

# Twisting the History of Steel Wire Rope

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(3/4/16 - Australian Mining) When it comes to productivity and progress, ingenuity is the backbone of the mining industry. Many will agree that mining activities have been the precursor to almost every significant technological development in our history. The period to which we attribute the most exponential growth in technology, the Industrial Revolution, owes everything to a few key inventions. The steam engine, the Bessemer Method and dynamite are often listed as the most important inventions of the modern age, but there is one other without which these things would not have had such remarkable impact on our lives.

At least, that's what occurred to me after I was invited to take a tour of the 120-year old Wirerope Works factory site in Williamsport, Pennsylvania. As a rigger I had always appreciated the importance of steel wire rope to mining and to civil engineering, but despite this seemingly simple invention being part of every single day of my life working in the mining industry, I knew very little about how it is made, and even less about its history.



They say you should never visit the sausage factory, and that may be true, but the wilfully ignorant are not to be trusted, and steel wire rope is certainly a special type of sausage. It was a visit that put me through the emotional spectrum, from disinterested to bemused, to bewildered, and finally awed at the sheer scale of the operation. It's a little bit like when you find out where babies come from: Horrifying and weird to begin with, but before long you find yourself utterly fascinated...

Flexible steel wire rope has been one of the mainstays of heavy industry for more than a hundred years. Whether you want to lash down scaff planks, carry out lifting and craning, use draglines for surface mining, or even pull down a massive statue of Saddam Hussein, wire rope has thousands of applications.

The Wirerope Works factory in Williamsport, Pennsylvania has a long history of producing this essential component of progress in the 20th century, and although cheaper imports from China and India continue to flood the market, the caretakers of the Bethlehem Wire Rope brand are still proud to produce a product of the highest quality on local labour and quality materials.

Based in Lycoming County in Pennsylvania, Wirerope Works (WRW) began its life as the Morrison Patent Wire Rope Company in 1886. The original mill was built upstream on the banks of the Susquehanna River to service the softwood logging industry, however regular flooding led to the relocation and inevitable expansion of the factory in the town of Williamsport.

The design and manufacture of steel wire rope was no longer in its infancy at that stage. The first practical use of steel rope in 1834 was credited to a German mining official named Wilhelm August Julius Albert, who worked at the Clausthal silver mines in Saxony.

Up until that point, all mining haulage was done with hemp fibre rope or chains. In the humid, damp conditions of an underground mine, moisture would cause the ropes to perish from rot, the gradual deterioration reducing their load bearing capacity, so they required frequent replacement.

Chains at that time were no better in terms of safety, as the Bessemer process for making steel was not invented until 1855. Iron chains lacked elasticity, but were also metallurgically inconsistent and therefore, unreliable. A single weak link could make a chain prone to catastrophic failure without warning, and there was no way of knowing which might be the weakest.

That first incarnation of modern steel wire rope was extremely effective for heavy haulage, and much more reliable than rope or chain. Albert Rope, as it came to be known, was a simple construction of three 3.5mm gauge wrought-iron wires, hand-

wound into strands, with three or four of those strands wound into a single rope. However, Albert rope lacked the flexibility of rope or chain, meaning it couldn't be drawn through a pulley sheave, and its use stopped in the 1850s.

But the idea for wire rope had already caught on in England, where thinner wires were woven around a fibre core, with six of those strands woven around a central fibre core, resulting in a more flexible product. This design, as well as a mechanical system for its construction (called a strander), was patented by Robert Newall, who brought the new technology to America, and the boom-time economy of the California Gold Rush.

However, it was in Pennsylvania where a German-born engineer and surveyor named John Roebling began to develop ropes which were entirely constructed of wire. Roebling used a 6/19 construction (6 strands; 19 wires per strand). A strand built of 19 wires of the same gauge resulted in a hexagonal profile, and desiring a round shape Roebling conceived of using three different gauges of wire to achieve that result. The effect of this was to reduce the space inside the rope, tightly packing the wires together, which gave the rope greater stability under load.

