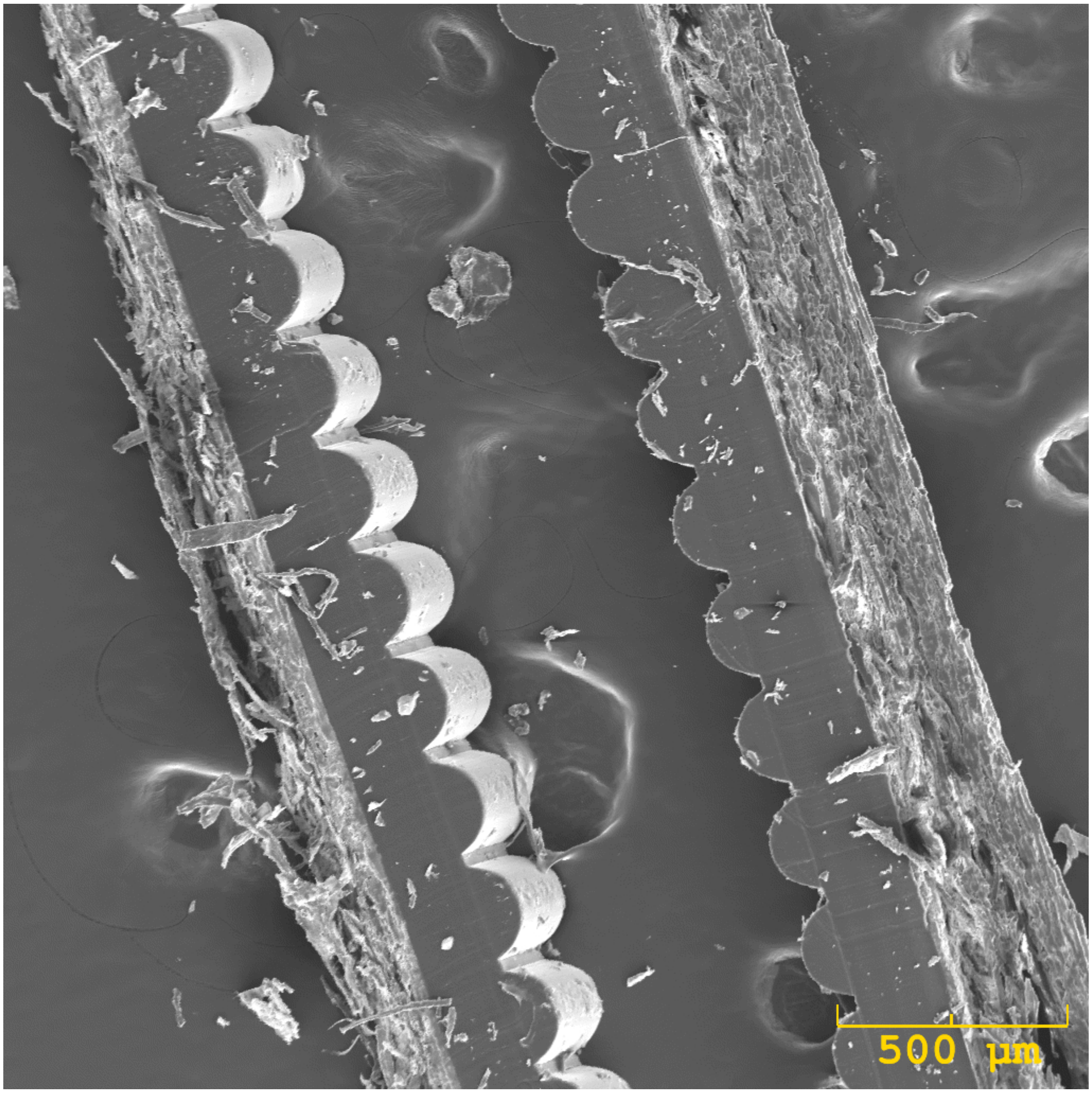

fig. 17: Low powered scanning electron image of two cross sections. 43x magnification.

