Black and Blue: Revelations in Harold Mahoney's X-rayed Anatomical Sections*

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The Rijksmuseum photography collection holds two cyanotypes of sagittal sections of the human anatomy: nearly life size, limbless, and unidentifiable masses of phantom shapes with painterly textures from the same body. One is more exterior, rendering only small traces of the ribs, pelvic bone and femur, like quick calligraphic brushstrokes (fig. 1). The other represents two or three sections deeper within the body, offering an illuminated ribcage against the shadow of the liver, enclosed within a broader trunk (fig. 2).

Beginning in the nineteen-nineties, photographs from this cyanotype series found their way into some of the most prestigious museum and private collections around the world. However, until now, museums and collectors have had no information on their production or authorship. This research started with an analysis of an original negative that led to the information about the creation and provenance of these images.[1] The negative film had emulsion on both sides, which was not characteristic of any traditional silver gelatin negative and was instead exclusive to modern X-ray film.[2] Twentieth-century X-ray negatives were coated with light-sensitive silver gelatin emulsion on both sides, but they were exposed to X-rays instead of sunlight or incandescent light. The film stock provided an approximate date of the nineteen-thirties.[3] After a preliminary investigation into X-ray history and the types of anatomical sections depicted, the work of General Electric technologist Harold O. Mahoney (1893-1952) provided exact matches to the negatives.[4] The cyanotypes held by the Rijksmuseum are positives printed from X-ray negatives of cross-sectioned frozen cadavers, from a study in Chicago, dating to approximately 1934-38.

< Detail of fig. 1

Mahoney's radiographic study demonstrated what bone and detailed soft tissue in the same image could look like, a feat the computerized tomography (CT) scan would realize in the future.[5] He collaborated with Northwestern University to carefully prepare the cadavers prior to X-ray exposure. For the first time in over thirty years, this article identifies the provenance of the cyanotypes, while uncovering the creator, subjects, original context and objectives.

Previously, when art museums exhibited the cyanotypes, the interpretations have projected a universal humanness onto them, as if the subjects mirrored any human because the bodies had no established social context or identity. Both Mahoney's work and this research include a remaining photograph that suggests a racial identity to the series and limits

Fig. 1
ANONYMOUS
after a negative by
HAROLD O.
MAHONEY,
Radiographic View of a Sagittal Sectioned Human Body, c. 1941-49.
Cyanotype,
900 x 350 mm.
Amsterdam,
Rijksmuseum, inv. no.
RP-F-2019-209.

Fig. 2
ANONYMOUS
after a negative by
HAROLD O.
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Radiographic View of a Sagittal Sectioned Human Body, c. 1941-49.
Cyanotype,
900 x 350 mm.
Amsterdam,
Rijksmuseum, inv. no.
RP-F-2019-210.

this universality. Mahoney's inclusion of the subject undermined prevailing racist beliefs about the radiographed Black body with the clarity and detail represented, and it also made the Black subject more visible within an inequitable power system.[6] For this research, moreover, making this photograph visible locates the radiographic series within American systems of race and science, and this new context renders the cyanotypes more culturally rich and complex.

Seeing the Unseen

Early experimenters with photography believed they were recording nature, in the words of William Henry Fox Talbot, 'without any aid whatever from the artist's pencil'.[7] However, not all the laws of nature were visible or easily accessible to the camera, contact print or human eye. Additional devices besides the camera and photographic chemistry, such as microscopes, strobes and telescopes, brought the microbes, cells, locomotion, moon and stars closer to the observer than photography alone ever could.

At the end of 1895, the German engineer and physicist Wilhelm Conrad Röntgen discovered a new kind of ray that could record the interior structure of materials on photographic surfaces. He called this discovery 'X-ray', with the 'X' representing a previously unknown ray.[8] Röntgen's new process involved the camera-less exposure of photographic glass plates to the rays emitted from a vacuum tube, a feat requiring a high-powered current from an electric coil generator (fig. 3). The exposed plate became a photographic negative. By placing a subject onto the plate and making an exposure, he learned that this radiation revealed objects and materials otherwise invisible, beneath and behind matter.

Röntgen asked his wife Anna Bertha to lend her hand, and with it he created the first radiograph of the human body (fig. 4). It shows a shadow of her skeletal hand with a ring on her finger. Röntgen's exposure produced a latent image that appeared after development. Where the plate received the most rays, the negative's emulsion hardened

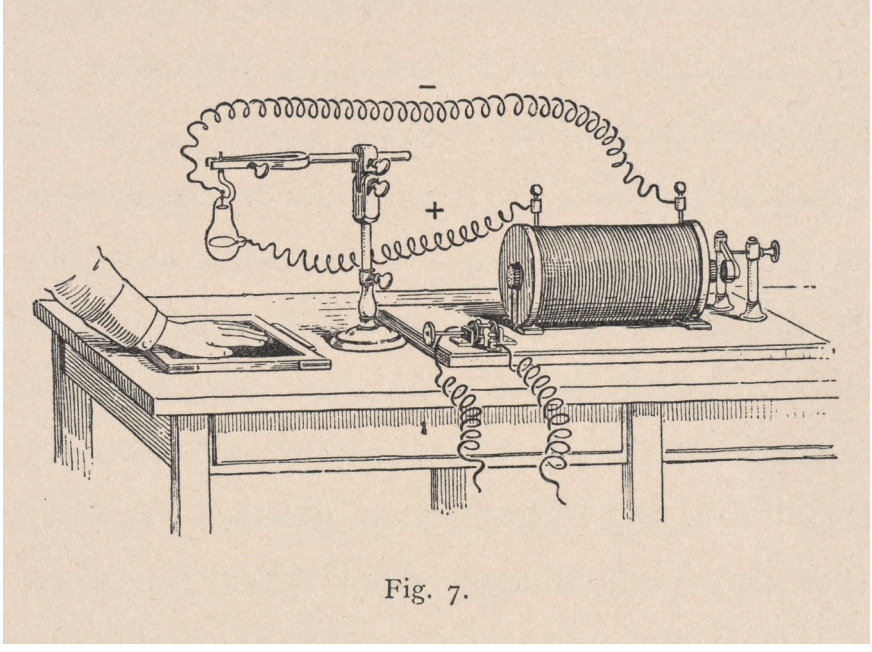


Fig. 3
Untitled Drawing, from Josef Maria Eder and Eduard Valenta, *Versuche über Photographie mittelst der Röntgen'schen Strahlen*, 1896, p. 12. New York, Metropolitan Museum of Art, inv. no. 2011.66.5; Alfred Stieglitz Society Gifts, Joyce F. Menschel Photography Library Fund, and Maureen and Noel Testa Gift. Photo © 2021. Image copyright The Metropolitan Museum of Art/ Art Resource/Scala, Florence

Fig. 4
WILHELM CONRAD RÖNTGEN, *Hand mit Ringen*, 1895. Radiographic print, 165 x 235 mm. Boston, MA, Harvard University, Francis A. Countway Library of Medicine, Collection of the Center for the History of Medicine, item E2003.I.47; gift of Dr Raymond A. Dillon to the Lloyd E. Hawes Collection in the History of Radiology.

and darkened, and where the plate received the least amount of rays, such as the bones, the negative appeared lighter. Röntgen's positive print made from the negative showed the reverse – dark bones surrounded by gradations of lighter shadows. Dense objects like bones or Röntgen's ring appeared more opaque, and soft tissue or flesh cast vaporous forms. With its ability to show the interior of mass and matter, the application of this process eventually became the most useful in medical settings.

The exposure of the interior human body onto the plate created a new photographic effect.[9] Radiographs presented layers of the corporeal

interior in varying states of vanishing and appearance. The exterior surface disappeared while specific layers of the interior appeared in spatial relation to the X-ray tube and the photographic plate. With this mediation, X-rays could focus on a specific interior layer without distractions of the skin, veins, or fluids. Bones were often the focal point of radiographs at the expense of losing the surface layer. Sometimes, a patient ingested contrast medium to highlight soft tissue organs, and this reduced focus on the surrounding bones. In some radiographs, however, some of the interior layers dissolved into each other, and this appeared as evidence of the vanishing effect. As early as 1896, radiography could expose corporeal elements beyond bone.[10] Yet not even the most accomplished radiographers could capture bone and detailed soft tissue in the same image.

Forty years later, Harold O. Mahoney led a study that overcame this challenge. *Radiographic View of a Coronal Sectioned Human Body* depicts a radiographed coronal section of the trunk, with all limbs removed (fig. 5). The bones glow in ribbon-like forms and, with the organs, provide a balanced, symmetrical composition. Moreover, the soft tissues of the lungs have a dappled shimmering appearance. The dense pelvic bone frames a strange swirling formation, which is its partially removed sexual organ. This layer offers a comprehensive arrangement of the musculature and bones, as well as the soft tissue, that fits together on a single plane.

