Underground Photography and American Mining Before 1920

By
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Photographs are a remarkable source of information about the past. They can give us a visual sense of the way things were that is almost impossible to get in any other way. Photographs have been an important source for mining historians in this context for quite some time—the richly illustrated articles in the pages of this journal provide ample testimony.

However, less is known about the use of photography as a tool by the mining industry. The development and spread of photography was key to the creation of a visual culture in America in the late nineteenth and early twentieth centuries. Photographs, it seemed, were everywhere, produced by professionals, businesses, experienced amateurs, and, especially after the invention of the Kodak in the late 1880s, by consumers themselves.[1]

Businesses took advantage of photography to convey their products and messages to the public in visual form; they also used photographs to communicate internally, within the firm. Historian Elspeth Brown argues that photography played an important role in the development of American industrial society. She posits the "central" role of photography in the "ways in which corporate managers have sought to secure the consent of workers, managers, and consumers in the unevenly successful project of rationalizing American capitalism."[2]

Mining companies, like other businesses, used photographs for these purposes. Photographs were powerful tools, but the nature of their power differed from that offered by other visual tools used in the mining industry, such as maps or drawings. Maps and drawings permitted engineers to intellectually control complex machines and spaces because these representations could be manipulated in the mind's eye or on

paper in a way impossible to do in real life. These sorts of visual representations also served as places to aggregate and spatially analyze data, helping engineers achieve insights or do work suggested by the arrangement or availability of information on maps and drawings.[3]

Photographs, by contrast, drew most of their power from their ability to capture a complete scene at a specific moment in time. Photos were *true*, or at least they seemed to be, and this property could be used by those in charge of industrial firms to advance corporate agendas. As Brown noted, "the photograph's privileged relationship to the real provided corporate managers with a persuasive medium of legitimization as they sought to naturalize new methods of work and consumption through various uses of photographic evidence."[4]

Mining companies only gradually learned how to take advantage of photographs as tools. The technical difficulty of underground photography limited the application of photography to surface features in the early years. Over time, however, photography became an accepted and common part of the business activities of mining companies.

This article explores the history of photography in American mining by coupling broad trends with specific examples. It begins with a discussion of the difficulty of underground photography, as well as some of the technical developments that helped make that process easier. It then considers the ways in which firms, mining engineers, and social reformers made and used mining photographs. The article concludes with a close look at the use of photographs in early mine safety efforts.

These examples, taken together, will help us understand how the power of photographs as tools made them an important part of mining activity by the 1920s. My intent is also to provide both a broad overview and specific examples of the creation and use of photography in mining in order to help future researchers who wish to analyze mining photographs that they encounter, particularly in other sectors of the mining economy, as there is much room for additional historical research.

Underground Photography and Mining

Photographs of underground mines were considered a technical trick into the 1880s and deemed of no importance to mining operations. Underground photography was not attempted successfully until the early 1860s, when French photographer Felix Nadar used electric arc-light to photograph the Paris catacombs.[5] Several successful attempts were made in 1865 in Great Britain, but they received little publicity. Timothy O'Sullivan, a member of Clarence King's fortieth parallel survey, took the first underground photographs in the United States when he captured several views of the Comstock Lode in 1867 by burning bundles of magnesium wire for a light source.[6]

The first attempts to use underground photos as part of mining operations were made in 1876, when Frederick Brown made photographs of the working face of Bradford Colliery in Great Britain to support mining litigation. Even so, underground photographs of any sort were scarce through the mid-1870s, and mining photos nearly unknown.[7]

Significant technical barriers to underground photography existed. Negatives using the wet plate process were ordinarily cumbersome to make and to develop, and required a significant amount of equipment. Dirty conditions underground only exacerbated the challenges posed by wet plates. But the biggest problem was creating enough light to expose the photographs. Inadequate light sometimes required exposures so long that the wet emulsion dried before the photo was fully exposed.

Early attempts at cave photography used battery-powered arc lamps, lime light, Bengal fire, and a host of other materials, but none were cheap

enough, portable enough, or gave off enough light to be useful to mining companies. In 1859, the first published experiments described the intense light given off by burning magnesium wire. The paper's authors, Robert Bunsen and Henry Enfield Roscoe, even speculated about a clockwork mechanism to automatically advance the burning wire from a spool.[8] Patent problems and manufacturing difficulties prevented magnesium from being manufactured on a commercial basis until 1864, and even afterward use of the product proved difficult to master.[9]

Enterprising photographers who wanted to make underground photographs had to contend with magnesium, as did O'Sullivan, or try more unusual approaches. George Bretz cooperated with the Smithsonian Institution to create underground photographs of the Kohinoor anthracite colliery in Pennsylvania in 1884. He first tried burning magnesium, but the experiment failed. The manager of the Philadelphia and Reading Coal & Iron Company, which operated the colliery, took an interest in the work and helped Bretz borrow an electric dynamo, a compressed air engine to drive it, five arc lamps of approximately sixteen hundred candlepower, and four thousand feet of wire to connect them all.

The dynamo and its engine had to be installed four hundred feet underground to be close enough to work. When Bretz started the dynamo and the lights, the spectacle attracted miners from throughout the colliery. "Many old miners were attracted to the spot, and were, if possible, more surprised and interested in the sight than the strangers present. Although most of them had spent the greater part of their lives in coal-mines, yet they had never before seen more than a few square feet of the coal at any one time."[10] Each exposure took ten to thirty minutes.

Magnesium remained expensive and difficult to use into the 1880s, but late in that decade both reliable dry-plate negatives and flashpowder became commercially available.[11] Flashpowder, while still dangerous, provided enough light that relatively short exposures could be made. This meant that underground photographs, beginning in the early 1890s, could hope to feature people without significant blurring.[12]

Using Photography in Mining

By the turn of the century the utility of photographs in mining operations had become important enough to warrant discussion in the mining press. An editorial in the February 1902 issue of *Mines and Minerals* began with a recapitulation of a story in the *Daily Mining Gazette* of Michigan's Keweenaw copper country. "Some time ago," the piece ran, the Tamarack Mining Company had created a full "gallery" in its mine office to facilitate photography of its mining maps. The company updated its mine maps monthly and took twenty- by twenty-four-inch photographs of them. These photo-maps were especially useful because of their small size, which facilitated mailing them to owners and potential investors, as well as including them in reports intended for non-engineers. *Mines and Minerals* emphasized the utility of these photographs:

> The great advantage of this method will be apparent at once to every engineer, as it gives maps of a size that may be easily handled or sent through the mails and which are also much more easily studied than are the large and cumbrous mine maps. A full set of such photographs also furnishes a valuable record of the exact condition of the mine at every period of its life. This is but one of the many new uses to which the camera is constantly being put about the mines and in connection with all forms of engineering work.

The editorial suggested that the Tamarack Mining Company's photographic practices proved that the company was a well-run mining enterprise. "It is common practice nowadays to

keep a detailed photographic record of all construction work, and some of the more progressive mines keep a record of progress within the mines in the same way."[13]

Once underground photography became more reliable, photographs could be used for legal purposes, such as evidence in lawsuits. In 1908, mining engineers Sewell Thomas and Jock Finney used flash photography to document the damage that lessees had done to the Mohawk Mine in Goldfield, Nevada. Thomas and Finney worked for the Goldfield Consolidated Mining Company, which had united many smaller mines and proposed to work them efficiently. Before their acquisition by Goldfield Consolidated, these smaller mines had been worked by a system of leasing. Independent miners contracted with the owner of a claim to work a portion of it in return for a cut of the proceeds.

Such a system worked well where capital for initial development was scarce, but since the lessees only got paid for ore extracted, they tended to concentrate too heavily on mining ore and neglected work necessary to stabilize and reinforce the mine. The requirement to perform this sort of work was usually spelled out in the leasing contracts, but lessees did as little of it as possible. Several leases, including the Frances–Mohawk, had been left in particularly dangerous shape.

Thomas and Finney took underground photographs to document the dangerous conditions that the lessees left behind. One surviving photograph shows a large jumble of rocks, which presumably had fallen from the top of the excavated stope in the mine. Thomas and Finney left a miner's candlestick in the corner for scale, and centered the photograph on a mine surveyor's heavy plumb bob suspended from above to provide a way to orient the photograph with respect to the horizontal. Their employer, Goldfield Consolidated, used these photos in a lawsuit against the lessees. The boom was over by the time the trial took place in 1909, but the company won significant damages due in part to the testimony provided by Thomas and Finney and reinforced by their underground photographs.[14]

As photographic equipment became less expensive and less cumbersome—from the early 1880s invention of the dry plate to the first Kodak film cameras at the end of the decade—mining engineers' use of photography became more widespread. In 1886 a leading mining engineer noted that "many members" of the AIME were "amateur photographers."[15] One British mining engineer, Herbert W. Hughes, experimented extensively with underground photography and presented his findings to the Royal Photographic Society in 1893. After recounting his careful and enthusiastic experiments, Hughes acknowledged the tremendous difficulty in obtaining good underground photographs, noting that even though he and his contemporaries were using dry plates and magnesium for light, only 15 to 30 percent of their exposures were usable.[16] Despite the enthusiasm of some mining engineers for experimenting with photography, most mining operations, particularly before the advent of dry-plate photography, simply hired local professional photographers for their photo production needs.[17]

The anthracite mines of Coxe Brothers and Co. provide an example of using photography to help document a mining company's surface plant. Mining engineer and part-owner Eckley Coxe used at least two local photographers to create a photo series of his iron breaker under construction in 1890, though later photographic duties might have been handled by a Coxe employee.[18] Images of the breaker and of machinery designed and constructed by Coxe's shops appeared in professional papers and perhaps in advertisements as well. Some of the extant photographs of the construction of the Coxe's iron breaker accompanied his extensive article written for other mining engineers describing the innovative plant.[19]

These images may also have been useful to keep other members of the family business partnership up to date. The Coxe Brothers' iron breaker was one of the first of its kind. Previous breakers had

Iron breaker at Drifton, Pennsylvania, under construction about 1890. (Negative 2-8, Coxe Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution. Scanned from the glass plate negative by Eric Nystrom, 2006.)

been made of wood, and the iron breaker replaced a wooden one that burned down, possibly due to arson, in 1887. While Eckley Coxe, who designed and built the iron breaker, lived on-site in Drifton, Pennsylvania, most of his family members who were also partners in the coal mining enterprise lived outside of the anthracite country in Philadelphia. Thus, pictures such as that above would have reassured the other family investors of the underlying strength of the new building, while also giving them a good look at how the company was spending their money.

