

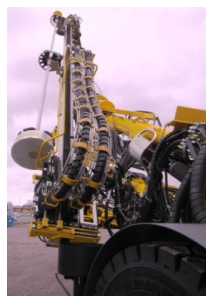
Clean hands, cool head, warm heart...

The Atlas Copco Experience



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Introduction



One of the first rigs I ever worked on was an old Atlas Copco Explorax, made by 'a Swedish company'. Seven years later, I received the opportunity of a lifetime to learn more about this company, Sweden and the entire global mining industry through the Atlas Copco Travel Scholarship, offered in conjunction with AusIMM to undergraduate engineers and geologists.

The experience began with an interesting week in the Perth facility mid-year, and concluded in Sweden, where I saw the new, improved version of my old friend the Explorax on my final factory visit.

Atlas Copco is a model of corporate social responsibility, excellent working conditions and good management, as well as the manufacturer, distributor and servicer of top quality, versatile machines catering to every corner of the mining industry. Through this report, I hope to share some of the experiences I had in Sweden with this outstanding company.

Stockholm, Rising

I arrived in Sweden on a weekend in November – the time of year I was advised to avoid, but when you're being treated like royalty, the weather hardly matters! A chauffeur welcomed me to the country and gave me a guided tour of the capital. The oldest part is a series of fourteen interconnected islands full of cobbled alleyways, beautiful buildings, museums and places to drink coffee. Sweden is a country truly blessed by geology. It sits on consolidated bedrock of granite and granite's metamorphic cousin, gneiss, which is so strong that only six metres of this stands between the roof of the workshop in the Nacka underground test mine and the buildings of Stockholm above.

The piece of crust we call the Baltic Shield underlies much of the country, composed of several Achaean cratons and other Precambrian rocks. The magmatism and hydrothermal activity from subsequent collisions and compressions concentrated copper, gold, silver and even magnetite in abundance. Aside from coherent bedrock and valuable mineralisation, geology has also blessed Sweden with a rising nation. The entire country is still rebounding from the loss of the last great ice sheets, at a smooth rate of approximately 5mm a year. This is faster than predicted sea level rise, and the bedrock beneath the city houses some of the world's most important servers.

Vasa... an epic Whoops

I also received a fully guided tour of the Vasa Museum in Stockholm. The story of the Warship Vasa provides a stark contrast to the modern Swedish business culture, which is efficient and socially responsible. The pride of Gustavus Adolphus's fleet, 70m in length and adorned with rich carvings, set sail in 1628, travelled 1300m, listed in a breeze and promptly sank to the bottom of Stockholm Harbour. It seems that no one was in a position to inform the king that his ship lacked sufficient ballast. It lay there for 333 years, preserved in anoxic, brackish, Baltic mud until the 1950s, when the persistence of a maritime archaeologist with a small coring device won out. The story of her discovery and salvation is an epic in itself, suffice to say she was raised by divers and barges, brought to a dry dock and sprayed with polyethylene for 17 years (many Atlas Copco staff remember this from their childhoods), after which the dry dock was converted to a museum.



Life-like forensic reconstructions of sailors whose skeletons were recovered from the Vasa.



Looking down on the bow of the great ship and the basement of the original dry dock below.

Underground Rock Excavation, Örebro

My Atlas Copco experience began properly when I arrived in Örebro, a small university city of 130,000 people, 200 km west of Stockholm. The Australian flag was flying proudly from the pole outside the building.

Örebro has three separate Atlas Copco facilities, the largest of which houses management and marketing for the entire Mining Portfolio (one of four business areas), and the Underground Rock Excavation (URE) headquarters. URE includes the Boomers (face drills), Simbas (production drills), tunnel stabilisers (Boltec and Cabletec), Scooptram, Hägg Loaders and Hägg Coms, Pedestal Booms, Utility Vehicles, Ventilation and Raise Borers. The division invests heavily in R&D, working intensely with clients. Throughout the trip, I received specialised presentations on each of these products, the service packages, the company philosophy and the business model. I then travelled all over the country, visiting the various production facilities associated with URE, as well as Surface Drilling Equipment (SDE) and Geotechnical Drilling and Exploration (GDE).

Exciting developments in URE

The Boomer (horizontal face drill) and the Simba (flexible production drill) are both equipped with the 'Measure While Drilling' system, which collects seven metrics describing rock condition and simultaneously calculates the most efficient settings. Drill plans and actual hole data can be wirelessly transmitted to the control room, a laser scanner eliminates the need for underground surveyors, and the machines can be operated remotely.

This automation technology applies to most machines in the Atlas Copco fleet, and there are six Simbas currently operating by tele-remote in Malmberget, a series of disseminated iron ore bodies in the far north. A single operator controls the whole fleet and the data is processed through an Atlas Copco server, capable of linking to Micromine. The company acts as a 'total solution provider' in the design of mines and systems, rather than simply a supplier.

With thanks to Travis, Julian, Johan and Marcus.

Surface Drilling Equipment and the future of grade control

The Eyra facility in Örebro is in charge of Surface Drilling Equipment (SDE), including the ROC Rig series. Here, I learned about the applications of the new Ore-alyser to open pit blasting. The Ore-alyser is a boom-mounted XRF that collects assay data while drilling blast holes. This can illustrate varying grades across a bench, facilitating selective mining and reducing dilution. The automation technology on the ROCs is also ideal for pits with fibrous mineral problems. Out in the yard I actually saw the XRF, mounted on the port boom of the ROC67, the same rig I drove off the pit wall in the Perth simulator! The yard also had some Simbas and a ventilation silencer. I stood inside and shouted my name, barely hearing myself. *Perhaps there are broader applications for this technology*, I thought.