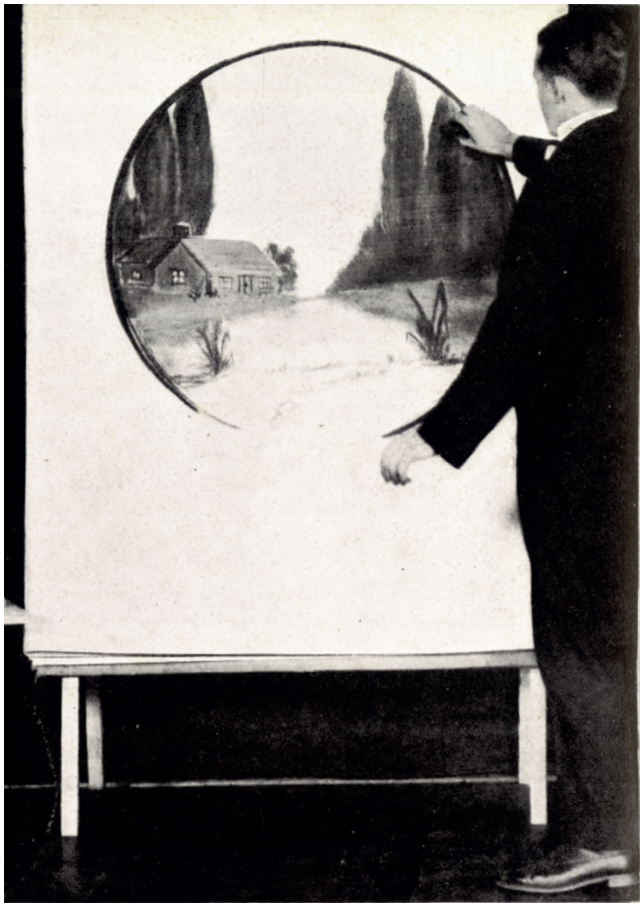
Uncovering the Creator

Harold 'Bob' Mahoney was an academically-trained studio artist and General Electric X-ray technologist born on 8 May 1893 in Zumbrota, Minnesota (fig. 6). He accomplished his seminal radiographic series of detailed soft tissue and bone with an academic art education and training in the formal principles of radiography.

< *Fig. 5*
HAROLD O. MAHONEY, *Radiographic View of a Coronal Sectioned Human Body*, c. 1934-38. X-ray negative, 899 x 349 mm. Brooklyn, NY, collection of David Winter.

> *Fig. 6*
ANONYMOUS, *Portrait of Harold O. Mahoney*, year unknown. Silver gelatin print, 203.2 x 254 mm. San Diego, CA, collection of Cindy Filips.

Fig. 7
Affiliated Lyceum Bureau, detail from *Scott & Mahoney* (promotional material), c. 1913-19. Iowa City, University of Iowa Special Collections, Redpath Chautauqua Bureau Records, msc0150, Box: 298.



Mahoney graduated from the Lyceum Arts Conservatory of Chicago, and as early as 1913 was a practising caricaturist and sketch artist for the Affiliated Lyceum Bureau.[11] He travelled with collaborators around the Midwest, performing at schools for American indigenous children, church recitals and university auditoriums (fig. 7). The Bureau recognized Mahoney's proficiency by stating, 'his talent is equaled only by his ambition. After his first year on the road he deliberately [gave up] a good position to study at the Art Institute of Chicago. There is deftness and surety about his strokes that evidence fine draftsmanship'.[12]

The Art Institute of Chicago offered drawing, modelling, painting, architecture and illustration, and was one of the only art schools in the United States to admit students of colour. Among its coursework was 'Artistic Anatomy', which included drawing the human form, studying casts from medical dissections, and students learned how to draw bones and muscles. Dissection was not offered at the Institute, but its programming explained that 'arrangements are easily made with the medical schools for any who desire it.'[13] Mahoney's lessons at the Institute introduced him to anatomy.

World War I signalled a further change in profession for Mahoney.[14] The war increased physicians' demand for radiography and a need for a

technological profession emerged. Schools in the United States began to offer radiography as professional technical training. Mahoney studied it at the Oklahoma Institute of Technology, which is now known as Northern Oklahoma College.[15] His professional venture into radiography followed the modernist impulse to examine the structure and underlying morphology of nature. Radiography provided a non-mimetic portrayal of anatomy rendered by means of new mechanical knowledge.

By 1920, Mahoney was working as a technical educator at the General Electric X-ray Corporation in Minnesota. He was one of the original members of the American Society of X-ray Technicians, which was chaired by Eddy C. Jerman.[16] Mahoney worked closely with Jerman, who led General Electric's X-ray Education Division and was responsible for creating the standards for the 'art' of radiography, meaning its emphasis on the formal elements of photographic quality to generate superior radiographs. Jerman explained his standards as follows: 'A good radiograph should contain the minimum of distortion, the maximum of detail without evidence of movement, sufficient contrast to make the detail plainly visible, and that degree of density which will in no way interfere with the maximum of contrast.'[17] These qualities were very much in line with straight photography aesthetics, which at the same time rendered subjects with strong detail and clear focus, thereby eliminating photographic manipulations that could cause distortions. An example of these qualities would be the exposures of fingers A, B and C (fig. 8). Finger A is clearly not manipulated, whereas B and C are covered in a contrast-cream that highlights the skin and nails. The cream shows the true density of the finger, but does not interfere with the exposure's contrast, and the distortions from the wrinkles are minimal. Jerman's standards aided X-ray technology to render subjects with contrast and detail, and reduce the X-ray effect, namely the fading of corporeal layers.

Mahoney's artistic interests ran concurrently with his work at General Electric. He maintained an artist studio in Chicago, drawing and painting the human figure, and he sought academic training to perfect his skill.[18] In 1925-26, he enrolled at the prestigious Art

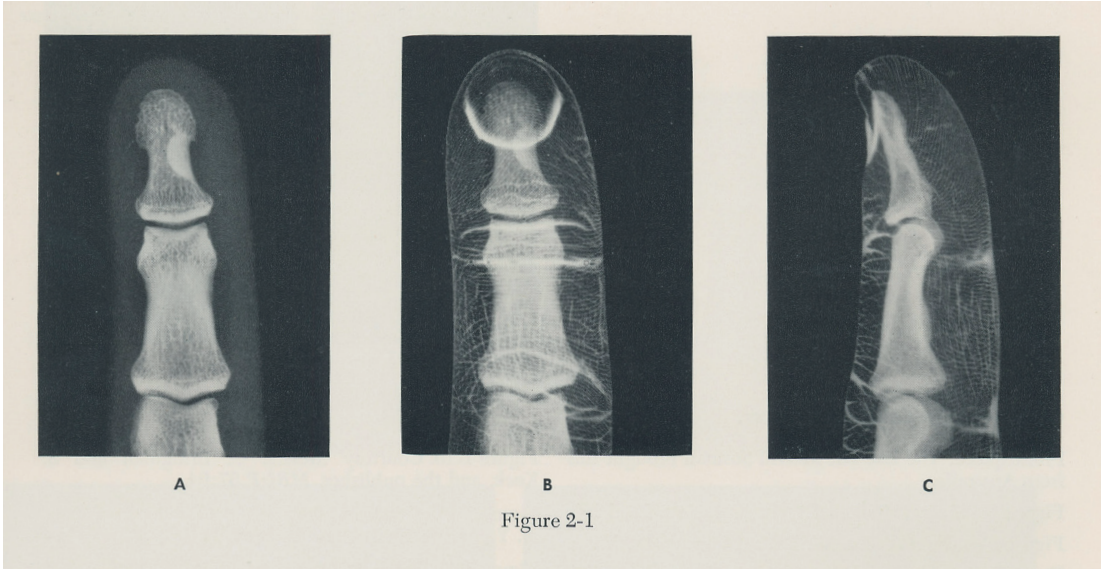


Fig. 8 *Fundamentals of Roentgenology* by Lucy Frank Squire, M.D., Cambridge, MA. Harvard University Press, Copyright © 1964 by The Commonwealth Fund.