Commercial photographers in mining towns did not depend solely on the business of mining corporations. Mining companies in Goldfield, Nevada, in the early twentieth century hired P. E. Larson, the local professional photographer, to document their works above and below ground. However, Larson also made money by selling images of mining to the general public. He went into mines and took posed pictures of miners at work, which he then retailed from his studio to the public at large, including the subjects of his photos. Miners bought these photographs, presumably in part so that they could show nonminers what work underground was like and in so doing graphically validate their occupational choice.[20]

Some mining companies, however, decided to take their own pictures, especially as developing equipment became more reliable and less expensive. The Calumet and Hecla (C&H) copper mine on Michigan's Upper Peninsula established an in-house photographic capability sufficient to both meet the general needs of the company as well as to specifically apply photography to min-

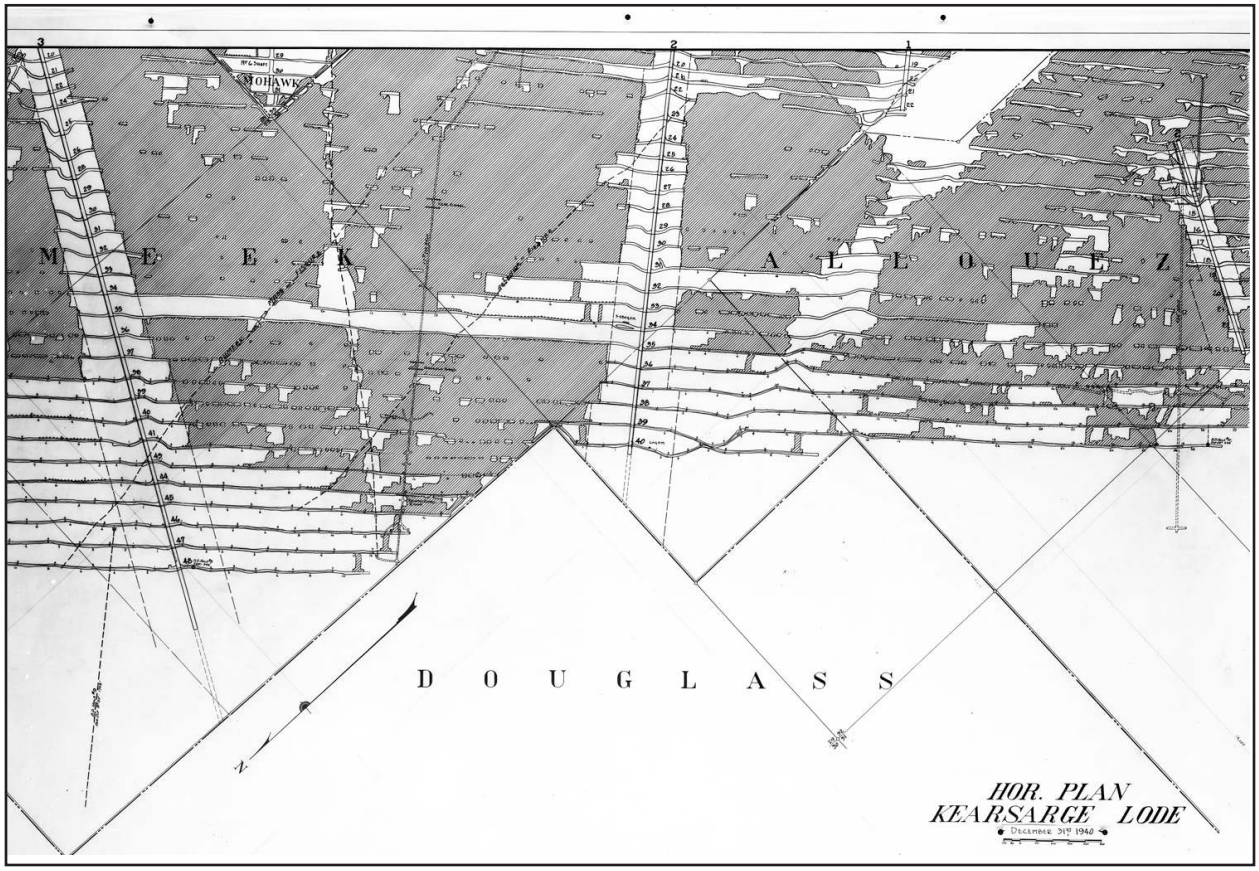
ing problems.

Calumet and Hecla probably used smaller, ordinary cameras for field or underground work, but larger cameras used by C&H for indoor reproduction of large maps have also survived. These large cameras used glass negatives up to twenty inches on a side, and were so large and cumbersome that they were permanently mounted to office furniture. C&H used these large-format cameras to take pictures of underground maps, such as the image below.

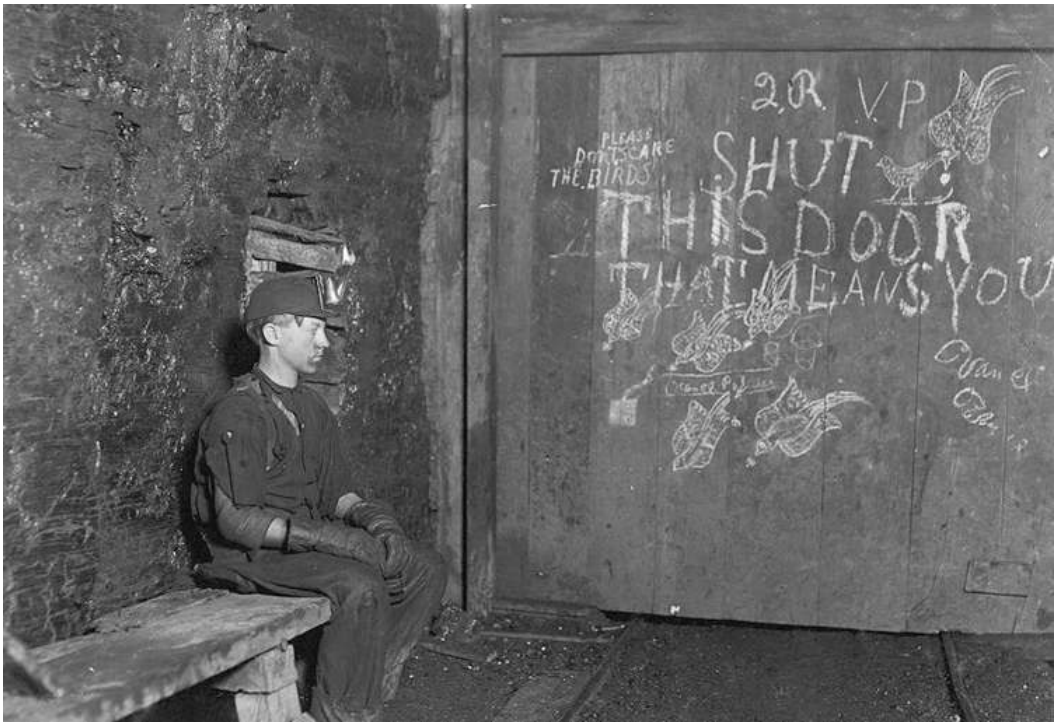
The maps themselves were fairly small-scale, representing a large area and intended to provide a broad look at the overall state of the underground. In contrast with a blueprint, which duplicated a map's scale faithfully enough to be usable for measurements, the large photographs further reduced the size of the image. Such photographs were thus not precise enough to guide on-the-spot work, but would have provided a general sense of progress.

C&H took pictures at regular intervals as maps were updated. A map was tacked on a wall or similar surface, and a slip of paper with the current date added in the area of the title block, also with pins, before the photograph was exposed. The relative ease of use and low cost of photographic technology permitted mine managers and engineers at the Calumet and Hecla to make frequent facsimiles of their main maps.

The resulting photographs might have been slightly more expensive than blueprints, but their smaller size made them easier to send through the mail to corporate officers or to investors, perhaps.[21]



Photograph of a mine map: "Hor[izontal] Plan, Kearsarge Lode, December 31st, 1940." Note the row of pins along the top border and the pinned date in the title block. (Image scanned from the negative by Michigan Technological University Archives.)