Low powered scanning electron image reveals the composition of the paper substrate and the clarity of the lenticular layer. Note the lack of definition in the pigment layer compared to the backscatter image on the previous page.

iii. Chemical Materiality of Paper and Pigment Samples

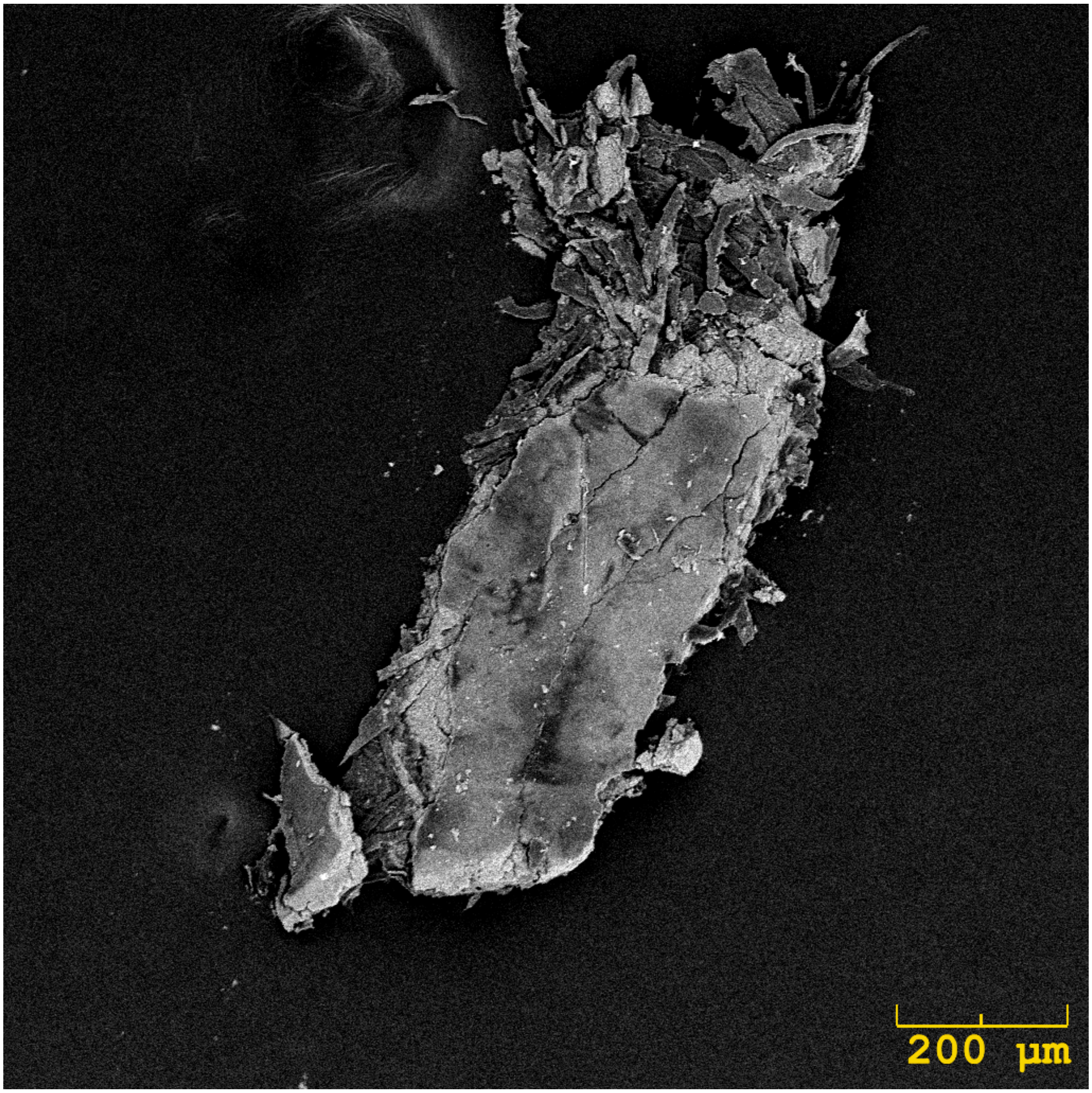

fig. 18: Backscatter electron image of red fragment, 43x magnification – Red sample