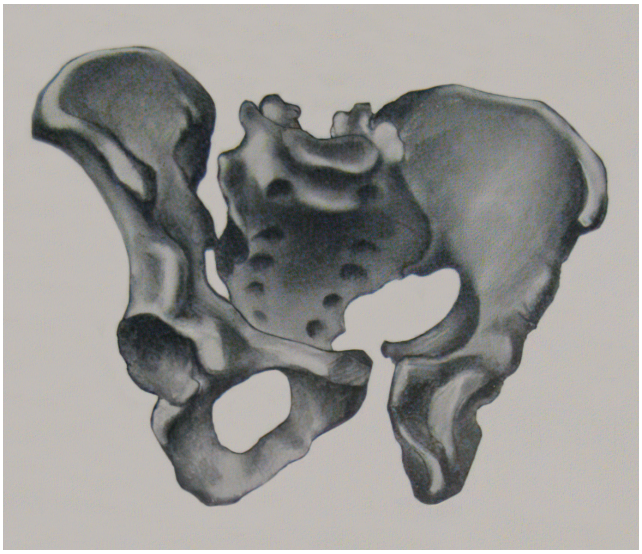


Fig. 9
HAROLD O. MAHONEY,
The Pelvis – Oblique View (Showing Separation of Ilium and Sacrum),
drawing c. 1934,
in Glenn Files,
Medical Radiographic Technic,
Springfield 1943,
p. 179.
Courtesy of Charles C. Thomas Publisher, Ltd., Springfield, IL.

Students League of New York, which around that time trained notable alumni such as Clement Greenberg, Lee Krasner, Milton Avery, and Elizabeth Miller.[19] Like the Art Institute of Chicago, the League admitted students of colour, including distinguished artists Joseph Delaney and Richmond Barthé. There, Mahoney studied under George Bridgman, 'an innovator in teaching anatomy and figure drawing', who taught many of the twentieth-century modernists.[20]

Bridgman emphasized compositional balance. In *Constructive Anatomy* (1920), he underscored that, prior to figurative construction, the student of art must mentally conceive of and understand the mass.[21] The student should start with blocks through which angles for composition and foreshortening could be drawn. Using this system, the student built a figurative construction with cubes and planar forms, before rendering the details. Bridgman's method considered bones as the 'laws of architecture' and muscles must be 'paired throughout the body … A vertical line in the centre divides the head or trunk into pairs equal, opposite, and complemental. … the limbs except for changes of position, are exact though reverse duplicates of each other.'[22]

Mahoney's education in radiography and academic art anatomy informed his future work on the series. In 1934, he received a temporary joint appointment between General Electric X-ray Corporation and Chicago's Northwestern University's Anatomy Department, where he had access to bones and drew them using the proportions he learned from Charles Schroeder, a German painter and instructor at the Art Institute of Chicago. He made the skeletal drawings, like the pelvis (fig. 9) to provide anatomical information for the proper positioning of the human body for radiography in X-ray literature.[23] In addition to drawings, Mahoney wanted to provide actual radiographs but he felt the methods employed in his day were 'unsatisfactory, principally because of the difficulty of maintaining the relationship of the various [anatomical] parts' with X-rays.[24] With the collaboration of Northwestern University's Anatomy Department, and his knowledge of figurative art and formal radiography, Mahoney consequently embarked on creating exposures that could teach anatomical positioning for radiographers.

The Process

Northwestern's Anatomy Department provided the bodies for Mahoney's study, which at the time were supplied by the Anatomical Gift Association.[25] Dr Barry J. Anson of Northwestern's Anatomy Department and Dr Roy F. Dent of General Electric jointly managed the process with Mahoney.[26] Previous studies included the radiographing of frozen body sections, but the processes did not involve months of dehydration, embalming or maintaining material uniformity so the results did not have the qualities of Mahoney's study.[27] Mahoney, Anson and Dent considered how to carefully prepare the cadavers prior to X-ray

exposure, because Mahoney recognized that X-rays detected variations in material consistency by superimposing corporeal layers in images. To reduce this unwanted effect, they constructed a special table designed for the purpose of creating parallel cross-sections in sequence that went through the anatomical mass, layer by layer, in parasagittal, paratransverse and paracoronal sections. These sections were three-quarters of an inch thick, had only few radiographic superimpositions, and retained superior detail and density.

After embalming and freezing a cadaver, they encased it in a rectangular block of paraffin wax, which offered ninety-degree angles for mathematical sectioning. Injecting paraffin into the body to preserve tissue was a common technique at the time, but Mahoney's use of a paraffin block as a guide through which to create uniform sections was new, and it was more similar to Bridgman's method of enclosing the masses of the body in cubes through which precise planes and draft lines could be made for symmetrical balance.

The team washed off the paraffin residue after sectioning and then dehydrated each section in a refrigerator for one year. Finally, Mahoney placed the sections on radiographic film and exposed them to X-rays to create the negatives. Based on the number of known radiographed cadavers, and the timeline required for each, the entire radiographic project probably took three or four years.

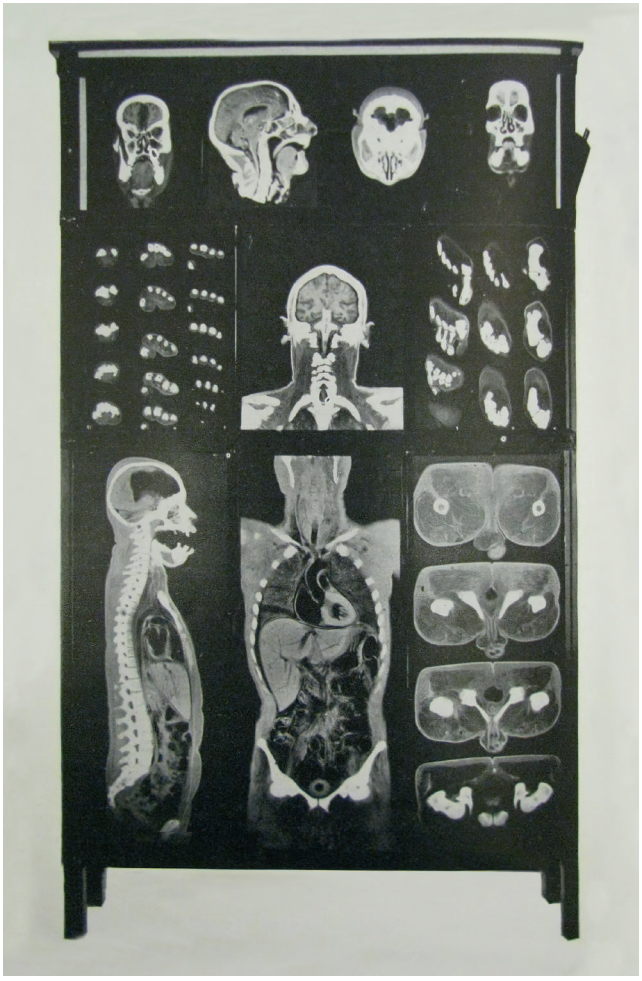


Fig. 10
Display case, in Harold O. Mahoney, Barry J. Anson and Roy F. Dent, 'Roentgenographic Preparations from Gross Anatomic Sections', *American Journal of Roentgenology and Radium Therapy* 56 (July 1946), no. 1, p. 52.

Exhibitions and Publications

Harold Mahoney's collaborative project created X-ray exposures of complex anatomical sections with a clarity never seen before. For exhibitions, he designed a glass display case that back-lit the negatives to illuminate the detailed anatomical figures (fig. 10). From 1936 to 1938, Mahoney presented the series of negatives as a new archive of anatomical knowledge.[28] However, with the social systems in place, knowledge was not equitably disseminated. At the time of Mahoney's exhibitions, medical and radiological societies had started admitting Black members but most of the constituency for knowledge was a white male audience. The American Medical Association that awarded Mahoney's study an Honourable Mention (1926) later acknowledged a history of obstructing Black physicians from membership.[29] Between the wars, white women accounted for as much as eighty percent of the radiography profession because, as a technical position, it was understood as support for the radiologist, and Black radiog-

raphers had limited training.[30] What this meant in practice was that it was primarily white audiences who had access to this knowledge. Mahoney also travelled throughout the country teaching radiography to the sisters of Catholic hospitals, who made up one-sixth of registered women radiographers.[31]

After he took the exhibition on the road, research publications began publishing the negatives. In 1941, Kodak scientist Arthur Fuchs republished a radiographed sagittal section in his study on 'Thoracic Vertebrae'.[32] General Electric republished several radiographs in their *Medical Radiographic Technic* series (1943), along with Mahoney's skeletal drawings.[33] He, Anson and Dent co-authored a report in 1946 for the *American Journal of Roentgenology and Radium Therapy*. In 1947, Mahoney delivered the first Jerman lecture to the American Society of X-ray Technicians with the focus on this study, in memoriam to his teacher Ed C. Jerman.