"Vance, a Trapper Boy, 15 years old. Has trapped for several years in a West Va. Coal mine. $.75 a day for 10 hours work. All he does is to open and shut this door: most of the time he sits here idle, waiting for the cars to come. On account of the intense darkness in the mine, the hieroglyphics on the door were not visible until plate was developed." (1908, Hine No. 0163, Library of Congress, Prints and Photographs Division, National Child Labor Committee Collection, LC-DIG-nclc-01076.)

Contact prints could be made directly from the large negatives onto blueprint paper or photographic paper, depending on the intended use. Photographs were also, by the twentieth century, relatively easy for a commercial printer to reproduce in printed material, such as annual reports. Visual tools helped C&H make reproductions frequently enough to add a temporal dimension to the spatial representation of the underground depicted on the maps themselves.[22]

After the company photographer took a picture, he had to develop the negative and make a print, if desired. That required a darkroom, and the C&H office building had an ingenious one built in. One part of the room was set up so that maps and drawings could be tacked to the wall and illuminated electrically. The camera was mounted over a large hole in the wall that divided the small room from the rest of the darkroom. As a result of this foresight, the photographer had a mere handful of steps to traverse between the camera back and the waiting developing bath.[23]

The darkroom was located in the attic, which was accessible from a staircase that led directly to the large drafting room. This again reinforces the importance of specialized spaces for production of visual representations, and indicates the need felt by turn-of-the-century mine managers and engineers to have the infrastructure to create and use visual representations, including photographs, close at hand.

The power of photography was not always exclusively reserved for corporate use. Social reformers around the turn of the century used it to capture scenes of exploitation, which they publicized in hopes of spurring governmental reform.

Mining was one target of reformers' efforts, but underground photos made up a very limited number of the pictures reformers took. This doubtless because of the twin challenges of underground photography and of getting invited underground at all, since such reformers were not customarily welcomed by industrialists.[24]

Lewis Hine, who later in life would be recognized as one of America's greatest documentary photographers, worked for the National Child Labor Committee (NCLC) from 1908 to 1924 documenting child labor in American industries. Particularly in the period between 1908 and 1911, Hine overcame the obstacles of access and took pictures of children who worked at the mines. Although most of his images of children in the mining industry were captured on the surface, Hine managed to take some underground as well. One of Hine's photos (previous page) was taken in 1908 in a West Virginia bituminous coal mine. The photo carries Hine's typically lengthy caption describing the circumstances of his encounter with the child, noting that the writing on the door was not originally visible in the darkness of the mine.

The NCLC used Hine's photographs in exhibits, lantern slide shows, circulars, and other publicity materials aimed at eliminating child labor.[25] They are an important, albeit rare, example of the power of the photographic image being turned on the mining industry without the consent of those who ordinarily controlled the mines.

Photography and Mine Safety

Photography was used extensively in safety education for miners. A close look at an example from the anthracite coal industry can also shed light on how photography could play a role in relations between management and labor in the mines. Faced with the seemingly intractable issue of preventing mine accidents without invoking additional governmental regulation or incurring undue expense, anthracite coal mine owners of the early 1910s responded with a wide variety of educational initiatives to increase safety in their mines.

One of these programs produced a seventy-page book titled *Mine Accidents and Their Prevention*, published by the Delaware, Lackawanna, and Western Railroad (DL&W) in 1912.[26] This rich source allows us to examine the nature of work in the anthracite industry at a time of technological change, the close link mine owners made between safety and "Americanness" in an effort to extend their managerial reach into the mines, and how managers used photographs to try to achieve greater underground control.

Mine Accidents and Their Prevention made sense in the peculiar work culture of the Pennsylvania anthracite fields. In order to understand the context in which the book was produced and was intended to be read, it is necessary to understand the history of anthracite production, the ways in which geology, law, and economics shaped the labor force, and the work traditions of the coal fields.

Anthracite coal's physical properties distinguished its development in the United States from the patterns common to other sectors of mining. Anthracite is a "hard coal" with an extremely high carbon content, found in the United States almost exclusively in three coal fields in eastern Pennsylvania.[27] By the first decade of the twentieth century, anthracite had been mined in Pennsylvania on a large scale for nearly one hundred years. The work performed by anthracite miners was a complex mix of traditional practices, new techniques facilitated by new technology, and the skills needed to extract coal out of specific geological spaces that varied in their characteristics.

The geology of anthracite coal helped foster a spirit of independence among anthracite miners. Unlike most bituminous deposits—where the coal existed as an essentially flat layer of strata that could be recovered by mining in large rooms—anthracite strata were folded and broken geologically, with much of the mineral occurring in steeply

pitched veins. Thus, most anthracite coal could not be worked in large level sections. Instead, anthracite miners extracted coal from small rooms, called breasts, which were divided from one another by large pillars of coal. Each breast was only big enough to be worked by a two-person team, a miner and his laborer.

The geological complexity of the anthracite fields, therefore, demanded a miner who could make independent decisions about how to best extract the coal from his working space with a minimum of waste. The miner drilled holes, fabricated and detonated explosive charges, dug out the coal by pick if necessary, and decided on the installation of roof supports. The laborer assisted the miner with moving supplies, especially timbers, cleaned the coal of rock and impurities after it had been blasted down by the miner, and loaded it into cars for transport to the surface. These men worked largely free of supervision and cherished their independence. It was a tradition in the mines, reportedly from English antecedents, to stop working whenever the boss was around.[28]

Most anthracite miners worked in a system that rewarded them only for productivity. This tradition may have started in the early years of mining when capital was scarce, but miners usually liked it because it gave them an incentive to work longer for more pay, or they could work less if they chose.[29] That gave them a feeling of independence. The anthracite companies liked the system because miners were not paid unless they produced salable coal.

The company typically paid miners for every car of clean—i.e. rock-free—coal hoisted to the surface. The company provided the infrastructure of tunnels, transportation systems, timbers, and ventilation to make the miner's underground contract work possible. However, the miner, not the company, paid the laborer. The miner also had to provide his own tools, and while the company provided supplies such as blasting powder and fuses, their cost was deducted from the miner's pay.[30] One implication of this system of production was that anything that required extra time or supplies lessened the miner's pay.

Anthracite miners had certain job protections. While miners could be hired and fired at will by the companies, the threat of labor activism and strikes provided an effective countermeasure. From the Workingmen's Benevolent Association and the Molly Maguires of the 1860s and 1870s to the United Mine Workers of America and the major strikes of 1902, 1906, 1912, 1922, 1923, and 1925-26, miners and their representatives clearly were not afraid to stand up to the corporations. And anthracite operators were denied one particularly effective strikebreaking tool available to capitalists in other industries.

According to Pennsylvania laws of 1889 intended to ensure competent miners, no person could work as a miner in an anthracite mine who had not served as a laborer for a minimum of two years, and miners had to be certified by the state. These laws were also originally intended to serve as a means to exclude the increasing number of Slav and Italian immigrants who came to work in the state's mines. Even though immigrants from eastern Europe had made significant inroads into the anthracite workforce by the start of the twentieth century, these laws still served to substantially limit the number of potential replacement workers available to mine owners during a strike.[31] Consequently, mine owners had an incentive to try to change the habits of existing employees as opposed to firing them and hiring more pliant workers.

Anthracite coal mining was a hazardous job.[32] The average fatality rate was over 3.5 per 1,000 workers per year between 1907 and 1912.[33] Put another way, anthracite mining saw more than 400 workers per year lose their lives in the last decades of the nineteenth century and first decades of the twentieth. Mark Aldrich, a historical economist, calculated coal mining fatality rates that showed that anthracite mining was, on average, even more dangerous than bituminous coal mining before 1920.[34] It was, in fact, among the most dangerous

of all industrial jobs. Aldrich points out that "in 1916, the hard coal miners experienced a fatality rate that was 4.75 times greater than that in manufacturing. Among major occupational groups for which data are available, only railroad trainmen typically ran greater risks."[35]

Anthony F. C. Wallace argues that this awful safety record was because anthracite mining was a "disaster-prone industry" where mine operators guilty of "optimum scenario thinking" blamed disasters and accidents on "careless" miners. A lack of working capital, low profit margins, high costs, and the economic structure of the industry tended to make any shutdown of the operation a costly one. As a result, operators and miners alike often chose more risky behaviors in order to avoid immediate hardship, rather than endure short-term economic pain to reduce risk.