With massive demand for coal haulage in Pennsylvania, as well as cable car applications for public transportation, and most importantly civil engineering projects to service, Roebling set up a wire rope factory in 1849 in Trenton, New Jersey. But he wasn't the first to invest in a factory like that: Other people had the same idea, and wire rope mills were starting to pop up around the United States. In only 14 years wire rope had gone from a hand-made experiment in a German silver mine, to a globally recognised tool of industry with high demand for scaled-up production.

If Roebling had any hubris about cashing in on this amazing new invention, you could be forgiven for thinking it was a little dampened when his arm and shoulder were horrifically mangled in an accident with one of his stranding machines. But it would seem that Roebling's interest in wire rope was not strictly for profit, however, as he had for some time harboured a bit of an obsession with sketching suspension bridges. He was a big fan of the expansionist philosophy of Manifest Destiny, and had been very keen on establishing a utopian settlement called Germania (now the

town of Saxonburg), where people like him trying to escape the brutal oppression of post-Prussian War Europe could be free to make sauerkraut and smoked pork products, unmolested by the authorities.

As luck would have it, farming cabbages didn't really agree with Roebling. He had studied in Berlin under the best academics in engineering, architecture, bridge construction, and hydraulics that Germany had to offer. Roebling was a very gifted individual, recognised at a young age as he grew up in Mühlhausen in Saxony, only 100 kilometres from the silver mines of Clausthal.

But Roebling recovered from his injuries, his factory continued to produce wire rope, and he designed and built a number of suspension bridges using his own product right up until he began design work for the Brooklyn Bridge. Unfortunately, Roebling managed to get his foot crushed by a ferry while standing on a dock trying to work out where the bridge should go. He died of tetanus 24 days later, but his son Washington went on to complete the Brooklyn Bridge project, while his son Charles would invent an 80 tonne wire rope machine.

By 1886, the year the Brooklyn Bridge was opened, a venture like setting up a wire rope factory in Pennsylvania was not at all a bad way to invest \$100,000 (probably about \$US3 million today), and that is precisely what three businessmen from Williamsport did.

Morrison Patent was changed to the Williamsport Wire Rope Company in 1888, manufacturing steel and galvanised wire rope "from one-eighth of an inch to two and one-half inches in diameter, and any length up to two miles in one continuous piece", according to an 1892 history of Lycoming County.

The move to the Williamsport site set the company up for a period of charged innovation and growth, fed by the demand for haulage in Lycoming County's massive lumber and coal mining industries. Williamsport was known as the "Lumber Capital of the World" and laid claim to having more millionaire residents per capita than anywhere else in the world.

The lumber boom in Lycoming peaked in 1891, and the neighbouring Indiana County saw a coal-mining boom start in 1900, so the industrial economy was perfect for the

growth of the Williamsport rope mill. A new wire mill was built in 1916, and the current rope mill was built in 1928, which was pretty poor timing considering the Great Depression would start the next year.

✘ By the time the Great Depression ended in 1939, the company was ripe for purchase by Bethlehem Steel, which renamed it the Bethlehem Steel Wire Rope division.

By 2004, the Williamsport site had been bought and sold a number of times, changing company names like a serial divorcee, acquiring assets from other defunct companies such as Roebling Wire Rope (the company started by John Roebling in 1849) but always keeping the Bethlehem Wire Rope brand, which became synonymous with top quality steel cable, and is still proudly emblazoned on their rope spools to this day.

In 2002 Williamsport Wire Rope Works bought out the bankrupt Paulsen Wire Rope, a rope mill located in nearby Sunbury, and continued to produce under the Paulsen name. But by 2003 the company was also in financial strife, and the management were looking for another buyer who could bail out the company and keep the 600,000 square foot Bethlehem factory running.