Despite the radiographic community's initial welcome to Mahoney's images, the technical process, which demanded substantial time, physical labour and cadavers, was too impractical to be broadly replicated. Other scientists had difficulty scaling his process with the same precision and acuity.[34] By mid-century, only a few scientists worldwide had adopted his methodology; however, even they admitted that they could not attain the 'superior' detail of his images.[35]

With his experience of mastering the formal qualities of radiography and exhibition, Mahoney became manager of General Electric's Customer Relations in Advertising and Sales Promotion and trained more radiographers at technical schools. He continued this work with more academic art training at the Art Institute of Chicago, where he studied painting, drawing and sculping the human form.[36] He died of cancer in 1952.[37]

Fig. 11
Army Medical Museum and Library, Seventh Street and Independence Avenue Southwest, Washington, DC, after 1933. Washington, DC, Library of Congress Prints and Photographs, inv. no. HABS DC,WASH,392-.

In the early nineteen-forties, the Army Medical Museum procured Mahoney's negatives from Northwestern University for 'permanent exhibition' (fig. 11)[38] At that time, the museum had become the primary exhibition venue of the Armed Forces Institute of Pathology and was open to the public to display the material and visual studies of morbid anatomy and the war-wounded.

After World War II, the museum experienced a shortage of space and initiated plans to build a new archive facility, relocate collection materials and deaccession a number of items.[39] As the negatives went through exhibition and de-installation, the museum records did not maintain Mahoney as the primary creator of the negatives. Towards the end of the nineteen-fifties, Dr Lucy Frank Squire, a rising radiologist in New York State, received deaccessioned materials from the museum that became part of her didactic collection.[40] Squire published *Fundamentals of Roentgenology* (1964), which became a standard for teaching radiologists and radiographers and is still published in revised editions to this day. Beginning with the first edition, Squire reproduced five of Mahoney's negatives to instruct readers how to 'focus down intellectually' through various layers.[41] Importantly, she did not indicate the pictures' date, original maker or technological process because those components had already been lost. By the time the deaccessioned

items passed into her hands, the archival processing had created unknown pictures primed to be appropriated beyond their original use.

Squire eventually worked at the State University of New York Health Center in Manhattan until her retirement and death in the nineteen-nineties. In the middle of the decade, the negatives along with cyanotype prints of the negatives appeared together at Manhattan's 26th Street flea market, which was how the cyanotypes entered the art market.

The Cyanotypes

Fine art photography dealer, Daniel Wolf, found approximately ninety cyanotype prints and negatives together at the flea market.[42] The cyanotypes were large contact prints, and each was cut to the same dimensions as its negative counterpart. The cyanotype process, with its Prussian blue tonality, had the benefits of practicality while conveying a striking colour.

The cyanotype colour results from a photochemical reaction between two iron salts.[43] When the photographer exposes the sensitized paper under light in a printing frame with a negative, an image appears in yellow and green tones and, after washing the print in water, the print deepens into cyan with the white of the paper visible. An optional bath of hydrogen peroxide intensifies the blue image. Other variations of this process can affect the hue and the stability of cyanotype prints.[44]

Cyanotype printing was inexpensive and not labour intensive in comparison to silver-based processes, and by the nineteen-forties, it had become part of the publication process to proof negatives onto cyanotype paper prior to their reproduction in print.[45] This positive cyanotype print of Mahoney's aforementioned negative is currently held by the Museum of Fine Arts, Houston, Texas (fig. 12). Dark Prussian blue has replaced the ribbons of light bones, the flesh's muscle striations are more pronounced and the black areas of the negative are now a lighter blue or white. The three blue dots along the bottom correspond with the holes in the negatives used to make the contact prints. Throughout the twentieth century, radiographic literature regularly published the negative image, as radiographers and radiologists were used to interpreting negatives instead of positive prints. As early as 1941, journals published Mahoney's radiographs, this continued through the nineteen-forties while the Army Medical Museum housed the negatives.

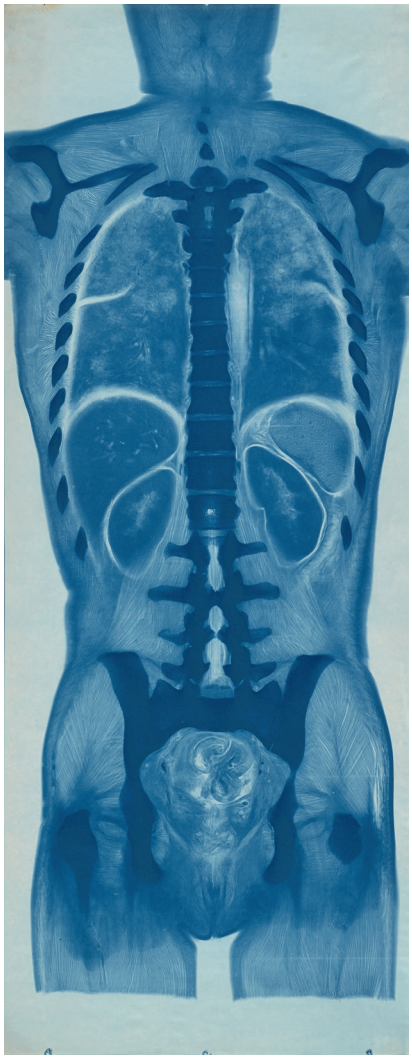


Fig. 12
ANONYMOUS
after a negative by HAROLD O. MAHONEY (fig. 5), c. 1941-49. Cyanotype, 899 x 349 mm. Houston, Museum of Fine Arts, inv. no. 2014.681; museum purchase funded by Joan Morgenstern in honour of Dr Gilbert Lechenger.

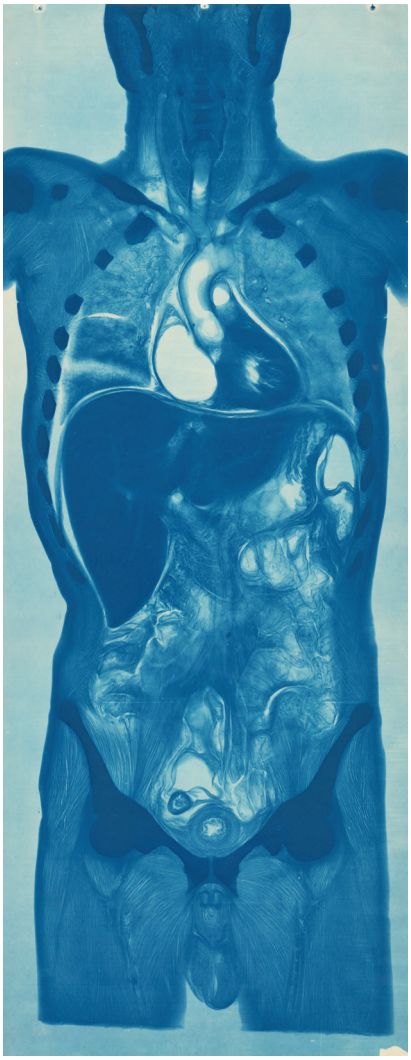


Fig. 13
ANONYMOUS
after a negative by HAROLD O. MAHONEY, *Radiographic View of a Coronal Sectioned Human Body*, c. 1941-49. Cyanotype, 900 x 350 mm. Washington, DC, National Gallery of Art, inv. no. 2002.6.1; The Horace W. Goldsmith Foundation, through Robert and Joyce Menschel.

Most likely, the museum created the cyanotypes to proof the negatives for publication. The divisions of the museum included the Army Medical Illustration Service, which had collected 100,000 negatives and, during wartime, used its facilities and staff to print photographs for museum-published atlases, graphics for military surgeons' education and for external publications using their collection items.[46] The cyanotypes have remained in pristine condition, lacking indications of frequent use.

The collection of radiographic negatives and cyanotypes contained a sequencing of specific anatomies, demonstrating that the original owner wanted to have the pictorial relationships maintained. For example, two cyanotype prints depict coronal sections from the same body: the print at the National Gallery of Art, in Washington, DC (fig. 13) is the section before the one at the Metropolitan Museum of Art in New York, NY (fig. 14). The first one presents fully observable organs such as liver, heart and intestines, as well as the neck muscles and oesophagus. It is also printed from one of the negatives featured in Mahoney's display case. One layer deeper, the second print reveals the cervical vertebrae at the neck and a glimpse of the spine at the waist, but less of the heart and intestines. Both cyanotypes share a heart, liver, intestines and pelvis. With the number of known printed sequences available, the lot would have comprised a decent-sized atlas. However, if the museum had planned an atlas for these radiographic negatives, it may not have completed publication due to the post-war changes.[47]

Daniel Wolf and the subsequent art dealers discovered these cyanotypes in the mid-nineteen-nineties, when there was a demand for historic process photography. The cyanotypes had no indications of their provenance with Squire, the Army Medical Museum, Mahoney or Northwestern University. Photograph historian John Wood acknowledged that the heedless rush of the photography market removed photographs from their original contexts and collectors had to strive to 'levels … unknown in most other areas of the arts. There is nothing to rely upon but one's own eye.'[47] With no information about these cyanotypes when they were found at the flea market, the collecting interest in the lot largely depended upon their novel subject matter rendered with the non-silver process.