English common law precedent held that employers were not liable for damages to employees if the damage in question was caused, even in part, by the carelessness or negligence of the employee. This precedent, combined with the legal notion that every employee was an independent agent, free to walk away from the job if he deemed it or the behavior of his fellow workmen unsafe, meant that the causes of accidents were almost always attributed to negligent employees. If conditions were truly unsafe, so the argument ran, the miner would have quit before he was injured. Instead, accidents must have been the fault of miners who were not being careful enough. The trope of the "careless miner" is frequently invoked to explain the source of safety problems in *Mine Accidents and Their Prevention*.[36]

Throughout much of the nineteenth century, most mine owners responded unenthusiastically to the idea of fixing safety problems. As a result, rates of injury and fatality in the anthracite industry remained high. The State of Pennsylvania, spurred by miners, passed pioneering regulations to solve some of the worst problems, but mine owners typically avoided expending any more effort than the letter of the law required.[37]

Near the beginning of the twentieth century, mine owners began to take more proactive steps to increase safety beyond that required by the letter of the law. The roots of this change in attitude are difficult to discern, but it is likely that fear of increased state regulation played a role, as did a desire to defuse rising union sentiment among miners. Major strikes crippled the industry in 1902 and frequently afterward; management not infrequently saw paternalistic care of workers as a way to defuse labor tensions. It is also possible that mine owners were captivated by a renewed sense of social concern typically associated with the Progressive movement, were motivated by the newly established U.S. Bureau of Mines' work on first aid and safety, or perhaps were inspired by the social concern shown earlier by a handful of anthracite operators, such as Eckley B. Coxe.[38]

One popular tactic among mine owners as a means to increase workplace safety was the education of miners. In 1910 the Coal Mining Department of the Delaware, Lackawanna, and Western Railroad began a project to take some 200 staged photographs of good and bad practices underground, which were then delivered as a lantern-slide lecture to large audiences of miners, "with telling effect."[39] Later, the DL&W combined many of these photographs, some 140 in all, with text into the thin, black, cloth-bound *Mine Accidents and Their Prevention*, published in 1912.

This book was intended to graphically illustrate principles of safety in anthracite mines, and also to teach English to immigrant miners. The authors envisioned the book being used in a tutorial setting, with the tutor asking simple questions about the actions shown by the pictures, then using the accompanying text to deliver a more specific lesson. Each page consisted of several pictures intended to visually narrate a sequence of events. The events were also recounted by simple sentences lower on the page, with key words in the margin for each. At the bottom of the page, the overall message of the narrative was delivered in capital letters.

Each event was recounted twice, on facing pages. On the left side, incorrect procedures were followed, mistakes recounted in red text, and workers always injured or killed. On the right page, the correct way of handling the situation was explained and diagrammed. The preface states: "Each series shows an accident. The first part of the series *shows how the accident happens* and the last part shows how the accident might be avoided."[40] These were idealized, archetypal accidents, removed from association with past events. These accidents would happen again, and it was up to an educated, safe miner to avoid them.

While the attention of the U.S. Bureau of Mines and state regulatory agencies focused primarily upon preventing catastrophic but relatively rare accidents, such as gas and coal dust explosions, *Mine Accidents and Their Prevention* paid closer attention to more common hazards.[41] Of the thirty good-and-bad mining scenarios contained in the book, nine concerned roof and rock falls, and another nine recounted accidents with explosives. Transportation accidents accounted for eight scenarios, two featured the hazards of electricity, and one scenario dealt with hoisting. Only one narrative—though a three-page example, longer than the others—focused on the risks of methane gas explosion. The authors explained in the preface that the mishaps represented were "only those accidents which have been of most frequent occurrence and the most fruitful in loss of life or limb."[42]

If these were ideal types of the most common anthracite accidents, it is fitting that many of them show clear evidence of the rapid pace of technological change taking place in the anthracite industry at that time. Aldrich argues that evolving technology added an additional complexity to the problem of reducing the number of accidents.[43] This is an easy point to understand from the view of the mine worker, who would have to unlearn old techniques or habits unsafe in the context of new technology, or would have to learn new skills for handling newly developed tools.

Mine Accidents and Their Prevention provides vivid examples of how old habits might lead to disaster in a new technological context. In both of the scenarios that discuss the hazards of electricity, a miner carries something on his shoulder—a drill in one instance, a metal powder can in the other—that makes contact with bare electric wires overhead which powered the mine's locomotives.[44] Before the advent of low-hanging, exposed electric wires in mines, a miner had little to fear from carrying heavy equipment over his shoulder. With the advent of electric locomotives, however, a miner needed to adjust his habits to avoid becoming "careless" and the victim of an accident. Here, as elsewhere in the book, the impetus for change is thrust upon the miner—it was not the duty of the mine owner to shield wires, but rather the miner's responsibility to evade them.

Other cases show ongoing transitions between technologies in the mine. In the realm of transportation, the first examples show mules pulling mine cars, but the pictures themselves suggest a different reality—overhead wires for powering electric locomotives are visible as well.[45] Several later scenarios show these electric "motors" at work. These machines required the use of new skills and procedures to avoid accidents, such as checking the brakes and the level of sand, used for traction, at the tops of steep grades.[46]

New trends in explosives technology are also apparent in *Mine Accidents and Their Prevention*. Since 1858, blasting powder, a close cousin of ordinary gunpowder, had been used in mines to move rock. Alfred Nobel invented dynamite in 1868 and it first entered use in western mines in the 1870s, but its high cost tended to prevent its use by contract coal miners. Eventually, the Bureau of Mines investigated the role of explosives in igniting underground coal dust or methane gas explosions and recommended substitutes for blasting powder.[47]

Mine Accidents and Their Prevention portrays a mixed use of dynamite and blasting powder. Dynamite was certainly less familiar to miners

than traditional blasting powder, and had to be handled in different ways. One hazard of dynamite was its tendency to freeze. Thawing it over an open flame or on a hot stove was considered unsafe. Although manufactured dynamite warmers existed, the "careful miner" portrayed in *Mine Accidents and Their Prevention* buried his frozen dynamite in a keg of warm mule manure.[48] What if all of the mules have been replaced by electric locomotives? The book offered no suggestions. In an effort to educate mine workers about safe practices, *Mine Accidents and Their Prevention* inadvertently threw the challenges posed by technological change into sharp relief.

Mine Accidents and Their Prevention covered more than mine safety. An introductory preface, printed in English, Polish, Lithuanian, Italian, and Russian, explicitly declared: "The purpose of this book is to teach mine workers how to prevent accidents and at the same time to teach the English language to those who cannot speak English."[49]

The book's primary vehicle for English instruction was its textual format, known as the Roberts System. This writing system had been developed by Dr. Peter Roberts to teach English to immigrants. Roberts lived in the eastern Pennsylvania anthracite country and studied the communities affected by the labor unrest of the 1902 strike. Interestingly, Roberts himself was quite sympathetic toward Slavic immigrants. Shrill warnings of "race suicide" and other anti-Slav rhetoric, so common among Progressive-era white elites, were absent from Roberts' writings.[50]

From 1907 onward, Roberts worked for the Young Men's Christian Association's program for the Americanization of recent immigrants. Roberts also sold his system to schools and set up schools of his own, enrolling a total of over thirteen thousand immigrants by June 1911.[51] Roberts' program was especially suitable for industry. Companies paid the YMCA for customized English instruction programs to educate their workers; the lessons spoke of industry-specific hazards, as well as of the need to follow orders from superiors.[52] A Roberts System's text had a distinct format, with the verb of the sentence isolated first for extra attention:

is walking:	In picture three the miner is walking under the trolley wire.
is carrying:	He is carrying his drill in his hand by his side.
can touch:	The drill cannot touch the wire now.
passes under:	The miner passes under the wire safely.
does receive:	He does not receive a shock.[53]

As the above example shows, Roberts was evidently quite concerned with the grammatical correctness of his lessons. While technically it is true that "can touch" and "does receive" are the proper verb forms of the third sentence and last sentence, any worker who focused on the highlighted verbs to understand the intent of the lesson might be confused, at best. This suggests that the book's mission to teach safety and mining practices could have been undermined by its English lessons. So why include them at all?

When anthracite companies first hired Slavic and Italian miners in large numbers in the 1870s and 1880s, the existing workforce of miners, predominantly from the British Isles, argued that the new immigrants would create an unsafe workplace because of their inability to speak English. But companies hired the newer immigrants, over the objections of the older ones, in the hope that they would be more dependent on the company and therefore more docile. After the 1902 strike, when the most radical miners proved to be new immigrants bound to each other by ethnic as well as labor solidarity, mine owners reversed their thinking and began to be more concerned about the lack of English skills among their employees.[54] Thus, English instruction for immigrant miners should be understood as an expression of the owners' desire for a more stable, controllable workforce.

In fact, it seems clear that English skills were not especially necessary for anthracite miners to

do their jobs safely. The underground work environment, which almost always involved just a miner and his helper, required a common language, but not necessarily English. In the aboveground works, the din of breaker machinery meant that oral instructions could rarely be understood anyway.[55] Additionally, recall that *Mine Accidents and Their Prevention* derived from a lantern slide presentation about safety. It is always difficult to know what even enthusiastic audiences comprehend, but it was clear that such a lecture was about mine safety and *not* about teaching English.

