Spring 5-9-2012

Miners and Their Machines: How Early Turn-of-the-Century Mining Techniques and Equipment Influenced the Tri-State Area

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Hisfory 430
May9th, 2012

There is very little doubt that the mechanization and modernization of early mining methods in the early 1920s and 30s within the tri-state area, and the entire United States for that matter, would have a profound impact on the miners and the rest of the country.[1] This paper will explore the positives and the negatives of the machinery that miners began to use shortly after the turn-of-the-century. In the hope to clarify, or at least improve, the ideas of why mechanization took place so quickly and so willingly by mine operators, what its impacts were on the miners, and how it changed the image of American miners. The goal in researching this paper is to find out more about the equipment and tools that would change the level of production in Picher and the surrounding areas. Ultimately, the goal will be to help others better understand how the rapid mechanization and modernization of the mining industry in the tri-state area would affect the miners, the surrounding community, and the land itself.

Although many have addressed the health risk of miners, such as air quality, workplace safety, and the day-to-day wear and tear of such physical activity that comes with working in a mine, we have not really determine whether machines made these problems worse or better.[2] The intent is to address the history of mining equipment, and the subtle changes that are brought about at first. As the demand for lead and zinc would increase, so too would the need for more efficient ways of extracting it from the ground. If a miner or mine owner did not modernize with

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[1]S.C. Gilfillan, *Technological Trends and National Policy: Including the Social Implications of New Inventions,* Report of the Subcommittee on Technology to the National Resources Committee. United States Printing Office, Washington, (June 1937)

[2]A.J. Lanza and Edwin Higgins, "Pulmonary Disease among Miners in the Joplin district, Missouri and its Relation to Rock Dust in the Mine". Department of the Interior, Bureau of Mines. Washington Government printing office, (1921).

the latest pieces of equipment to improve the efficiency of their mine, you can almost bet that their competition would. This would ultimately push smaller mines out of business.

In addition to the mechanization itself, the intent is also to address the matter of labor issues with regards to mechanization. There should also be a look at how mechanization and modernization may not have always been well received by individual miners, but the demand for minerals such as lead, zinc, copper, gold, and coal would continue to grow as fast of this the United States would.

The unique problems and challenges that faced, both underground and strip-mining, would give rise to inventions custom-designed and built for the sole purpose of digging and transporting minerals and materials from mines. Not only were there changes in the equipment the miners used to dig with, but also their individual equipment.

Mining companies would invest huge sums of capital into machinery knowing that their investment would not be recuperated for decades. Pieces of equipment such as our own "Big Brutus" might work for several decades before it is replaced with a more efficient method of mining. In some instances, these pieces of equipment might be torn down and sold for scrap.

By the time full-scale mining had begun in the tri-state area during the early 1900s, underground mining techniques had become easier and more commonplace. The machines and tools that were used initially would have been very crude by today's standards. Picks, shovels, buckets, and ropes might have been the only tools that a lone independent miner would have. In order to stay competitive with other miners they would have to work harder or modernize.

There was a direct correlation between how quickly a mine would change over to laborsaving equipment and the cost of labor itself. If a mine owner or operator could simply hire more people to do the work of the machine it would not make sense to invest and maintain equipment. The introduction of machines that would do the work typically done by men was not always well received by the miners. Fortunately as the industry began to grow, so too did the demand for secondary and tertiary positions. Eventually the traditional pick and shovel miner would become a heavy equipment operator. For all the new equipment that was coming to the mines, and surrounding supportive industries, mechanics would be needed. Electricians were not only needed for a growing demand of mines, but also aboveground industries in residential areas as well. Plumbers, who installed the pumps and mechanisms to remove water from the mines, would be needed in the same fashion. Truck drivers, train conductors, engineers and supervisors would all be needed to continue the growth of the industry.[3]

The men who actually worked down inside the mine shoveling ore into the tubs would be relatively unskilled, and without the help of the labor unions or demand for lead at the time would make very little money. The toll of shoveling ore into the tubs on a miner's body became quite obvious in William James Cassidy's study of the tri-state zinc and lead mining region. According to Cassidy a young 19-year-old man could fill 60 to 70 tubs per day, but after 2 to 6 years of working in the mine this number would drop to 35 to 40. Since the miners were being paid by the ton, they would place a wooden paddle with their designated number on in the bucket after filling. As these tubs were lifted out of the mine the paddles were counted, and compared to the total tonnage removed from the mine at the end of the day by the mine foreman. If a miner did this same type of work 10 years down inside the mine prior to 1927, they were often