Fig. 14
ANONYMOUS
after a negative by HAROLD O. MAHONEY, *Radiographic View of a Coronal Sectioned Human Body*, c. 1941-49. Cyanotype, 908 x 352 mm. New York, Metropolitan Museum of Art, inv. no. 1996.351; The Horace W. Goldsmith Foundation Gift, through Joyce and Robert Menschel. Photo © 2021. Image copyright The Metropolitan Museum of Art/Art Resource/Scala, Florence

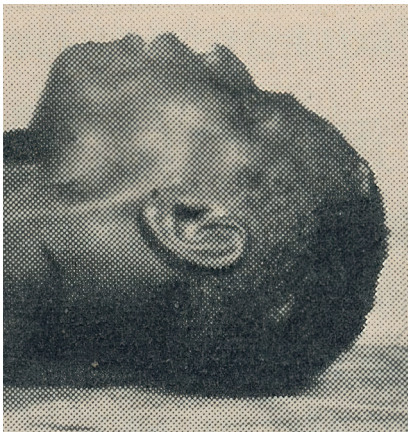


Fig. 15
Detail of *Photograph*, from Harold O. Mahoney, 'A Radiographic Study of Anatomic Sections', *X-Ray Technician* 19 (July 1947), no. 1, p. 6. Photo: © ASRT Museum and Archives, Albuquerque

The Subjects

As radiographed subjects, the bodies reveal comprehensive landscapes of arteries, calligraphic bones, shimmering organs and fibrous muscles. The technical processing and provenance of the radiographs explain the novel effects. However, the X-ray is just the surface. A deeper examination of these photographs reveals the subjects and social systems in which they lived. Harold Mahoney chose to illustrate his study with a photograph of a cadaver, prior to full sectioning and radiography: a man of colour in repose. This subject, beautifully preserved in the face, is the identity of the series (fig. 15).[49] At the time, Northwestern University did not admit Black medical students, but this photograph and supporting information suggest that Black Americans likely contributed their bodies, consensually or not, to this series.[50]

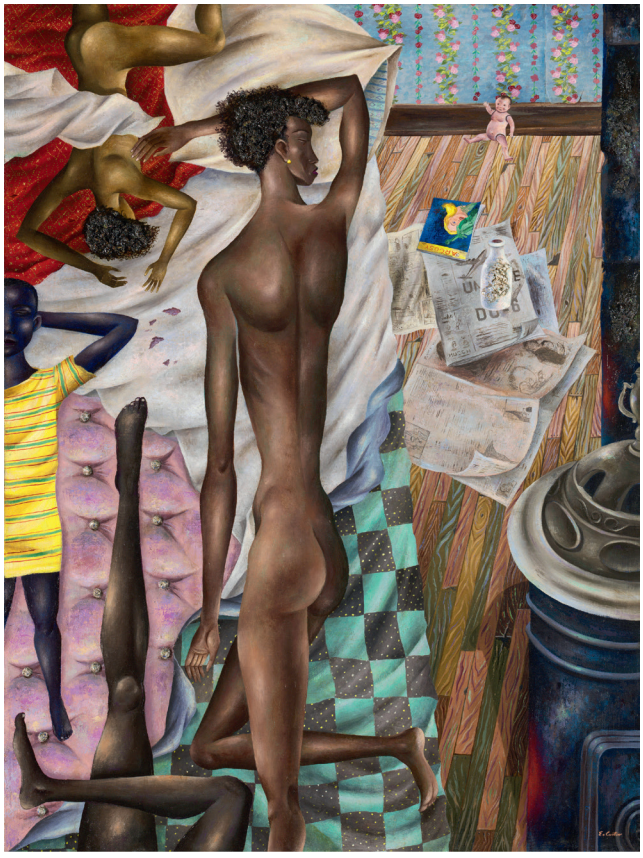
The subject arrived as a cadaver at Northwestern through social systems that did not enable growth or project value on the Black American population. After the American Civil War, in the latter part of the nineteenth century, Southern states imposed Jim Crow laws, which mandated the racial segregation of living spaces and public utilities, and suppressed Black voting. These laws drove many Black Americans to relocate from the South to the Northern cities during the Great Migration and Great Depression. The Black population in Chicago swelled to 6.9 percent in 1930, and simultaneously, the city enacted discriminatory housing policies influenced by Jim Crow.[51] Racial segregation limited Black Chicagoans to overcrowded neighbourhoods known as the Black Belt. According to sociologist John Gibbs St Clair Drake, whose research pioneered Black studies in the United States, the population density in the Black Belt was '90,000 to the square mile compared with 20,000 to the square mile in adjacent apartment areas'.[52]

Eldzier Cortor, who was an artist of the Chicago Black Renaissance movement, painted intimate scenes of the Bronzeville neighbourhood and its overcrowded living quarters for residents. *Room No. VI* depicts four mostly nude figures resting on a mattress in a crowded apartment (fig. 16). Their elongated figures do not fit within the cramped picture field, the space amputates, contrasting the white baby doll's body that appears whole with plenty of space around it. Cortor's work shows the effects of the segregation and discriminatory policies, while at the same time represents these figures as comparatively authentic, beautiful and with community. These living conditions were widespread in the Black Belt. The area's lack of quality housing and poor sanitary conditions contributed to a death rate for Black Chicagoans that was double that of whites.[53]

These social conditions may have played a role in Northwestern's acquisition of cadavers. Scholar Harriet Washington has shown that early twentieth-century anatomical dissection included a Black majority of cadavers and the trafficking was a – sometimes covert – national trade.[54] The Illinois Cadaver Act of 1885 enabled Northwestern and Mahoney access to the bodies in public institutions and those that were unclaimed and had no private funds for burial.[55] In Chicago's Bronzeville neighbourhood, thirty-six to sixty-nine percent of Black families were on economic relief.[56] With the systems in place, it is highly likely that the bodies in this study are largely or exclusively Black Chicagoans.

Black subjects did not frequently appear in radiographic literature prior to this project. Prejudices created a cultural index in radiography that positioned the most easily penetrable bodies and materials on a continuum of value. Scientists found that authentic diamonds and other precious stones appeared with transparency where-as paste imitations had degrees of opacity: 'the X-ray was an infallible test of a genuine diamond and that a real stone would transmit the rays as easily as glass permits the passage of light, while a spurious stone was opaque to them.'[57] Josef Maria Eder and Eduard Valenta created this table of materials by their penetrability (fig. 17), which shows that carbon in the form of diamonds is among the most permeable. Moreover, scientific observations on material penetrability transferred to prejudices about bodies based upon skin colour. White women were frequent subjects in radiographic literature. Scientific and cultural material eroticized white women's bodies as easily penetrable and transparent as a way of making X-rays more palatable for public consumption.[58]

Fig. 16
© ELDZIER CORTOR, *The Room No. VI*, 1948. c/o Pictoright Amsterdam 2021 Oil and gesso on Masonite, 1073 x 800 mm. Chicago, Art Institute of Chicago, inv. no. 2007.329; through prior acquisition of Friends of American Art and Mr and Mrs Carter H. Harrison; through prior gift of the George F. Harding Collection. Photo: © 2020. The Art Institute of Chicago/ Art Resource, NY/ Scala, Florence