English language instruction was one significant component of a push by the YMCA and others to "Americanize" immigrants.[56] Ford Motor Company, for example, emphasized English language instruction and Americanization in an effort to increase the stability and loyalty of its workforce.[57] J. H. Dague and S. J. Phillips, who led the Scranton YMCA's miner education efforts, developed *Mine Accidents and Their Prevention* "under the direction" of the superintendent and the assistant superintendent of the Coal Mining Department of the DL&W.[58] In addition to the mining content, the authors added "a number of lessons on American Citizenship especially prepared for this book by W. J. Torrey, Esq., who has been closely connected with the Young Men's Christian Association['s] work for [i]mmigrants in Scranton, Pa."[59]

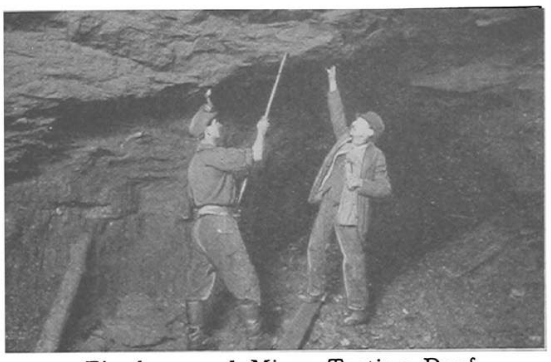
These citizenship lessons described the multiple-step process of getting first papers, getting second papers, then becoming naturalized. The book also contained two forms that the immigrant needed. The lessons, similar in format to those on mining safety, were illustrated with pictures such as the American flag, the interior of the U.S. District Court at Scranton, and the U.S. district court judge.[60] The authors even retreated from absolute grammatical correctness by emphasizing a negative verb, "cannot," in this section to drive home the point that non-citizens are not allowed to vote. The message was clear: being an American citizen was best.

want:	Do you want to be a citizen of the United States?
can do:	There are some things which no one but a citizen can do.
cannot vote:	A man cannot vote unless he is a citizen.
are passed:	Many good laws are passed for citizens only.[61]

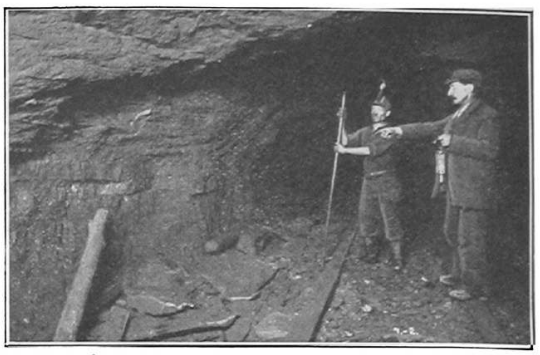
The Delaware, Lackawanna, and Western likely paid to develop the book and cooperated by supplying pictures, while the YMCA personnel provided the authorial expertise. Both groups would benefit: the YMCA through financial support and the further spread of its Americanizing, evangelical Christian message, and the DL&W through having a safer, more loyal, more controllable workforce. It is also likely that DL&W managers believed that the company might be able to gain additional respect in the eyes of fellow mine operators. Company officials boasted of their safety programs in the industry journal *Coal Age*, and the copy of *Mine Accidents and Their Prevention* that I examined had been sent to another coal producing company, Lehigh Coal & Navigation, by the National Safety Council, a cooperative non-profit group dedicated to increasing occupational safety.

The DL&W also sought to use *Mine Accidents and Their Prevention* to exercise greater managerial control over the notoriously independent anthracite miners by teaching them an approved "correct" way to do their jobs in the interest of increased safety. As historian Harold Aurand noted: "Against this backdrop of entrenched traditionalism, safety education provided the engineers with a platform for inculcating their notions of correct mining procedures."[62]

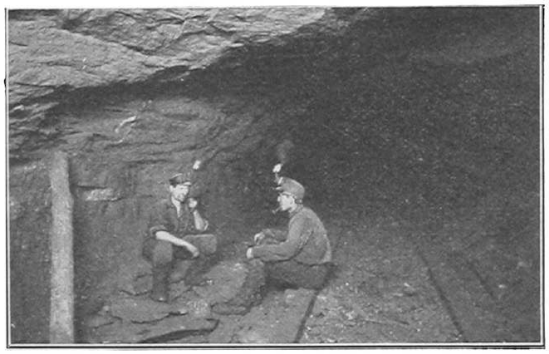
However, the engineers' ideas of best practice frequently did not consider its economic cost to miners. Aldrich put it a slightly different way, noting that new approaches to mining "proved a hard sell, in part—as the company soon discovered—because its approach was not always 'the best.' . . . Convincing the men to follow company safety



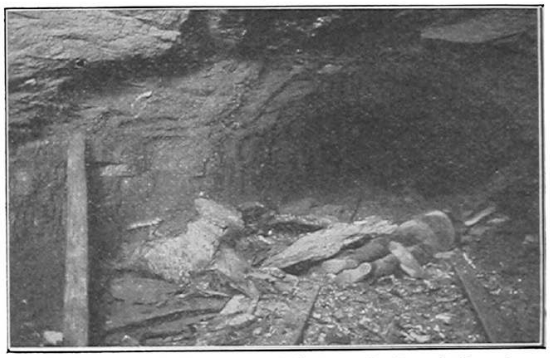
Fire-boss and Miner Testing Roof



Fire-boss Tells Miner to Stand Prop Under Roof



Miner and Laborer Smoke Before Obeying Order



Miner and Laborer Under Fall of Roof

MINER NEGLECTING ORDERS

are	:	Here are the fire-boss and the miner.
hangs over	:	This rock hangs over the road.
are testing	:	The miner and the fire-boss are testing it.
is safe	:	The rock is not safe.
orders	:	The fire-boss orders the miner to put that prop under the rock.
goes away	:	The fire-boss goes away.
sit down	:	The miner and the laborer sit down to smoke before they stand the prop.
falls	:	The loose rock falls on them.

What does the fire-boss tell the miner to do? Does the miner obey the fire-boss at once? What are the miner and laborer doing? What happened to them while they smoked? Should the fire-boss wait till the prop is placed?

MINER, DON'T DELAY MAKING YOUR PLACE SAFE.

Sixteen
16

"Minder Neglecting Orders," Mine Accidents and Their Prevention, *16.*

rules must have been difficult when it was clear that they sometimes knew more about mining efficiently than the company did."[63] *Mine Accidents and Their Prevention*, for example, instructed that if a miss-fire occurred, the miner was to wait fifteen minutes. If the charge had not yet detonated, the proper procedure was to report it, block off the entrance to the breast, and go home for the day—without wages.[64] In another expensive suggestion, management instructed immigrant miners to remove props using dynamite, a costly proposition for a contract miner.[65]

The choice to use photography to assist in this project of increasing managerial control over anthracite miners was undoubtedly deliberate. The reality of each scene portrayed in *Mine Accidents and Their Prevention* lent veracity to the idea that the social relations depicted should be modeled by the immigrant-miner audience. As historian Elspeth Brown has argued:

> Within industrialization and scientific management, in particular, the photograph's denotative meaning is often coded as scientific 'objectivity,' a mask that enables managers to cloak the photograph's contingent, connotative meanings. Managers promoted and profited from the slippage that occurred when culturally managed interpretations (connotative meanings) were misread as simple transcriptions, or analogies, of material reality (denotative meanings).[66]

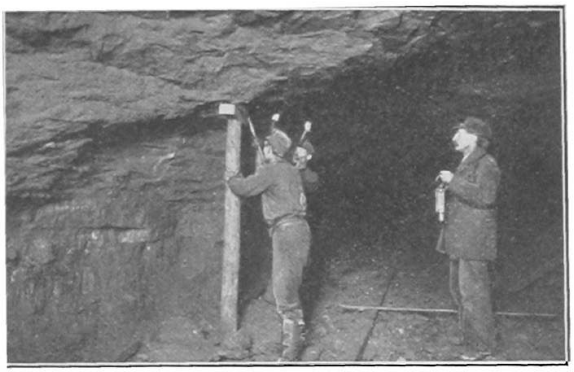
Brown's notion of connotative and denotative meanings can help us interpret one example from *Mine Accidents and Their Prevention* that stands out glaringly as a case of management using safety to exercise greater control over miners' work. Recall that miners traditionally ceased working when management was present. In a scenario titled "Miner Neglecting Orders, (opposite), the fire boss and the miner test some rock hanging over the road.[67] The "fire boss" was an independent, assistant foreman-level manager charged with monitoring levels of explosive methane gas in the mine. As safety practices in the mine became more complex, the fire boss became generally responsible for ensuring the enforcement of safety rules.

After the miner and the fire boss find that the rock is loose, the fire boss orders its removal. The miner and laborer sit and smoke before doing so, presumably waiting for the boss to go away. While they are smoking, the rock falls and crushes them. The lesson at the bottom of the page carefully shifted the issue from disobedience to safety: "Miner, Don't Delay Making Your Place Safe." The facing page (see page 118), titled "Fire-Boss Sees That Orders Are Obeyed," moved the rhetoric of instruction to the fire boss. This linguistic shift masked both the fact that the miner was the intended audience, and that one of the miner's cherished traditions, that of not working in the presence of a boss, was under attack:

tests:	The miner tests the rock and finds it is not safe.
tells:	The fire-boss tells the miner to stand a prop under the bad rock.
does:	The fire-boss does not go away.
waits:	He waits until the prop is stood.
knows:	Now the fire-boss knows the men are not in danger.
must be:	The fire-boss must be sure every place is safe.
helps:	Every careful miner and laborer helps to prevent accidents.

Fire-Boss, See That Your Orders Are Obeyed Promptly.[68]

The photograph shows the fire boss standing and watching as the miner performs the work. The authors of *Mine Accidents and Their Prevention* wanted their immigrant readers to miss or ignore the connotative meaning of the photograph: that they were being told to change their work habits and give up a cherished cornerstone of their traditional independence. Instead, the authors wanted the photograph understood for its denotative



Fire-boss Waits to See Orders Carried Out

FIRE-BOSS SEES THAT ORDERS ARE OBEYED

tests : The miner tests the rock and finds it is not safe.
tells : The fire-boss tells the miner to stand a prop under the bad rock.
does : The fire-boss does not go away.
waits : He waits until the prop is stood.
knows : Now the fire-boss knows the men are not in danger.
must be: The fire-boss must be sure every place is safe.
helps : Every careful miner and laborer helps to prevent accidents.