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[3]S.C. Gilfillan, *Technological Trends and National Policy: Including the Social Implications of New Inventions,* Report of the Subcommittee on Technology to the National Resources Committee, United States Printing Office, Washington, (June 1937).

physically unable to work by the age of 30.[4] Labor unions would grow increasingly popular and powerful to increase wages and working conditions of miners. This in turn would lead the mine owners to reevaluate the cost of the machines that were available to them and that would cut labor cost.[5]

Some inventions that we would take for granted today, such as flashlights and headlamps, still had a long way to go when came to reliability and usefulness. Just having a light bright enough that you could see with down inside the mine was a valuable and necessary tool. Flame Safety Lamps as they were called, were still in use all the way to the 1920s and 30s. A safety lamp was slightly different than open flame, in that it burned inside a glass cylinder. This would help to control the flow of oxygen and lessen the probability of a gas ignition down inside the mine. Unfortunately, some miners would forget the proper use of the safety lamp. The problem was bad enough that the US Bureau of Mines actually published a leaflet, spelling out the typical accidents that were caused by misuse of the safety lamp.[6] This publication would describe various ways that miners would lose their lives. Some would range from improper inspection of the lights, the shattering of the glass globe that surrounded the flame, or just a miner opening up his safety lamp to light up his own cigarette. Although lead and zinc mine had less gas, standards for mine safety would be adopted all over the country.

The first portable electric lamps or what we would refer to as lanterns, still had a lot of catching up to do when it came to being practical. The early dry cell battery lanterns still had the

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[4]William James Cassidy, "The Tri-State Zinc – Led Mining Region: Growth Problems and Prospects", University of Pittsburgh, Pennsylvania, (1936).

[5]Maier Bryan Fox, "United We Stand: The United Mine Workers of America, 1890-1990" Washington DC, Published by the United Mine Workers of America, (1990).

[6] L.C. Ilsley, *Misuse of Flame Safety Lamps and Dangers of Mixed Lights,* Department of Commerce, Bureau of mines, Washington Government printing office, (1925).

relatively old-style look of the old kerosene lantern, including the ring you could use to hang it. This new type of battery operated light would undergo a full round of testing by the US Bureau of Mines. The Bureau of Mines would determine that the electric lamps could ignite mine gas, if the light bulb was broken. After further testing, they would determine that as long as it was only a 6 volt battery, the light was very unlikely to ignite gasses in the mine.[7]

Inventions such as these would go on to influence what we recognize as the modern-day flashlight. Underground miners today have customized safety helmets with a slot directly on the front used to hold the headlamp with a 3 foot long cord that goes to a battery pack worn on the miners' belt. They are lightweight, corrosion resistant, and often waterproof.

As electricity became more readily available, whether produced on-site by the mine operators themselves or from the local power grid, underground mines would benefit from the use of semi-permanent lighting throughout the work areas. Once again, the Bureau of Mines would conduct testing to ensure that mines were operating safely.[8] After conducting several tests of various voltages and amperages, the Bureau of Mines would make a determination over what system would be best to use. The familiar looking light bulb enclosed in a heavy glass globe, with what looks like a small metal basket around that, would become the normal looking light fixture for work areas inside of mines. Airtight switch boxes and wiring enclosed inside metal pipe would also become the norm.

Although technically not considered to be a machine or equipment, dynamite would be considered a very integral tool in underground mining. According to Samuel Weidman, the

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[7] H. H. Clark, *Permissible Electric Lamps for Miners,* Department of the Interior, Bureau of Mines, Washington Government printing office, (1914).

[8] H. H. Clark, *Electric Lights for Use about Oil and Gas Wells,* Department of the Interior, Bureau of Mines, Washington Government printing office, (1914).

consumption of dynamite would be about one pound for every ton of material extracted from the mines. The use of explosives was so common, that at the end of every shift miners knew it was time to begin drilling holes to insert the charges. Sometimes the dynamite was emplaced by a designated individual, other times it was simply slid into the holes by the miners working in that particular part of the mine. At the end of the shift the dynamite was detonated and the mine would be left overnight for the dust to settle.[9] Some of the pieces would have to be broken down further with the jackhammer, but much of the ore could be scooped up and put into mine carts.