The pigment layer can be seen as the solid, flat surface of the sample, while the fragmented, darker pieces around the edges and most easily visible at the top can be understood as the paper. Spot samples of the pigment layer and the paper layer were both analyzed.

iv. Spot Sample Spectrum of Paper from Cross Section

A spot sample of the paper did not reveal any metal byproducts. There were high silicon levels present, but no calcium. The paper appears to be relatively pure for publication purposes. High gold (Au) and palladium (Pd) were present due to the sputter coating. All the paper samples contained the following elements: calcium (Ca) (dominant element), chlorine (Cl), aluminum (Al), phosphorous (P), silicone (Si), carbon (C), oxygen (O).

CHAPTER VIII: PRESERVATION CONCERNS

In the 1960s by Arthur Rothstein himself suggested that there were printing and preservation problems with the xograph®. Fluctuating temperature and humidity during production caused expansion and contraction of the plastic layer, which could result in misalignment of the lenticular screen and a distortion of the image layer, creating an failed object. Although this problem was evident immediately, he also mentioned other preservation issues. He described a need to strengthen the lenticular screen to prevent "scuffing," which Rothstein addresses in his lecture in Appendix II.[88] I was unable to discover whether advancements in strengthening the lenticular screen and preventing abrasions and "scuffing" were attained. In his 1970 *Color Photography Now*, Rothstein dedicated a chapter to preservation concerns related to color photography. But while the cover of the book featured an xograph® adhered to the fabric surface, credited as "XOGRAPH® cover pioneered by Visual Panographics, Inc. for *Venture* magazine,"[89] Rothstein did not address specific preservation concerns regarding the xograph ® in his book.

As these photomechanical objects age, they appear to be yellowing. It is unclear which element the yellowing comes from: the paper substrate or in the lenticular plastic screen. The sampling in this thesis shows that neither material is seeping into the other, but each may be deteriorating. It is also possible that the paper and plastic material are accelerating the yellowing and deterioration of each other through direct contact.

The completion of the tests on the xograph® samples made it evident that the plastic and the paper present independent preservation issues. The pigment layer

[88] Arthur Rothstein, Transcribed Lecture, 1966. 24.
[89] Arthur Rothstein, *Color Photography Now.* (New York: American Photographic Book Pub., 1970), 88.

demonstrated no bleeding or seeping into the plastic layer at all. This has led to my conclusion that the longevity of xograph® material is less reliant on the materiality of the plastic lenticular screen than on the quality of the paper substrate.

CHAPTER VIII: CONCLUSION

According to Rothstein's *Color Photography Now*, xograph® production "requires a blending of scientific and creative aspects of color photography, plastics technology, and modern printing methods."[90] This technology encompasses the scientific, the photographic, and the world of mass media publications. The desire to recreate a three-dimensional environment in a two-dimensional medium still continues today, as demonstrated by the growing popularity of 3D films that incorporate stereoscopic technology to enhance the experience of the viewer.

As I conducted my research, I discovered that no standards are in place for preservation or storage of three-dimensional objects like an xograph®. To take two examples: The George Eastman House International Museum of Photography and Film stores these lenticular objects horizontally in archival boxes, stacked and staggered together with several other objects and without any interleaving or separation of materials. Letters, magazine articles, and other related ephemera are mixed in with the autostereoscopic material. The Prints and Drawings Division of the Library of Congress, stores xographs® in non-archival file folders, allowing the objects of various sizes to shift, curve, and overlap within the enclosures.