The US wire rope manufacturing industry had changed dramatically over the course of 100 years. From an exciting new industry that would allow explosive growth in the productivity of coal mining through the development of dragline surface mining operations in the early 20th century, as well as enabling some of the biggest civil engineering projects ever seen since the Pyramids of Giza, the US stable of 27 wire rope companies had been consolidated down to just three names: Bridon, WireCo, and Bethlehem.

Bridon is another Pennsylvania company, based 100 kilometres away in Wilkes-Barre. Unlike Williamsport which remained a local manufacturer, Bridon expanded rapidly, acquiring other wire rope companies and branching out across the world, developing into a massive, multinational conglomerate, as did WireCo Worldgroup.

With two global entities for domestic competition, Bethlehem also faced increasing pressure from low-cost offshore wire rope producers in countries like China, Korea

and India.

Present executive vice-president Lamar J Richards remembers circumstances were looking grim for the Bethlehem brand and for the local employees, with a bid for takeover by Pennsylvania, USA and world market rival WireCo Worldgroup in late 2003.

“Instructions from the ownership at the time were, because we were about to be bought by a competitor we really weren’t going to be making wire, so we had to get rid of all the raw material, the rod, our starting point for the wire,” he said.

“Being the industrial little guys that we are, we removed several thousand tonnes of rod, so at the end of 2003 we only had one pack, two tonnes left. We would normally have 2000 tonnes in stock.

“We were later informed by our assessor that the deal probably wasn’t going to go through, and then our sole rod supplier went out of business in November. We didn’t really have any credence with any other suppliers, and availability was extremely tight, there was a rod shortage.

“So in that environment, there was an effort by local people to see if they could put together a coalition to buy the company and keep the manufacturing here in Williamsport. The concern was that with a competitor buying we would ultimately be folded up and moved.”

And it was in this environment that local businessman Tom Saltsgiver, owner of a successful modular housing manufacturing plant, started to consider the prospect of buying an ailing historic business of significant value to the local economy, and decided to accept an invitation to take a tour of the Bethlehem plant.

But I didn’t know any of those things when I found myself standing, probably in the same spot as Mr Saltsgiver did when starting his tour, right there in the foyer of the single largest wire rope manufacturing facility in North America on a muggy Thursday morning. I had arrived at the factory with a junket of assorted journalists, exhausted from touring a gamut of other factories and fighting off a particularly vicious head cold, quite oblivious to the fact that our tour bus had, having dropped

us off, already left with my camera bag still on board. Perhaps one could have forgiven me for being a little out of sorts at first. But not for long...

Walking into the front offices of Wirerope Works on Maynard Street, it's clear there's pride in the product here. Foot-long samples of rope in varying configurations and gauges lie on polished timber plinths in the foyer, cleaned of oil with sharp edges ground smooth for safe handling by visitors.

On the walls hang photographs of major construction projects which were supplied with Bethlehem brand wire rope: Madison Square Gardens, the restringing of the Brooklyn Bridge, the Niagara Falls tightrope.

Our hosts are all of a distinguished vintage, and they usher us into an opulent but small boardroom, resplendent in walnut lining (I'm later informed it's faux timber) with a long table and large sumptuous leather chairs. I can tell they're pretty excited to have us here. There's a distinct chemistry between these guys, a lot of joking around and backhanded compliments: They've worked together for a long time.

Lamar J. Richards, the executive vice president of Wirerope Works, explains to us some of the history of the plant (see Australian Mining February 2016), but one of the most touching stories he tells us is about how the present owner, Tom Saltsgiver, came to buy the company and keep it alive for the sake of the local economy in Williamsport.

The owner of a successful modular housing manufacturing plant, Saltsgiver picked up the Bethlehem while it was in some very dire straits, and did so against the better advice of friends, family and colleagues, according to Richards.

"There was an effort by local people to see if they could put together a coalition to buy the company and keep the manufacturing here in Williamsport," Richards said.

"The concern was that with a competitor buying there was a good chance we would ultimately be folded up and moved.

"In trying to put together that coalition [Saltsgiver] came in for a tour and went through the place, and then he indicated that he was interested in buying.