Hard lessons were still being learned about explosives during this time. While it was very economical to use explosives to move rock material, it also had unpredictable effects on the roof of the mine. Inspectors known as trimmers would go into the mines shortly after a blast or just prior to the other miners to inspect for loose rock. Nitroglycerin, or blasting oil as it was sometimes called, was the primary ingredient the dynamite. By itself it was rather unstable and dangerous to work with, but mixing it with sawdust, shredded paper, or other cellulose material made it safer and easier to use. At first it was thought that using nitroglycerin rather than diluted dynamite might be more economical because it had more explosive power in a smaller space. The hazard in transporting and storing of nitroglycerin however, made it cost prohibitive. It was also discovered that the relative effectiveness, or RE factor, would separate dynamite and nitroglycerin into the two categories, high explosives and low explosives. Dynamite and ammonium nitrate exploded more slowly than the nitroglycerin, thereby having a better push effect against the ore that was in the ground. This meant less cracking in the walls and the roof

[9] Samuel Weidman, *Miami/Picher Zinc/ Led District,* Norman University of Oklahoma Press, (1932).

the mine, making work for the trimmers who inspected the mine for loose rock after blasting much easier.[10]

After only a few feet of lateral movement in a mine, it was necessary to use and efficient means of moving the desired material or waste that was left behind. The best way to do this was by a mine cart. In nearly every historical photograph that is seen of an underground mine, there was what appears to be a small set of railroad tracks. These tracks would serve as a smooth means of conveyance of the heavy mine carts, whether being used to move the mined material, equipment, or even the miners themselves. The mine carts themselves had to be incredibly heavy and durable. This created a whole new demand for manufacturers to provide this type of equipment for a mine. The mine carts came in a variety of sizes to accommodate the different sizes of shafts and methods of loading or unloading.[11]

The manufacturing of items such as mine carts, metal bins, hoppers, air tanks and anything else that would require joining two pieces of metal together would speed up dramatically with the advancement of welding. Welding was a relatively new technology of the turn-of-the-century. Prior to welding the best way to join two pieces of metal was by bolts or large metal rivets. Rivets were far less expensive than a typical bolt, however the noise and heat required installing a rivet made welding a far better alternative. By the 1930s, welding had become commonplace for manufacturing, and even some field repair of equipment.[12]

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[10] *United States Army Engineer Field Manual 5-34*, Fort Leonard Wood, Missouri, (2002).

[11] *Chase Catalog of Dump Cars, Transfer Cars, and Turntables*, The Chase Foundry and Manufacturing Company, Columbus, Ohio (1928).

[12] S. C. Gilfillan, *Technological Trends and National Policy: Including the Social Implications of New Inventions,* Report of the Subcommittee on Technology to the National Resources Committee, United States Government printing office, Washington, DC, (June 1937).

The kinds of power needed down inside a typical mine, other than that of man or mule, are broken down into three categories; electric, pneumatic, and internal combustion engines. Each one of these had their own advantages and disadvantages when it came to where a miner was working, and what the task at hand was.

Probably one of the safest and commonly used tools in underground mining just after the turn-of-the-century was the pneumatic jackhammer and drill. Each required a high-pressure airline that would move a piston back and forth with such power and force that it would actually sound like a machine gun. The advantages of pneumatic tools were that they had few moving parts, and were both rugged and reliable. Since no electricity or fuel is needed to power them, there was no worry of electrical shock if they became wet, nor did they produce toxic exhaust gases that internal combustion engines would. Miners would also use the same type of tools with long drill bits to hammer holes into the rock to accommodate the sticks of dynamite that would be placed in later. At first these tools were a source of some the fine silica dust that later would be discovered to be the source of breeding disorders such as silicosis. The problem was solved by having a constant stream of water sprayed onto the drill bit, or supply water through a hold running down the center of the bit. This would improve the air quality in the mines dramatically as well as extend the life of the drill bits by keeping them cool. The disadvantages of pneumatic tools were that they relied on an outside source of air lines from a compressor.[13] The air compressor itself was gasoline, diesel, or electric and would seldom be located in the mine itself.

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[13] S.C. Gilfillan, *Technological Trends and National Policy: Including the Social Implications of New Inventions,* Report of the Subcommittee on Technology to the National Resources Committee, United States Government printing office, Washington, DC (June 1937).

With all of the additional water needed for both wet drilling and spraying down of rock dust, one would think that there would be a problem with water accumulating quickly in some of the more highly productive mines. In actuality water only tended to be a problem in some of the deepest mines and accumulate in lower natural caverns. Many of the larger mines throughout the tri-state area were actually connected like roads by the lateral drift mines underground, and would share in the cost of pumping water out of their connected mines. When the water would gather in these areas, referred to as sumps, it would then be pumped out by heavy-duty electric centrifuge pumps. Approximately 43 separate pumping stations in the Oklahoma-Kansas area would pump out more than 9000 gallons a minute of this water that was used to keep the dust down in the mines. Some of the water being pulled up from the mines would be so acidic that it would cause plumbing and pumps to corrode at an alarming rate. This made it necessary to install corrosive resistant pumps and specially coated pipes to withstand corrosion. [14]

Even though the air quality was improved by wet drilling and spraying water to keep the dust down, ventilation was still always a concern inside the mines. Most of the mines would be ventilated with two or more vertical ventilation shafts that were connected by horizontal drift mines. If there was not enough natural airflow through the mine then electric blowers would be used to help improve the air quality.