What are the miner and laborer doing? Why does the fire-boss not go away? Who must be sure that every place is safe? Who can help to prevent accidents?

FIRE-BOSS, SEE THAT YOUR ORDERS ARE OBEYED PROMPTLY.

Seventeen
17

"Fire-Boss Sees That Orders Are Obeyed," Mine Accidents and Their Prevention, *17.*

meaning alone: that, of course, it is ordinary and natural for a fire boss to directly supervise a miner, as is shown in the photograph.

Mine Accidents and Their Prevention combined safety, English instruction, and Americanization in a subtle and deliberate attempt to create a more obedient anthracite workforce, to increase management's control, and to reduce the number of underground accidents. The book froze in time a moment of technological, social, and economic change in the anthracite coal industry. The technological transformations already underway accelerated in the next decades, creating an increasingly mechanized, and controllable, workplace underground. The mechanized mine quickly gave way, in turn, to "stripping" operations that worked from above the ground.

More frequent strikes and the energy needs of World War I bolstered labor unionism, raised wages, and, most importantly, created work stoppages in the immediate post-war era that permanently eroded anthracite's market share in the U.S. domestic fuel economy. Shrinking market share, combined with high labor costs and widespread mechanization, reduced total employment in the anthracite industry substantially even before the coalfields were essentially exhausted in the 1950s.[69] The Delaware, Lackawanna and Western Railroad sold its anthracite holdings relatively early, in September 1921, less than a decade after it published *Mine Accidents and Their Prevention*.

Perhaps the most interesting lasting effect of the safety education movement, of which *Mine Accidents and Their Prevention* was part, was the ongoing use of re-enacted accident illustrations to teach safe practices. In their preface, the authors assert that "the basic idea of these lessons, namely, the making of a series of photographs to show the successive stages in the occurrence and prevention of an accident originated with R.A. Phillips," superintendent of DL&W's coal operations.[70] It is not known whether Phillips was the first person to create photographic re-enactments of mine accidents for instructional purposes, but the photos in *Mine Accidents and Their Prevention*, taken in 1910, are the first that I have found made for such a purpose. Later, other coal companies followed suit, and within a few years, the *Miners' Circular* series published by the U.S. Bureau of Mines used the format for mine safety education.[71]

One of DL&W's anthracite competitors, the Delaware and Hudson Coal Company, hired independent photographer John Horgan, Jr., of Scranton, from 1915 to 1917 to document staged scenes of safe and unsafe underground practices. Horgan, a professional photographer since at least the mid-1880s, had moved permanently to Scranton in 1903. Much like the photos in the earlier *Mine Accidents and Their Prevention*, Horgan's scenes showed correct procedures—such as a miner and a laborer barring down loose rock overhead after firing a shot—as well as incorrect actions—such as a miner working with an open flame lamp set on a powder box and crimping a blasting cap with his teeth.[72]

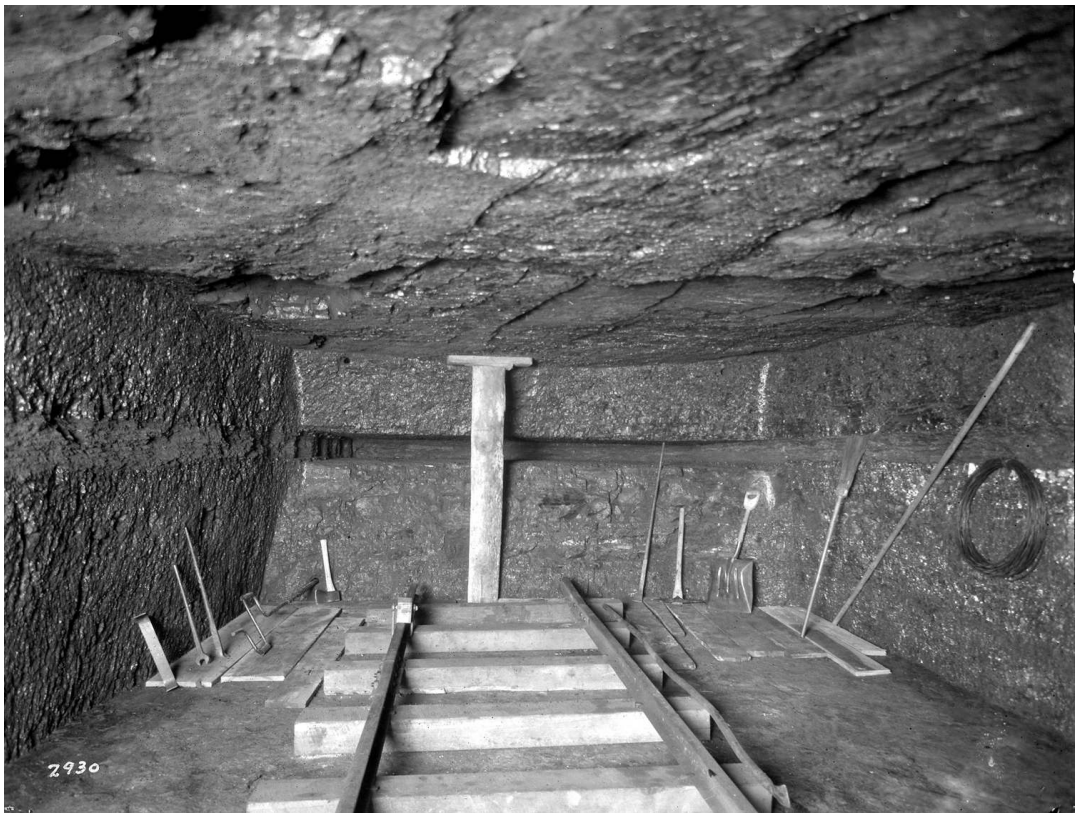
The Delaware and Hudson also engaged Horgan to take pictures for other corporate purposes, including a series illustrating the history of anthracite mining eventually published by the corporation in 1932. D&H coal managers' explicit intention was to improve the public relations of an industry in decline. Management blamed the negative publicity from the several anthracite strikes for encouraging users to turn to other fuels. If that were the case, then a public relations effort based on putting the industry's best face forward through a positive account of the historical importance of the anthracite industry, might improve matters.[73]

All told, Horgan worked for Delaware and Hudson, among other clients, from 1905 until his death in 1926, producing over seventeen hundred negatives for the company during that time.[74] Horgan's long relationship with the company and his substantial output on their behalf suggests the importance that photography had attained by the twentieth century for a major anthracite producer such as the Delaware and Hudson.

Consolidation Coal Company, which mined bituminous coal in western Pennsylvania, Maryland, West Virginia, and Kentucky, likewise kept a photographic archive of its activities from the 1910s through the 1930s.[75] The company's photos, which may have been taken by one of its employees, included pictures of buildings, mines, towns, and the changes wrought by the company's arrival in a virgin coal field. However, the photos also showed off prize-winning gardens, recorded picnics, and re-staged mining accidents.[76] The company published at least some of these re-enacted accident photographs in the monthly newsletter it sent to employees. The content of the newsletters was clearly intended to increase miners' loyalty to the company and to teach safe mining practices.[77]

One such photograph, below, shows a miner re-enacting the accident that killed Frank Hall on 4 August 1926 in Consolidation Coal's No. 204 mine. Hall was sitting on the edge of a coal loading machine when his supporting hand slipped and he evidently became entangled in the machinery. This photograph recapitulates the trope of the careless miner by implicitly blaming the accident on Hall, who was clearly leaning on a surface not intended as a perch for a worker. Hall slipped while resting on a piece of metal that guarded miners from the gears of the machine. Thus the reenactment photograph reiterates Hall's culpability, while emphasizing that the company upheld its end of the bargain by providing safe machinery.

"Fatal Accident to Frank Hall, Mine No. 204, 8-4-26." (Negative 2744B, Consolidation Coal Company Photograph Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution.)



"Model Room, Mine 204, 8-18-1930." (Negative 2930, Consolidation Coal Company Photograph Collection, Division of Work and Industry, National Museum of American History, Smithsonian Institution.)

Consolidation Coal Company also produced a handful of photographs showing a positive vision of good underground practice. The photo above depicts a "model" room in Consolidation's No. 204 mine. Newly laid tracks enable the coal cutting and loading machine to reach the working face, and the cut-out strip shows that the cutter, at least, had already visited. The left rail has been properly fitted with a clevis block, to prevent machinery from going too far and falling off the tracks. Hand tools, including a large wrench, a rotary hand drill, a hatchet, iron bars, a broom, a pick, and the ever-important coal scoop, rest against the wall and boards placed on the floor. The roof is in good condition, having been carefully cleaned of any hanging rock or other obstruction. The lone prop, which must have been installed after the coal cutter carved the horizontal notch in the face, shows that the safety of the roof is considered even where the prop's proximity to the working portion of the room might be inconvenient.

Such a degree of cleanliness in a portion of a working coal mine would seem difficult to accomplish, or even paradoxical. At that time, almost all mining machinery operated on rails, hence the need for the tracks in the photo. We might presume that the coal cutting machine needed those tracks to make the gouge, but the lack of coal debris between the ties on the track suggest that the track is new. The hand-powered drill in the lower left is partially inserted into a hole being drilled in the face at the bottom corner. However, with the boards in place on the floor, it does not look like the drill would have sufficient clearance to turn a complete revolution. Thus, to actually work this

face, at least some of the boards on the floor at the face must be removed.