“He had the financial wherewithal to do that because the business he was in at the time was modular home building, and he had a plant about 20 miles from Williamsport.

“Back in 2003-4 housing growth was going great, and he had this financial business and he had the ability to get financing without any question.

“In the face of us being in a tough market, under the previous ownership we were undercapitalised. We didn’t have two pennies to rub together, and in the face of that our current owner stepped up, bought the place and put up working capital to keep the place running.”

Inability to secure raw materials meant many workers had to be laid off, and upon purchase the company called up 88 people to come back to their jobs.

About a year in from the purchase, Richards explains, Saltsgiver invited staff for a dinner with him and his wife.

“Our owner is extremely laid back, you would never think he was the owner of companies, or that he’s a multi-millionaire,” Richards said.

“So we go to this dinner, and my predecessor asked Tom to get up and say a few words, so he gets up and he says, ‘So I guess you folks would like to know why I bought this place?’ and we all sat there and said ‘Yes sir, we would’.”

So Saltsgiver tells the story: “Well, when I was looking at it to buy it, all my friends in the area who knew about the business said, ‘Don’t even think about it, don’t even think about it, it’s a bad deal’.”

“My financial advisors all looked at it and said that’s a disaster, don’t touch it.

“And my family, they said, ‘We don’t know anything about the steel business, don’t do it, we know modular homes we’ve made a good living doing that, don’t throw your money away here’.”

Richards said thus far it looked like three strikes, and surely that would have been the end of it for the prospective buyer, but he continues: “and this stuns me to this



day, because he said 'I prayed about it, I felt that God had answered my prayer and told me to proceed'."

As it turned out, the newly renamed Wirerope Works became profitable after 18 months of capital support. Shortly after that, the housing bubble burst.

"It's not often you'll find an individual who's willing to gamble millions of dollars based on his faith," Richards said.

After this brief history lesson we are handed hardhats and earplugs and instructed that it will be very difficult to hear anything inside the factory. They weren't wrong. Although the tour from that stage onward was sparse on information, I found myself going from a sense of bewilderment at the extreme conditions of the workplace to being strangely entranced with the manufacturing process.

One of the first things shown to us is the floor. The factory is tiled with timber bricks, grain pointing upward and creating a very unique effect where the timber had been polished by decades of wear. The timber floors are a result of Williamsport's logging history, when wooden blocks were cheap and readily available in bulk. To this day when any flooring needs repairs or replacement, Wirerope Works still uses the original material. To walk on it is remarkably different from concrete, and where I can compare the two it is noticeably easier underfoot. Bear in mind the factory is 620,000 square feet, so a lot of what essentially was scrap lumber had been put to good use.

First we are shown the raw material: 4mm steel wire in loose looking coils about 6 foot across, lifted by forklifts and taken through to a hydrochloric acid bath which will strip off any contaminants. Having been battling a common cold for a few days, I didn't need to be told the fizzing pool before me was acid. Plumes of vapour were pouring off the bath, and before I could think of doing anything about it the congestion in my head loosened and poured down the back of my throat, and I suddenly I could breathe more clearly and easily than I had done for days! I realised it was the corrosive vapour that had cleared my head, and it might soon start to work on the tissues of my sinus. I tried to hold my breath while our host laughed and tried to explain, incoherently over the roar of the factory, the process of treating the raw material.

A small crane cabin with a lifting arm, fronted by glass and inhabited by a doleful looking man, ran back and forth along the length of the acid pool, picking up the large coils out of the bath and moving them down the line, gradually shuffling each one over the course of hours before they were considered clean enough to be taken for heat treatment in the furnace.

The operator did not wear any respirator or breathing apparatus, and I wondered if it were possible to build up a tolerance to acid fumes, or did it just slowly eat away at one's alveoli? He's still working here, I supposed.