The heaviest, most difficult and sometimes considered to be the most dangerous of the work done at the mine was actually lifting the ore out of the ground through long vertical shafts. Weidman considered this to be one of the most interesting phases of the mining operation. Hoisting practices had progressively improved to maximize the efficiency. The 40 to 60 foot tall

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[14] Samuel Weidman, *Miami/Picher Zinc/ Led District* Norman University of Oklahoma Press, (1932).

derrick would be built directly above the main hall shaft. Sometimes these towers- like structures would be enclosed to protect the hoisting mechanism of the tower and enable an operator to work year-round.[15]

These heavy hoisting practices were actually developed in the tri-state area according to Samuel Weidman's report. The heavy carts of ore would be placed in the center of the hole directly beneath the tower. The hoist operator would be situated directly above the hole so that he could see the progress of the bucket being brought up, but often times could not actually see the very bottom of the hole. He would lower an empty bucket down into the shaft and slow its descent as it approached the bottom. A worker down inside the mine referred to as the "hooker", would swing the relatively lighter bucket over the top of the fully loaded bucket and place it off to the side. As soon as the cable went slack he would disconnect the empty bucket and hook on to the full one. The hoist operator would then release the clutch, sending full power to the lifting mechanism. Several hundred pounds of ore would be lifted up through the shaft and stopped at a predetermined height. An angled door directly beneath the bucket would be closed and the ore dumped.[16] After the lead ore would slide down to an awaiting hopper; the angled door would reopen in the process continued. Each lift would average approximately 300 tons, and the process could be done about every 40 seconds.

The vast majority of these lifting derricks would use a 220 V electric motor as a source of power. The tower itself could be made out of either wood or metal, but mine operators would realize that a metal tower would be lower maintenance and fireproof. There were seldom any

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[15]Samuel Weidman, *Miami/Picher Zinc/ Led District*, Norman University of Oklahoma Press, (1932).

[16] ibid

verbal signals from the lift operator or hooker. A safety signal referred to as a "skidoo-bell" would be within arm's reach of the lift operator, and would be used as a warning if any debris or material would fall back down to the shaft.

Finally the ore would have to be transported to the mill for separating and refining. This would be done by a steam or gasoline locomotive tram car. While the use of steam locomotives was relatively cheap to operate, the time that it would take each shift to fire up the boiler and keep the small locomotives moving became more expensive than simply using a gasoline engine. Steam shovels that were also being used above ground, would eventually give way to the diesel electric power.[17]

The enormous piles of chat that were left behind after the ore was separated from the rock grew bigger and higher with the use of conveyor belts. This method of moving rock, dirt, chat or any other dry material became an indispensable tool for many mine operations. An electric motor at the end of a long metal frame would continuously turn the belt from a lower area to a higher one. If a miner was still needed to shovel, they would only have to lift material a few inches off the ground rather than up and over the side of a large metal container.

Nearly all the mines in the tri-state area received their electricity from a power plant on the Spring River, located about 15 miles Northeast of Picher. Supplying the growing demand of equipment in the area was solved by the secondary industries such as foundries, supply houses, and other shops that would cater to the needs of the miners and their equipment. Above ground

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[17] ibid

secondary and tertiary businesses would continue to grow not only to meet the demands for lead, but for the ever-growing demand for coal that was also in abundance.[18]

With the advancement of technology one would think that these machines would put people out of work. As Gilfillan points out, this may have been the case initially but later the increased demand and productivity that were produced would also create more jobs. A whole new demand for what would be considered to be skilled labor would arise from this industry, and the manufacturers who supported it. Steelworkers, welders, electricians, plumbers and heavy equipment operators would all be connected either directly or indirectly with mining operations such as this one in the United States.

In conclusion, the increase in machinery and technology used to extract lead ore out of the ground in Picher did not appear to have caused any immediate dangers for the miners. By the time increase of the machinery was being used, the dangers of silica dust in the air were already being well documented. Wet drilling and rules for spraying water on freshly excavated rock helped to curb this problem. The survival rate for miners improved, and overall working conditions were made better.

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[18] S.C. Gilfillan, *Technological Trends and National Policy: Including the Social Implications of New Inventions*, Report of the Subcommittee on Technology to the National Resources Committee, United States Government printing office, Washington, DC, (June 1937).

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