In addition to poor housing practices, collections management and database software could be improved. No institution uses consistent terminology or vocabulary to classify their lenticular material or earlier three-dimensional photographic methods. As I conducted my research, I had to investigate a variety of terms to find these objects within the collections I studied. These included: "xograph," "lenticular," "autostereoscopic," "hologram," "parallax panoramagram," "three-dimensional," among others. By better

[90] Rothstein, *Color Photography Now*, 141.

identifying these objects and improving the use of a standardized terminology for them they could be better accessed and understood by researchers and institutions.

In an archival environment fixated on digitization, perhaps an investigation of how best to digitally display and reproduce these objects could be pursued. Housing and preservation standards could be tailored to the materiality of these objects with further research on the chemical composition of xographs®.

It is my belief that xographs® should have a stronger presence in photographic history. Although thought of slightly kitschy today, these objects were the first of their kind and available to the average consumer. I am interested in conducting further research investigating the xograph® as a marketing tool and in further understanding its triumphs and downfalls in the histories of 1960's magazine publication and marketing.

The initial excitement for the xograph® was there: *The Saturday Review* went as far as to refer to the photomechanical process as "the fourth major breakthrough since the 15th Century."[91] In Rothstein's 1966 speech delivered to the Research and Engineering Council of the Graphic Arts Industry,[92] his enthusiasm and belief in the xograph® was certainly engaging. However, he pointed out during the question and answer period that the xograph® had preservation issues including scuffing or abrasions on the surface from physical handling, cracking from bending the plastic beyond its physical flexibility, or from extreme shifts in temperature, likely from improper storage under frequent fluctuations of temperature and humidity.[93] The problem was that the xograph® was a "one-hit wonder." Once the item became known and the norm, the novelty wore off. With the increasing popularity and improvements in television broadcasting, the

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[91] Visual Panographics, Inc. "Xograph® 3-D," advertisement, c. 1965.
[92] See Appendix II
[93] Arthur Rothstein, Transcribed Lecture, 1966.

xograph® became unsustainable and a financially irresponsible method of photomechanical printing.

Lenticular photography is still present, and experiencing a new found popularity in mass publications. In recent years, many books are featuring lenticular photography and demonstrate continued research and development in the field of autostereoscopic images. Dan Kainen and Carol Kaufman's 2012 book *Safari: A Photicular Book* includes seven "photicular" images of animals in the wild. Kainen describes "photicular" images as a development from lenticular technology. The photicular images are created by slicing individual video frames "into very thin, adjacent strips to create one master-image."[94] The final image "comes alive in fluid, film-like motion."[95] I am curious as to whether the resurgence of lenticular images in publications is related to the expiration of the patent of the xograph®.

This investigation as a thesis topic began with the simple question, "what is an xograph®?" Yet, because of the largely uninvestigated nature of this topic, the questions are truly endless. Involving the world of mass marketing, publication, camera technology, patents, on top of the physicality of the objects, the topic reveals always more to investigate and learn: it just requires much more time, and perhaps a variety of strategies.

Prior to this thesis, little has been written on the xograph® in a cohesive report, making information difficult to access on this seldom-discussed topic. It is my hope that this thesis may also serve as a guide to pursue further preservation tests and instigate conversations about the longevity of these unique, printed photomechanical objects.

By better understanding the technical process, historical presence, and chemical

[94] Dan Kainen and Carol Kaufmann, *Safari: A Photicular Book* (New York, N.Y.: Workman Publishing, 2012), 3.
[95] Ibid.

materiality of these parallax panoramagrams, I hope that future research can serve to preserve these items for institutions and private collectors alike.

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APPENDIX I: TERMINOLOGY

Autostereoscopic

An image that produces a three dimensional effect and does not require optical eyewear or apparatus.