We all back away from the deadly head-cold cure and are led to the furnace, where 12 of the washed coils are set up to feed wire through an oven blazing at 1000 degrees Celcius, only 360 degrees shy of melting point. I realise wearing my jacket, despite the cool Pennsylvania humidity, was not the smartest thing in the world to do and we walk past the contained inferno, pouring with sweat.

It's becoming amply clear to me that this is an extremely dangerous workplace, and we continue to the other side of the furnace where the cherry glowing wires are fed down into a simmering oil bath for quenching.

We file past, only a couple of feet from the long vat of hellbroth with no rails or guards and I think to myself, 'this must be the single most dangerous thing I have ever stood near'. Having been a labourer and rigger for most of my adult life, I have certainly worked in some unsafe conditions, from high rise buildings with no fall arrest equipment to a uranium mine with no proper PPE, but even those experiences didn't seem to come close to standing next to this long vat of near-boiling oil. What would happen if one of us stumbled, reaching out for grip and finding only oil that could burn off a limb in seconds, or worse, what if one could fall in altogether! I reassured myself a victim of clumsiness would pass out almost instantly from the shock of the burn. Small comfort as we tried to stay as far away from the vat as possible, with a few feet of leeway for space.

Once cool enough, the wire passes through hydrochloric acid to wash off all traces of contaminant, and I hold my breath as we walk the length of the pool, our host taking deep breaths as if it were fresh spring air and not lung melting fumes, laughing as he watches the visitors squirm... Does he know something I don't? I sure hope so.

A coating of zinc phosphate, another rinse, and another final coating prepares the wire for extrusion, which has two key functions. The most obvious is for achieving the correct gauge of wire required for twisting into the various rope products, but extrusion also means the steel wire is stretched to align the structure of the steel to align in a single direction, which strengthens and increases the breaking strain of each wire.

However, the most important part of all of this is the stranding process, and here is where my reactions turn from shock to awe. As a rigger using steel wire rope on a daily basis for slinging, I had often wondered how the rope was produced, and here it was before my eyes: The factory floor - acres of it - was full of lines of planetary stranders, all with sets of wires in large bobbins, as many as 64 wires on a single machine, feeding into a single, oily strand of rope. The factory had machines of all sizes hard at work, furiously spinning to produce the some 1200 different combinations of wire rope that come out of the factory every three months.

The machines are clearly dangerous, spinning at a rate of knots. Later that evening I met a local teacher in a bar who tells me about a worker he knew of who was dragged into a strander and ripped to pieces. I didn't need to be told this was possible, it was obvious. But my sense for this hazardous workplace was quickly being replaced with a gripping fascination for the process.

We're led past rows and rows of finished product on massive timber spools printed with the Bethlehem logo and our guide Norm Szamocki, director of operations, screams at us that this is the product they affectionately refer to as "Tank Yank", their product which is used by the US military to kit out their M88 Hercules recovery vehicle, usually deployed for rescuing incapacitated tanks. This is the same machine and cable that helped the people of Iraq to drag down the Saddam Hussein statue in Firdos Square, Bagdad, an event in which the people who manufacture Bethlehem wire rope were proud to have a hand.



Finally, we come to the heart of the factory: We stand, astonished, gazing up at the 12 foot tall, 800 tonne closing machine, designed to produce the 7 inch rope for dragline boom pendants, and construction cable like that used to build the Brooklyn Bridge. The already huge strands are all dragged into a central point, slowly weaving the helical pattern of wires around a hefty centre rope into a single massive cable which will one day end up on a dragline somewhere in the world.

The whole process is mesmerising, and it occurs to me that this place is like a Disneyland or Mecca for riggers. It's a real privilege to see how this is product made, the effort that goes into ensuring the finest quality product is produced for a discerning market that eschews the cheaper overseas manufacturers.

With a history spanning 120 years, the Wirerope Works factory has seen plenty of hard times, but it's also had a lot of luck. With good leadership at the helm from the likes of Saltsgiver and Richards, and ongoing demand for steel wire rope, the old Williamsport factory could continue to produce its quality bespoke products for another 120 years.