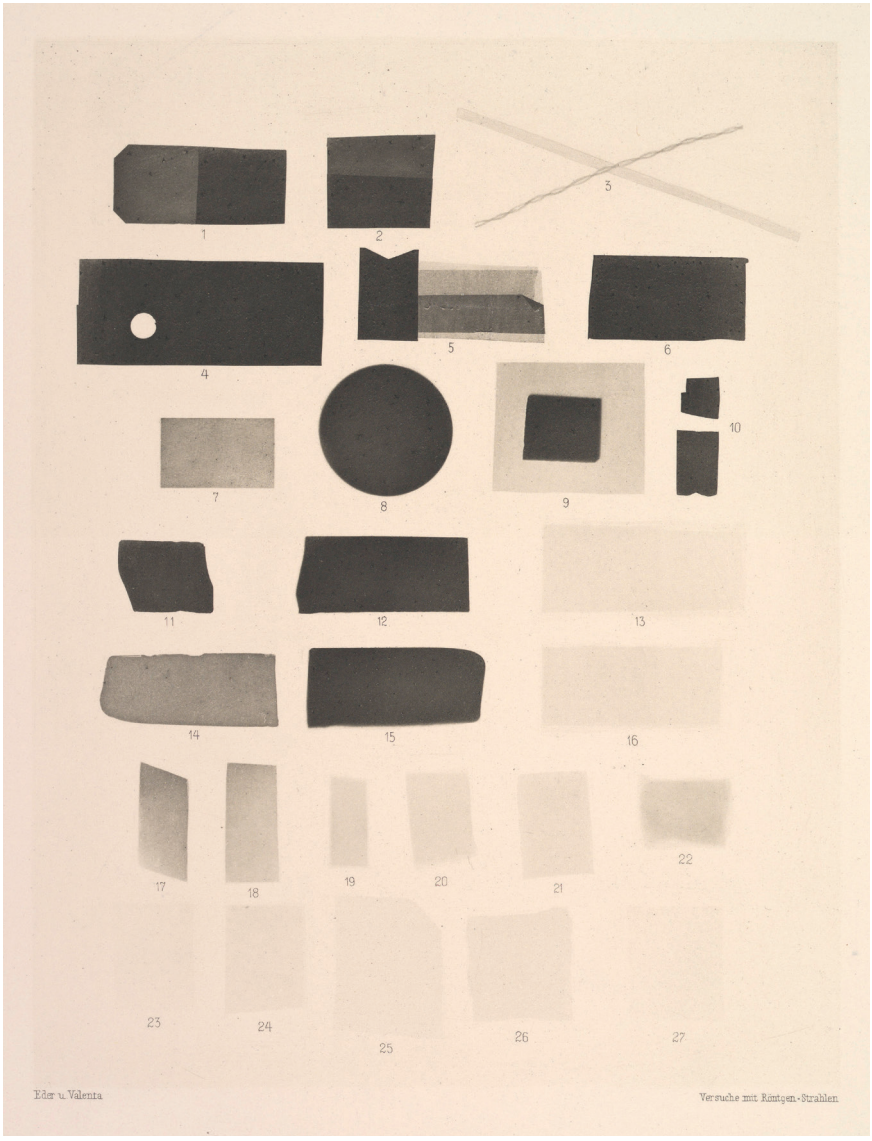


Fig. 17
X-ray of Samples of Various Materials (Plate 5), from portfolio in Josef Maria Eder and Eduard Valenta, *Versuche über Photographie mittelst der Röntgen'schen Strahlen*, 1896. Photogravure, 230 x 177 mm. New York, Metropolitan Museum of Art, inv. no. 2011.66.5; Alfred Stieglitz Society Gifts, Joyce F. Menschel Photography Library Fund, and Maureen and Noel Testa Gift. Photo © 2021. Image copyright The Metropolitan Museum of Art/Art Resource/Scala, Florence

Black subjects were on the other end of the spectrum. In 1896, a Memphis physician remarked, 'A genuine negro's skin is perfectly black, and black being perfectly opaque, it seems that it would offer some resistance to cathode rays.'[59] This logic suggested that the Black body was considered a highly impregnable or challenging site for X-rays – resulting in poor clarity, and an illegitimate one for representation due to the prejudice about opacity.

The belief that Black bodies had thicker skin, tissue and bone than white bodies led some scientists to believe that Black subjects required more radiation for exposure. This famously occurred in 1911, when X-ray technologists exposed the head of boxer Jack Johnson for non-medical intrigue, increasing the dosage from fifteen seconds to five and a half minutes due to his 'muscular and cartilaginous covering'.[60] Until at least 1968, these racist beliefs about

Black bodies resulted in some American X-ray technologists increasing dosages by forty to sixty percent longer for Black patients.[61] The cultural index in radiography that positioned Black subjects in the zone of opacity had racist and harmful implications, and to this day the health consequences are not fully known.

Mahoney's study did not address dosage adjustment based upon race, but it did challenge the existing presumptions about the opacity of Black subjects. Each radiograph presents the body with lucidity, clarity and detail of tissue and bone, contrary to the prejudice that Black bodies were more opaque, unclear and difficult to read. *Radiographic View of a Coronal Sectioned Human Body* depicts a body with its delicate textures and organs visible (fig. 18). The uniform section removes most of the thoracic vertebrae from the posterior view, except at the transept. Below the transept, the valves of the heart dissolve into the branching of the lungs; the dissolution is indicative of the X-ray effect. With the focus on the human torso, this research could have provided information for positioning patients for the national tuberculosis crisis, which was the second highest leading cause of death among the Black American population.[62] Secondary research that cited this study did not address the race of the subjects, which suggests that the heavily manipulated work transcended prejudice or that the scientifically racist belief systems persisted.[63]

Mahoney and his colleagues' personal views on race are lost to history. However, the study's procurement of the bodies capitalized upon people who suffered economic misfortune, which largely included the Black population. More broadly, American medical experimentation at the time was racist. This was during the early years of the infamous Tuskegee Syphilis Study, which failed to deliver treatment to six hundred syphilis-infected Alabama share-croppers and lied to the participants, telling them that they were receiving treatment. Harriet Washington has asserted that from the perspective of American medicine, these participants were worth 'more dead than alive'.[64] The bodies for Mahoney's study came from this system that failed and exploited Black Americans.

With a medical system discreet in operations, it was uncommon to see a photograph of a subject prior to dissection or sectioning in a published form. Of the published reports on this study, only Mahoney's singularly authored article included the photograph of the subjects. This photograph and the supplemental historical evidence establish a social identity to frame the subjects in the radiographs, enabling

Fig. 18
HAROLD O. MAHONEY, detail from *Radiographic View of a Coronal Sectioned Human Body*, c. 1934-38. X-ray negative, 899 x 349 mm. Brooklyn, NY, collection of David Winter.

an interpretation of Black life and death in their exposed entrails, presence and fragmentations. Ralph Ellison described the Black American experience of social invisibility and alienation in *Invisible Man* (1952): 'I am an invisible man. No, I am not a spook … I am a man of substance, of flesh and bone, fiber and liquids – and I might even be said to possess a mind. I am invisible, understand, simply because people refuse to see me. Like the bodiless heads you see sometimes in circus sideshows, it is as though I have been surrounded by mirrors of hard, distorting glass. When they approach me they see … everything and anything except me.'[65] Repositioning the social identiy of the subject is the beginning of visibility, but more must be done to construct a fully-realized portrait of lives and the communities they came from.

New Insights

This article establishes the provenance of the Rijksmuseum's cyanotypes, bringing to light the maker, the technologies, the subject and the cultural attitudes prevalent in the United States underlying the production. In summary, Harold Mahoney directed this project in Chicago, which notably captured detailed soft tissue and bone in the same radiograph, and he aimed to create new anatomical knowledge for the radiographer with these images. This is the critical information that museums and galleries have needed for the last thirty years.

However, this research also exposed serious social inequities and the bodies are no longer just phantom masses in blue. With their sinews, bone and organs, the bodies of some Black Americans comprised these interior landscapes in the radiographs. The Illinois Cadaver Act of 1885 did not guarantee the full consent of the subjects because the Anatomical Gift Association of Illinois sent the bodies, both Black and white, that needed burial at the public's expense to medical educational facilities. These

cyanotypes printed from the radiographs have now entered the aesthetic domain, and a reckoning must occur in terms of under what conditions these photographs can be appreciated.

While some museums have explored wall text as a response to provide context for the art of colonialism, art that depicts stereotypes or systems of slavery, the reckoning with these cyanotypes should mobilize the assets and engagement of Black scholarship. Turn of the century social reformer Ida B. Wells was a historical precedent. She was a journalist and co-founder of the National Association for the Advancement of Coloured People who led a rigorous anti-lynching campaign. According to Leigh Raiford, Wells curated material on lynching with photographs that could make the Black identity more visible and human.[66] Wells's strategy involved supplementing a pamphlet, essay, or exhibition with a photograph 'professionally made' of a lynching, 'of herself', or of a lynch victim's family.[67] This approach increased awareness of the brutality, developed compassion for the Black community, and added names of white support for the anti-lynching movement.[68] Together, the photographs and text supported a Black reclamation of the tragic and unjust narrative with a new archive of knowledge about the Black American identity.

The inequities present in the cyanotypes similarly prompt a need for more equitable measures in their display or interpretation. To scale Wells's approach, the subjects in the Rijksmuseum's cyanotypes have no known families, but there is now an estimation of where they came from – Chicago's Black Belt community. Eldzier Cortor's depictions of Chicago's Black life, among other Black Chicagoan artists of the time, can provide the important perspective on that community. The Cadaver Act did not guarantee the agency of the people who were sectioned and radiographed. This means that to complete the strategy and rectify a narrative for our time, art museums can actively engage in conversations with living Black scholars, artists or museum staff to frame the cyanotype narrative for a contemporary interpretation.