Lenticular photography

A method of photography that fragments the image during recording, but is later reassembled for viewing. The image may be divided into linear components or other geometric shapes. Lenticular photographs are comprised of two or more images to produce a single photographic object.

Lenticular screen

The lenticular screen is a plastic transparent support adhered to the image surface of a photographic object. For a parallax panoramagram, the screen is embossed in a geometric pattern, often in vertical, cylindrical strips.

Parallax stereogram

The parallax stereogram is another form of autostereoscopic photography. It varies from the parallax panoramagram as it is produced by two separate lenses (hence, “stereogram”). The lenses mimic the left and right eye, which transmit the subject through a lenticular screen within the camera, interlacing the two images to produce a single stereo record. A plastic lenticular screen is adhered to the final print designed to register perfectly with the interlaced images, as is the case with the parallax panoramagram. This method was originally patented in 1903 by Frederick E. Ives.

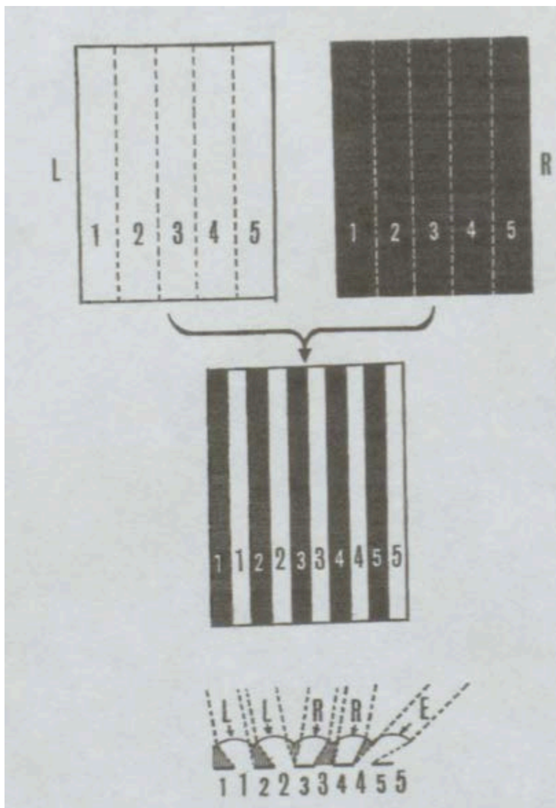

fig. 19: Diagram of a parallax stereogram. “Three-dimensional Printing.” *Camera*, August 1964.

Parallax panoramagram

The parallax panoramagram is unique as it uses a singular lens to produce a stereoscopic illusion. As the lens is open, the camera arcs around the subject. The images are then transmitted and received through a screen within the camera, synchronized to register perfectly with the plastic screen adhered in the final printing stage. The lens remains open for this entire process to allow a smooth reception of the desired view onto the Ektachrome transparency film. This limited the technique to motionless, posed compositions. This movement during exposure makes the transition of viewpoints seamless and constant, without any abrupt visual transitions. The parallax panoramagram allows for a wider viewing angle than the parallax stereogram.

APPENDIX II: ARTHUR ROTHSTEIN'S LECTURE AND QUESTION PERIOD DELIVERED AT THE RESEARCH & ENGINEERING COUNCIL OF THE GRAPHIC ARTS INDUSTRY

The following thirteen pages reproduce a transcription of a speech delivered by Arthur Rothstein in May of 1966 and the question and answer period that followed. The transcription includes his personal inscriptions on each page.

The original transcription was discovered in the Arthur Rothstein Manuscript Collection at the Library of Congress during my research. It shows how Arthur Rothstein and Cowles Communications promoted the xograph® during its peak. Thanks to Rothstein's daughter, Annie Segan, PhD, for her generosity in allowing the manuscript's publication for the first time.

It should be noted that the first page is numbered "11", and continues from "15" onwards. This is how the transcription was found; pages "12," "13," and "14" are missing.