The model room portrayed in this photo represented the company's vision of an ideal work space in an explicit, denotative representation of a clean room and an orderly arrangement of tools. The photograph's subtle, connotative meanings expressed the company's wishes as well. The mark of the coal cutting machine stands out, but no human laborers appear in the ideal room. This suggests the company's frustration with its human workers. Consolidation Coal had succeeded in destroying unions in all of its far-flung holdings by May 1927.[78] Machines could not organize and would always obey. If humans could not be replaced entirely, the company would at least prefer that those miners who remained behaved more like machines.

Conclusion

Those in charge of mining corporations harnessed photography's visual power to help them work more efficiently and to gain an advantage over mine labor. Whether taken by an independent professional or a member of the company's staff, developed commercially or in-house, publicized, sold, or perhaps merely left ignored in company files, taking and using photographs was a well-established practice in the mining industry by the 1920s. Photographs kept investors or family members informed about happenings at the mine, and they helped managers document physical progress recorded on mine maps. Commercial photographers found a market for views of mining machinery and underground scenes from mining companies, but also from mine workers and the public at large.

Photographs mining companies made to encourage mine safety are particularly rich historical sources which, when set in the appropriate context of the typical work practice of underground mining, reveal the extent of managerial efforts to exercise control over labor. Companies attempted to use photographs to denote safer underground practices, but the connotation of many of these photos was that an individual's safety depended on abandoning old freedoms and adhering to the company's way of doing things.

Mine safety photos also gave managers a new visual medium through which to deliver the old message that the individual miner was always at fault for accidents. Although the trope of the careless miner had been widespread as the explanation for almost all underground accidents since at least the middle of the nineteenth century, photographic re-enactments of mine accidents seemed to show the "objective truth" that each injured individual had been doing something wrong. The same photographs could also offer proof—in the form of machine guards, for example—that the company had done its share to make the workplace safer. Thus, it was up to the miner to be safe, and it was his fault if he were hurt or killed.

In contrast, if a miner wished to turn the visual power of photographs against his employer, he had few options. Lewis Hine was able to create underground photographs that provoked, rather than stilled, criticism of mining companies, but Hine's photos stood out precisely because they were so unusual. Normally, when mine management used photographs as tools, the images—like other visual representations—concentrated power in the hands of those who made and used them.

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Notes:

1. See: Reese V. Jenkins, *Images and Enterprise: Technology and the American Photographic Industry, 1839-1925* (Baltimore: Johns Hopkins University Press, 1975); David E. Nye, *Image Worlds: Corporate Identities at General Electric, 1890-1930* (Cambridge, MA: MIT Press, 1985); Alan Trachtenberg, *Reading American Photographs: Images as History, Mathew Brady to Walker Evans* (New York: Hill and Wang, 1989).
2. Elspeth H. Brown, *The Corporate Eye: Photography and the Rationalization of American Commercial Culture, 1884-1929* (Baltimore: Johns Hopkins University Press, 2005), 16.
3. Eric C. Nystrom, "Learning to See: Visual Tools in American Mining Engineering, 1860–1920" (Ph.D. diss., Johns Hopkins University, 2007).
4. Brown, *Corporate Eye*, 14.
5. Chris Howes, *To Photograph Darkness: The History of Underground and Flash Photography* (Carbondale: Southern Illinois University Press, 1989), 8-9.
6. William Goetzmann, *Exploration and Empire: The Explorer and the Scientist in the Winning of the American West* (New York: W.W. Norton and Co., Inc., 1966), 442; Trachtenberg, *Reading American Photographs*, 144-54; Howes, *To Photograph Darkness*, 35, 43, 73-5.
7. "Photography Underground," *Mining and Scientific Press* 34 (6 Jan. 1877): 7; Howes, *To Photograph Darkness*, 81-3, 163.
8. Robert Bunsen and Henry Enfield Roscoe, "Photo-Chemical Researches, Part IV," *Philosophical Transactions of the Royal Society of London* 149 (1859): 920-23.
9. Howes, *To Photograph Darkness*, 20-3.
10. Fred P. Dewey, "Photographing the Interior of a Coal Mine," *Transactions of the American Institute of Mining Engineers* 16 (1888): 307–12.
11. Howes, *To Photograph Darkness*, 87, 105, 131. Flash-powder was useful for indoor photography as well as underground photography. Social reformer Jacob Riis began using it in 1888, a year after its invention, and was an ardent advocate.
12. Bretz included people in some of his 1884 shots with only limited blurring, but this was due to the extraordinary patience of the miners who posed for him rather than the speed of his photography.
13. "The Camera in Mining," *Mines and Minerals* 22 (Feb. 1902): 307–8.
14. Sewell Thomas, *Silhouettes of Charles S. Thomas: Colorado Governor and United States Senator* (Caldwell, ID: Caxton Printers, Ltd., 1959), 169-70, 171-2. The photograph I described is Plate 15.
15. Rossiter W. Raymond, "The Ives Process of Photo-Mechanical Engraving and its Usefulness to Engineers," *Transactions of the American Institute of Mining Engineers* 15 (1887): 271.
16. Herbert W. Hughes, "Photography in Coal Mines," *The Photographic Journal* 18 (1893): 93-101.
17. Several histories of mining-town photographers exist; in addition to those cited below, see: Tom Beck, "Photography Caught in the Middle: 1870-1895," *Proceedings of the Canal History and Technology Symposium* 4 (1985): 147-73; and Duane A. Smith and Hank Wieler, *Secure the Shadow: Lachlan McLean, Colorado Mining Photographer* (Golden: Colorado School of Mines Press, 1980).
18. See the photographers' markings on the prints from the iron breaker series, Coxe Collection photographs, Division of Work and Industry, National Museum of American History, Smithsonian Institution (hereafter DWI). These prints correspond to some of the glass negatives in the Coxe collection as well, which indicates that Coxe's arrangement with the local photographer involved handing over the negatives. The possibility that later a Coxe employee handled photographic duties is suggested by the glass negative time-exposure "Drifton Clad in Snow March 5th 1893, at 9:30 am Good Light," Coxe Glass Negative 3-20, DWI.
19. Eckley B. Coxe, "The Iron Breaker at Drifton, With a Description of Some of the Machinery Used for Handling and Preparing Coal at the Cross Creek Collieries," *Transactions of the American Institute of Mining Engineers* 19 (1891): 398-474.
20. Ronald T. Bailey, *Frozen in Silver: The Life and Frontier Photography of P.E. Larson* (Athens, OH: Swallow Press/Ohio University Press, 1997).
21. Examples of these glass negatives are held by both the Michigan Technological University Archives, Houghton, MI, and the Keweenaw National Historical Park, Calumet, MI. For examples of contact prints on blueprint paper, see Binder B and Binder C, Map Drawer 61, Michigan Technological University Map Collection, MTU Archives. No photographic prints of these plates are known to exist, but some have been scanned by the Michigan Tech archives. See Calumet and Hecla Large Format Glass Plate Negatives, MTU Archives.
22. This same goal of reproducing a master map periodically to track progress could also be achieved by using blueprints, as was the practice at the neighboring Quincy Mine; see, for example, the monthly progress maps made by the Quincy Mining Company from 1907 to 1926, Drawers E-J, Accession number KEWE-00033, Keweenaw NHP Archives.
23. See:"Calumet & Hecla Mining Co., General Office, Dark Room, Engineers' Office," [blueprint], 6 June 1905, Drawing 6424, Drawer 99, MS-005 C&H Drawings Collection, MTU Archives.
24. Hine sometimes had to pose as an inspector or other official to gain access, but as a third party employed

by neither management nor labor, Hine had less to lose than a miner whose job depended on the company he sought to expose. This author knows of no examples of underground photography being used directly by miners or laborers to advocate for better safety or working conditions in the American mining industry prior to 1920, but such images, if found, would be of significant historical interest.