Contemporary poet and philosopher Fred Moten, who examines aesthetics in Black American culture, has theorized, 'Black and blue are highly charged colours in the cosmology of African American culture and historical experience. Night's blackness holds a unique suggestion of terror in Black American history. One is also reminded that the ancestors of many families escaped slavery under the cover of darkness in the blue-black night. … the entire history of Africans in North America can be told through reference to these two colours.'[69] Although the colours in the cyanotypes metaphorically suggest horror and tragedy. Moton's colour theory suggests there is also the opportunity for the framing of agency. Art museums as culturally powerful institutions can integrate people of colour to reclaim the narrative.

A cyanotype from the National Gallery of Art, Washington DC, shows a sagittal section (fig. 19). The X-ray effect can be seen in the spine as it gradually fades, dissolving into the right lung, thereby creating a tension of presence. In the profile the soft shadow of the jaw's outer flesh frames the cranial structure's calligraphic outlines and glassy rendering. The prismatic effect separates the eye from the cranium, suspending it in a pool of blues. It is now clear that this subject is both Black and blue, human but also fragmented, and from a time of racial segregation. Unlike the other cyanotypes, this particular subject has an open eye that looks forward to a future of meaningful change.

< *Fig. 19* ANONYMOUS after a negative by HAROLD O. MAHONEY, *Radiographic View of a Sagittal Sectioned Human Body*, c. 1941-49. Cyanotype, 900 x 350 mm. Washington, DC, National Gallery of Art, inv. no. 1999.33.1; The Horace W. Goldsmith Foundation, through Robert and Joyce Menschel.

ABSTRACT

Approximately ninety cyanotypes and negatives depicting interior views of the human body – among the most obscure works in the art world – are now in the Rijksmuseum Photography Collection. They have no established provenance, production or creator, and without these factors, interpretations for the last thirty years have resulted in speculations. By examining an original negative and print, aided by research in X-ray history, this study uncovered the missing information. Harold Mahoney, a Chicago-based X-ray technician and an academically trained artist of the early twentieth century, was the original creator of the negatives. With his radiographic process, he managed to capture detailed soft tissue and bone in the same image on film, decades before computerized tomography scans.

Art museums around the world have until now emphasized the universal humanness in the cyanotypes, as the social identity and context were unknown. This research has brought a racial identity to the series through a surviving photograph of a subject that Mahoney chose to supplement his published study. The racial core that appears from beneath the X-rays creates an interpretive framework for an American narrative about this photographic series, resonating with the historical and contemporary need for Black visibility and value. With new social inequities discovered in the cyanotypes that could complicate exhibition, this study also suggests an approach for museums to welcome a Black reclamation of the narrative. This research establishes the provenance and foundational analysis for the series that has fascinated museums and collectors for three decades.

NOTES

* The author would like to acknowledge David Winter, collector of Brooklyn, and Jeff Rosenheim, curator in charge of Photographs at the Metropolitan Museum of Art, both of whom were significant at the initiation of this research and upon its completion during the Covid-19 pandemic. She thanks Kathryn Conner Bennett, professor at Old Dominion University, for her editorial support. Additionally, the author recognizes the following individuals who were interviewed for this article: the late Catherine Price, the daughter of Harold 'Bob' Mahoney, and her daughter Cindy Filips; the late Daniel Wolf, the photography dealer and collector who discovered these radiographs in Manhattan; Paul Stone, historian of the Armed Forces Institute of Pathology; the artist Francis Cunningham and Robert A. Novelline M.D., both collaborators of Lucy F. Squire.

1 David Winter, a Brooklyn-based collector and dealer, lent me a negative and a cyanotype print to study.

2 Modern X-ray film had photographic emulsion on both sides. Prior to double-sided emulsions, radiographers needed intensifying screens to enhance the contrast of images on the fluoroscope and the X-ray photograph. Double-sided emulsion film offered more contrast and reduced the subject's exposure time, therefore it came to be known as 'non-screen film'. T.A. Longmore, *Medical Radiography: Radiographic and Clinical*, New York 1944, pp. 28-32; ibid., *Longmore's Medical Photography*, New York 1962, pp. 471-72.

3 David Winter's negative was stamped 'Agfa Safety Film'. After professionals found cellulose nitrate X-ray film unsafe due to its flammability, safety film appeared on the photography market, beginning in the nineteen-twenties for Kodak and the nineteen-thirties for Agfa. See David G. Horvath, *The Acetate Negative Survey: Final Report*, Louisville, February 1987 (report, University of Louisville), https://gawainweaver.com/images/uploads/Horvath_AcetateNegativeSurvey.pdf (accessed 28 January 2018).

4 All work authored by Mahoney relevant to this study is in this note: Harold O. Mahoney, 'Anatomy', in Glenn Files, *Medical Radiographic Technic*, Springfield 1943, pp. 168-202; Harold O. Mahoney, Barry J. Anson and Roy F. Dent, 'Roentgenographic Preparations from Gross Anatomic Sections', *American Journal of Roentgenology and Radium Therapy* 56 (July 1946), no. 1, pp. 49-54; Harold O. Mahoney, 'A Radiographic Study of Anatomic Sections', *X-Ray Technician* 19 (July 1947), no. 1, pp. 3-13.

5 Mahoney's study emerged concurrently with 'body-section roentgenography', which instead used X-rays to non-invasively slice

through the body. The early radiographs were often blurry and did not succeed at capturing soft tissue and bone in the same image. Emerging in the early nineteen-seventies, computerized tomography scans, which utilized X-rays to non-invasively section bodies and record the slices on the computer, created clean representations of soft tissue and bone. Body-section roentgenography was the technical precursor to the CT scan, while Mahoney's study achieved the high-quality visuals of it.

6 The adjective 'Black' in this story identifies people in the United States who may have descended from regions of the world such as Africa, Asia and Oceania, and dispersed to the Western Atlantic. 'Black' is capitalized because these people have shared cultural and historical experiences, including discrimination based upon their skin colour.

7 William Henry Fox Talbot, 'Introductory Remarks', in ibid., *The Pencil of Nature*, London 1844, p. i.

8 W.C. Röntgen, 'On a New Kind of Rays', in Otto Glasser, *Dr. W.C. Röntgen*, Springfield 1945.

9 Lita M. Tirak, 'Ch. 1: X-ray Vision and the Body', in ibid., *Radiant Exposure: The Art and Spectacle of the X-Rayed Body in American Visual Culture*, Williamsburg 2016 (unpub. diss. College of William and Mary).

10 William James Morton, who wrote the first X-ray manual in the United States, published that he could obtain 'delicate, ghost-like, yet clearly defined, outlines of skin, muscle, tendon', and 'veins, arteries, and soft tissue organs when injected with a contrast medium'. See William James Morton and Edwin W. Hammer, *The X-Ray; Or, Photography of the Invisible and Its Value in Surgery*, New York 1896, pp. 144, 157-58.

11 Iowa City, University of Iowa Libraries, Special Collections, Affiliated Lyceum Bureau, *Scott & Mahoney*, c. 1913-19, MSC0150, p. 6; 'Chilocco Items of News', *The Indian School Journal*, September 1913, p. 336.

12 *Scott & Mahoney*, ibid.

13 'Artistic Anatomy', *The Art Institute of Chicago: Circular of Instruction…*, Chicago 1909, p. 39.

14 In 1917, Mahoney registered as a 'Private' during World War I in his home of Tonkawa, Oklahoma, where he received training in X-ray technology. He still identified as a 'cartoonist' for the Lyceum Bureau.

15 Sister M. Gaudentia, 'In Memoriam: Harold O. Mahoney', *X-Ray Technician* 24 (November 1952), p. 217.

16 Margaret Hoing, *A History of the ASXT: 1920 to 1950*, Saint Paul 1952, pp. 13-15.

17 Ed C. Jerman, *Modern X-Ray Technic*, Saint Paul 1928, p. 119.

18 Correspondence with Mahoney's daughter, Catherine Price, 11 August 2015.

19 Dates and coursework from Mahoney's student registration card, Special Collection, The Art Students League of New York.

20 James E.B. Breslin, *Mark Rothko: A Biography*, Chicago 2012, p. 61.

21 George B. Bridgman, 'Introduction', in ibid., *Constructive Anatomy*, London 1920.

22 Ibid., pp. 11, 114.

23 Files 1943 (note 4), p. 168.

24 Mahoney 1947 (note 4), p. 5.

25 Personal correspondence, message from Dr Larry Cochard in the Anatomy Lab, forwarded by Grant P. Upson, 3 September 2015.

26 Of the three collaborators, Mahoney was given the most credit for the study by the radiographic field. Files 1943 (note 4) only credited Mahoney as the author, who utilized the anatomy from Northwestern, and Mahoney's 1947 article mentioned Dent and Anson as 'associates' (note 4). Mahoney and General Electric took ownership of this project whereas Northwestern University lost the documentation of the study over time. The 1936 exhibition of these negatives at the *Illinois Medical Journal* lists Mahoney as the primary creator in collaboration with Northwestern University. https://archive.org/stream/illinoismedicalj70unse/illinoismedicalj70unse_djvu.txt (accessed 5 December 2020). Note 33 demonstrates secondary research crediting the study only to Mahoney.

27 See Nathan Barlow and James C. Thompson, 'Small Pneumothorax in Tuberculosis', *Hygienic Laboratory Bulletin* 132 (1922), pp. 7-38; Maximilian Weinberger and Emil M. Engel, *Atlas der Radiographie der Brustorgane*, Vienna/Leipzig 1901. These radiographs superimpose the interior layers, and the soft tissue is also not highly detailed.

28 Mahoney 'exhibited first at the Kansas City (1936) meeting of the American Medical Association (awarded Honorable Mention); by invitation at meetings of Illinois State

Medical Society, Springfield, 1936 (Certificate of Merit), Fifth International Congress of Radiology, Chicago, 1937, and at the San Francisco (1938) meeting of the American Medical Association'. See Mahoney, Anson and Dent 1946 (note 4), p. 49.

29 Jonathan Sidhu, 'Exploring the AMA's History of Discrimination', *Propublica*, 16 July 2008, https://www.propublica.org/article/exploring-the-amas-history-of-discrimination-716 (accessed 21 June 2020).

30 *The Outlook for Women in Occupations in the Medical Services: Physical Therapists 203.8*, 1945, p. 2. Black men and women were limited to training opportunities at Freedmen's Hospital (Washington, DC) and St. Mary's Infirmary (St Louis), as well as through school and hospital assistantships. Ibid., p. 5.

31 Sister M. Gaudentia 1952 (note 15); *Outlook* 1945 (previous note), p. 2.

32 Arthur W. Fuchs, 'Thoracic Vertebrae Part 1', *Radiography and Clinical Photography* 17 (1941), no. 1, p. 3.

33 Mahoney 1943 (note 4).

34 John Carty, 'Some Important Considerations of Soft Tissue Anatomy as Revealed by Radiography of Anatomical Sections', *Radiology* 37 (December 1941), no. 6, p. 729; Marvin L. Daves and William E. Loechel, *The Interpretation of Tomograms of the Head: An Atlas*, Springfield 1962, p. IX.

35 Ibid.

36 Correspondence with Adam Torres from the Art Institute of Chicago, 13 August 2015: Mahoney attended in 1949. He took classes in Figure Drawing, Sculpture and Figure Painting. In 1950, he enrolled in a Colour class.

37 Correspondence with Cindy Filips and Catherine Price, 2 September 2015.

38 Mahoney, Anson and Dent 1946 (note 4), p. 49.

39 Correspondence with Paul Stone, 30 September 2015, author of *Legacy of Excellence: The Armed Forces Institute of Pathology, 1862-2001*, Fort Detrick, Md, 2011.

40 Correspondence with Lucy Squire's son, Gordon Squire, 7 September 2015.

41 Lucy Frank Squire, *Fundamentals of Roentgenology*, Cambridge 1966, pp. 24-26, 28.

42 According to the records of Daniel Wolf, who was one of America's foremost fine art photography dealers, he accounted for eighty-eight of the prints and re-sold them to private collectors and dealers. Personal correspondence, 6 October 2015.

43 Sir John Herschel invented this process in 1842.

44 Christina Z. Anderson, *Cyanotype: The Blueprint in Contemporary Practice*, New York 2019.

45 Historically, cyanotypes were a critical part of the publication process. In the nineteenth century, Anna Atkins illustrated several volumes of *Photographs of British Algae* (1843-53) with actual cyanotypes of contact-printed botanical specimens. Prior to 1860, photographers such as Eadweard Muybridge employed the process for proofing negatives. John Hannavy (ed.), *Encyclopedia of Nineteenth-Century Photography*, New York 2013, p. 361; Anderson 2019 (previous note).

46 *Army Institute of Pathology: Army Medical Museum*, Washington, DC, 1945, National Library of Medicine, https://collections.nlm.nih.gov/bookviewer?PID=nlm:nlmuid-12710220R-bk#page/1/mode/2up (accessed 8 December 2020).

47 There is a small chance that Eastman Kodak Co. printed the cyanotypes. Lucy Squire's second husband was Halford R. Clark, a Kodak scientist and the son of Kodak's George H. Clark. While Kodak had the facilities to print them and had many products to produce beautiful cyanotype prints, the company also prioritized having the information about the images for their publications. By the time Squire received the radiographs, the process and authorship had already been lost. Without these key components, compounded by the fact that the radiographic negatives were made with Agfa film, Kodak didn't have much to showcase in terms of information.

48 John Wood, *The Photographic Arts*, Iowa City 1997, p. 40.

49 The image in its entirety shows the body with its arms and legs pre-removed on the sectioning table. The body came to Mahoney in that condition. For ethical reasons, I have chosen to crop the photograph down to a close-up of the face as a means of respecting the remaining wholeness of the pictured man.

50 St Clair Drake and Horace R. Cayton, *Black Metropolis: A Study of Negro Life in a Northern City*, Chicago 2015, p. 528.

51 Arnold R. Hirsch, *Making the Second Ghetto: Race and Housing in Chicago 1940-1960*, New York 1983, pp. 17-18.

52 St Clair Drake and Cayton 2015 (note 50), p. 204.

53 Ibid., p. 202.

54 See Harriet A. Washington, *Medical Apartheid: The Dark History of Medical Experimentation on Black Americans from Colonial Times to the Present*, New York 2006, pp. 117-19, 131-38.
55 See Illinois 1885 Cadaver Act; Michael Sappol, *A Traffic of Dead Bodies*, Princeton 2002, pp. 123-24.
56 St Clair Drake and Cayton 2015 (note 50), p. 659, table 29, showing the 'Comparison of Selected Social Data for Areas Within the Black Belt: 1934-1940'.
57 'X Ray in Boston Society', *New York World*, 5 April 1896, p. 20.
58 Tirak 2016 (note 9), 'Ch. 2: For You, See Inside: Women and the Commodification of X-rays', pp. 83-141.
59 'They're Keeping Eyes on It', *The Commercial Appeal*, 13 February 1896, p. 3.
60 'X-Ray Shows Jack Johnson to Be Almost Bullet Proof', *The Evening World*, 22 March 1911, p. 14.
61 For an example of the increased dosage recommendation in print, see Charles A. Jacobi and Don Q. Paris, *X-ray Technology*, St. Louis 1964 (3rd ed.), p. 102. To learn more about the public reckoning, see the following Senate Hearings documents: Lawrence R. Fess and William S. Cole, 'Radiographic Exposure Factors', 5 June 1968, *Radiation Control for Health and Safety Act of 1967: Hearings before the Committee on Commerce United States Senate, Part 2*, Washington, DC, 1968, pp. 859-60, 937-39. See also Ralph Nader, 'Letter to Senator Bartlett', 11 June 1968, *Radiation Control for Health and Safety Act of 1967: Hearings before the Committee on Commerce United States Senate, Part 2*, Washington, DC, 1968, pp. 857-65. Among his evidence, Ralph Nader identified a General Electric chart showing a recommended increased dosage for Black Americans, but the dates for when this chart was enforced are unknown.
62 National Tuberculosis Association and Benjamin Kendall Emerson, *Report of the Committee on Tuberculosis among Negroes; A Five-Year Study and What It Has Accomplished*, New York 1937, p. 10.
63 Fuchs 1941 (note 32); Carty 1941 (note 34); Daves and Loechel 1962 (note 34).
64 Washington 2006 (note 54), p. 164.
65 Ralph Ellison, *Invisible Man*, New York 1980 (original ed. 1952), p. 3.
66 Leigh Raiford, 'Ida B. Wells and the Shadow Archive', in Maurice O. Wallace and Shawn Michelle Smith, *Pictures and Progress*, Durham 2012, p. 299.
67 Ibid.
68 Ibid, p. 303.
69 Fred Moten, 'Black and Blue in White', in Glenn Ligon, *Blue Black*, exh. cat. St. Louis (Pulitzer Arts Foundation) 2017, pp. 61-62.