25. Trachtenberg, *Reading American Photographs*, 164-72, 190-209.
26. John H. Dauge and Samuel J. Phillips. *Mine Accidents and Their Prevention* (New York: Coal Mining Department of the Delaware, Lackawanna and Western Railroad, 1912). The copy I examined is located in the coal mining collection, room 5028, National Museum of American History, Smithsonian Institution, Washington DC.
27. These fields are the Wyoming field, the Lehigh field, and the Schuylkill field, from north to south. There are some differences in patterns of ownership, markets, and geology among the three fields, but it is safe to generalize that the three eastern Pennsylvania fields have much more in common with each other than they do with other coal-producing regions.
28. Carter L. Goodrich, *The Miner's Freedom: A Study of the Working Life in a Changing Industry* (Boston: M. Jones, 1925; reprint, New York: Arno Press, 1977), 56; quoted in Harold W. Aurand, "Mine Safety and Social Control in the Anthracite Industry," *Pennsylvania History* 52, no. 4 (1985): 234.
29. The sources the author has consulted indicate that "working less" was the more common outcome. Miners would get their work done and knock off by mid-afternoon. However, one suspects some other factor at work limiting their ability to increase production, such as a lack of cars for hauling coal to the surface or the time needed for gas abatement after blasting.
30. Not all miners were paid on the basis of production. The mining company contracted some miners to perform other kinds of work (driving gangway tunnels, for example) at a certain amount of money per foot or per yard of progress. However, miners usually made more per hour working on a production basis. See: Harold W. Aurand, *Coalcracker Culture: Work and Values in Pennsylvania Anthracite* (Selinsgrove, PA: Susquehanna University Press, 2003), 82-94.
31. Aurand, *Coalcracker Culture*, 72-3.
32. For an excellent analysis of mine safety in the context of industrial safety generally, see: Mark Aldrich, *Safety First: Technology, Labor, and Business in the Building of American Work Safety, 1870-1939* (Baltimore: Johns Hopkins University Press, 1997). For a clear analysis of the political economy of mine safety efforts, focusing on bituminous coal mines, see: William Graebner, *Coal-Mining Safety in the Progressive Period: The Political Economy of Reform* (Lexington: University Press of Kentucky, 1976).
33. Aurand, "Mine Safety and Social Control," 227-8.
34. Aldrich gives figures for both anthracite and bituminous coal as far back as 1870 and 1874, respectively, though he is careful to note reliability problems with the data. The fatality rate per thousand workers for anthracite exceeded that of bituminous mining in 38 of the 47 years of available annual data between 1874 and 1920. The rate of fatalities per million man hours, available for both industries from 1880 (except for 1909) paints a slightly different picture. Anthracite exceeded bituminous in 25 of the 29 years from 1880 to 1908, but from 1910 to 1920 bituminous suffered more fatalities per million man hours every year save one. Aldrich's data extends to 1939, though I end my analysis of it at 1920 to fit the scope of this paper. Aldrich, *Safety First,* Appendix 2, pp. 298-308, especially table A2.1, pp. 300-1. A useful graph of the fatalities-per-thousand-workers data, computed as three-year moving averages and including data from Britain, is on page 42.
35. Mark Aldrich, "The Perils of Mining Anthracite: Regulation, Technology and Safety, 1870-1945," *Pennsylvania History* 64 (1997): 361.
36. Anthony F. C. Wallace, *St. Clair: A Nineteenth-Century Coal Town's Experience with a Disaster-Prone Industry* (Ithaca, NY: Cornell University Press, 1988), 265-75, 446-56.
37. Aurand ("Mine Safety and Social Control," 229-30) calls the pre-twentieth century anthracite industry's response "passive." On the passage of mine safety legislation, see: Wallace, *St. Clair*, 293-314.
38. On the Bureau of Mines, see: Mark Aldrich, "Preventing 'the Needless Peril of the Coal Mine': The Bureau of Mines and the Campaign Against Coal Mine Explosions," *Technology and Culture* 36 (1995): 483-518; Graebner, *Coal-Mining Safety*; L. Michael Kaas, "A History of the Bureau of Mines, with Some Highlights of Its Involvement in Anthracite Mining," *Mining History Journal* 13 (2006): 73–92; William S. Kirk, *The History of the Bureau of Mines* (Washington, D.C.: U.S. Department of the Interior, U.S. Bureau of Mines, 1996); and Fred Wilbur Powell, *The Bureau of Mines: Its History, Activities, and Organization* (New York: D. Appleton and Company, 1922). On Coxe's efforts, see: James J. Bohning, "Angel of the Anthracite: The Philanthropic Legacy of Sophia Georgina Coxe," *Canal History and Technology Proceedings* 24 (2005): 150-82.
39. Aurand, *Coalcracker Culture*, 79-80; Dague and Phillips, *Mine Accidents*, 4. It is interesting that these lectures were originally a performance, in front of a large audience. What would that audience have said? What would they have understood? How were the photos presented? How did the collective discourse contribute to a learning environment? How could the presenter understand its "telling effect"?
40. Dague and Phillips, *Mine Accidents*, 4, italics mine.

41. For Bureau of Mines' efforts against explosions, see: Aldrich, "Preventing 'the Needless Peril of the Coal Mine.'" In his 1997 article, Aldrich contended that "None of the [company safety] programs systematically addressed the major causes of haulage accidents, roof falls, or gas explosions." Aldrich, "Perils of Mining Anthracite," 376.
42. Dague and Phillips, *Mine Accidents*, 5.
43. Aldrich, "Perils of Mining Anthracite," 361-2.
44. Dague and Phillips, *Mine Accidents*, 54, 55.
45. Dague and Phillips, *Mine Accidents*, 22-3, 26-7.
46. Dague and Phillips, *Mine Accidents*, 28-9; also see 34-5 and 36-7.
47. See: Eric Twitty, *Blown to Bits in the Mine: A History of Mining and Explosives in the United States* (Ouray, CO: Western Reflections Publishing Company, 2001).
48. Dague and Phillips, *Mine Accidents*, 52.
49. Dague and Phillips, *Mine Accidents*, [iii]. I would like to thank Massimo Petrozzi for examining the Italian text; he agreed that it said exactly the same thing as the English translation.
50. See: Peter Roberts, *The Anthracite Coal Industry: a Study of the Economic Conditions and Relations of the Co-Operative Forces in the Development of the Anthracite Coal Industry of Pennsylvania* (New York: Macmillan Company, 1901); Peter Roberts, *Anthracite Coal Communities: a Study of the Demography, the Social, Educational and Moral Life of the Anthracite Regions* (New York: Macmillan Company, 1904). On "race suicide," see: Gail Bederman, *Manliness and Civilization: A Cultural History of Gender and Race in the United States, 1880-1917* (Chicago: University of Chicago Press, 1995), 199-206.
51. Paul McBride, "Peter Roberts and the YMCA Americanization Program, 1907-World War I," *Pennsylvania History* 44 (1977): 145-62.
52. McBride, "Peter Roberts and the YMCA," 148-52. In the Consolidation Coal Company Photograph Collection at the Smithsonian Institution there is an image, dated 25 January 1913, of miners enduring an English Language class. A poster of one of Roberts' lessons appears on the back wall. CCC negative number 732, Consolidation Coal Company Photograph Collection, DWI.
53. Dague and Phillips, *Mine Accidents*, 55.
54. The licensure law for miners was intended in part to exclude Eastern Europeans from the ranks of anthracite miners, but eventually it had the opposite effect, discouraging experienced but non-anthracite English and German miners from taking jobs in anthracite country. Aurand, *Coalcracker Culture*, 75-7.
55. Aurand, "Mine Safety and Social Control," 228.
56. McBride, "Peter Roberts and the YMCA," 154-9. These efforts did include education about mining as well; see: Harold W. Aurand, "Education of the Anthracite Miner," *Proceedings of the Canal History and Technology Symposium* 4 (1985): 93-106, which also mentions *Mine Accidents*.
57. Thomas P. Hughes, *American Genesis: A History of the American Genius for Invention* (New York: Penguin Books, 1989), 218-9.
58. Dague and Phillips, *Mine Accidents*, [v] (title page).
59. Dague and Phillips, *Mine Accidents*, 5.
60. Dague and Phillips, *Mine Accidents*, 63-9.
61. Dague and Phillips, *Mine Accidents*, 63.
62. Aurand, "Mine Safety and Social Control," 234.
63. Aldrich, "Perils of Mining Anthracite," 372.
64. Dague and Phillips, *Mine Accidents*, 40-1.
65. Dague and Phillips, *Mine Accidents*, 11.
66. Brown, *Corporate Eye*, 15.
67. Note that the rock is in what could be considered to be "common space," not in the breast, where only the miner and his helper worked. This scenario is found in Dague and Phillips, *Mine Accidents*, 16-7.
68. Dague and Phillips, *Mine Accidents*, 17.
69. See: Thomas Dublin and Walter Licht, *The Face of Decline: the Pennsylvania Anthracite Region in the Twentieth Century* (Ithaca, NY: Cornell University Press, 2005).
70. Dague and Phillips, *Mine Accidents*, 4.
71. See, for example: Edward Steidle, "Dangerous and Safe Practices in Bituminous Coal Mines," U.S. Bureau of Mines, *Miners' Circular* 22 (Washington, D.C.: USGPO, 1919).
72. Gwendoline E. Percival and Chester J. Kulesa, *Illustrating an Anthracite Era: The Photographic Legacy of John Horgan, Jr.* (Pennsylvania Historical and Museum Commission and Anthracite Heritage Museum/Iron Furnaces Associates, 1995), 7, 13, 17-8, 25, 28-34.
73. *The Story of Anthracite* (New York: The Hudson Coal Company, 1932).
74. Percival and Kulesa, *Illustrating an Anthracite Era*, 3, 17.
75. The photos are in the Consolidation Coal Company Photograph Collection, DWI. Geoffrey L. Buckley, *Extracting Appalachia: Images of the Consolidation Coal Company, 1910-1945* (Athens: Ohio University Press, 2004) reprints some of the photographs and sets them in the context of the business activities of Consolidation Coal. For a company-produced history prior to the 1930s, see: Charles E. Beachley, *History of the Consolidation Coal Company, 1864-1934* (New York: The Consolidation Coal Company, 1934).
76. For mining accidents, see, for example: negatives nos. 2147, 2150, 2151, 2159, 2164, 2165, 2170, 2171, 2172, 2173, 2183, and 2184, Consolidation Coal Company Photograph Collection, DWI. These date from 1922.
77. Buckley, *Extracting Appalachia*, xvii-xviii.
78. Beachley, *History of Consolidation Coal*, 70.