With thanks to George and Hans-Olav.



Pretending to drive a new rig is as much fun as driving off pit walls in simulators!

GIA and Grängesberg – the town that moved

GIA – Grängesberg Industries AB (AB meaning incorporated) was founded in 1884, and acquired by Atlas Copco URE less than a year ago. Their first product was the pelican shovel, used by miners of the era, followed by a locomotive, designed and manufactured in-house. Various utility vehicles were added to the product line, as well as ventilation equipment, the Kiruna electric truck (designed for Kiirunavaara), and finally the Hägg Systems. Gabriel, the Regional Business Manager for these products drove me all the way from Örebro to Grängesberg, and back again.

Grängesberg developed around a rich iron deposit, mined from the 16th century to 1987, when the mine employed 1500 people. When houses began subsiding, it became obvious the town was actually *on* the ore body, so it was picked up and moved. A new era of production is planned for the abandoned pit, which means the town will be moved for a second time. The 3000 residents are a shadow of the former population, but the town is by no means abandoned. It has a working brewery, railway line, and a beautiful theatre inside a building called Cassels, an exact copy of the original Bank of London. The town also has GIA.

Here, I learned about the range of URE utility vehicles. Scissor lifts that can level on slopes (Scistec) or lift an entire team to the roof (Liftec), service trucks with fluids and fuel (Filtec), the Cabletec with automatic grout handling, and the Perstec to transport work teams underground were among the vehicles acquired with the portfolio. I also learned about the Hägg Loader, an ingenious excavator that uses a conveyor system rather than turning around, adjustable to any truck or rail car height. Tests, which pitted the Hägg systems against conventional loading and hauling in a tunnel project, saved a total of \$700,000 USD and 30 days.

Then Tomas, passionate and knowledgeable about his ventilation systems, taught me to always look up as I enter the decline. Atlas Copco sell complete ventilation systems rather than the components. The optimal configuration of secondary vents and ducting is completely customised, installed and adjusted as the mine grows. The silencer also achieves an 18-decibel noise reduction – quite significant on a logarithmic scale.

After an intense day of learning, Gabriel and I drove home to Örebro the scenic way, in search of moose for the Australian tourist. We didn't find Sweden's 'most dangerous animal', but in the last of the daylight, we passed villages of traditional wooden houses with smoking chimneys, on lakeshores in the forest. Amongst them were white brick houses made of the Kvarntorp shale.

With thanks to Gabriel, Hans, Tomas and Daniel.



Old GIA pelican shovel heads in Kiirunavaara underground museum



Gabriel outside Cassels, Grängesberg

Raise Boring and the smoking sulphide mound (Nasta, Örebro)

Johnny Lyly, the expert on Robbins Raise Boring began his presentation with the question: *What could you use this for?* A machine that can drill smooth, vertical holes without explosives would obviously be ideal for ore passes and ventilation shafts, but I was surprised to learn about a high-grade uranium deposit beneath a Canadian lake, where the raise borer was the primary production machine, box-holing straight into the ore pod from beneath and remotely controlled from a protected tunnel.

Robbins, a Canadian company manufactured the first Raise Borer in 1962, which Atlas Copco acquired along with the name in 1993. The company recently discovered the 1962 prototype was still in use, when its Moroccan owners contacted Atlas Copco seeking spare parts. Its advantages for vertical drilling applications are its speed, elimination of explosives and the smoothness of the tunnel, as long as the operator can maintain the ideal pressure for the diameter, rock strength and installed power.

Near Nasta is Kvarntorp, an old shale quarry where the company test machines in soft rock conditions. Mining began at Kvarntorp in the Second World War when the oil shortage made oil shales temporarily viable. After the oil was extracted, the tailings, unfortunately rich in reactive pyrite, were piled up in a mound over 100 m high. In consequence, Kvarntorp Hill has been smoking like a volcano and releasing acid runoff since the 1950s. What do you do with a smoking sulphide mound in a residential area?

In Sweden, you catch the runoff in sealed ponds, build a ski-slope, put some sculptures on top (like an abstract Viking church), build 300 stairs and a winding path back down, and issue a 'Conquer The Stairs' challenge to the local population. Conquering the stairs apparently involves repeating this exercise ten times, running.

Once is quite sufficient, I thought with burning lungs, while Johnny strolled casually up. The wind was blowing a thick fog up the slopes, where it collected on top, mixing with the sulphurous gases that rose in small puffs from various vents. In the poor visibility, a dusting of ice highlighted each plank of the eerie sculptures. This is a good case study in both mine rehabilitation and Swedish attitudes.

With thanks to Johnny, Jaspreet and Kirsi.

Fagersta, where hammers are born

Fagersta is reasonably close to Grängesberg, and I arrived to find Björn, Product Manager for top-hammers in places such as Kazakhstan, waiting patiently for me at the hotel. After two pints of beer, a huge meal and glass of wine, I really had to insist on no dessert. *"But you're with Atlas Copco now"*, He protested.

How will I survive back at home? I wondered.

The next morning we went to the Secoroc factories, where tungsten carbide tips go into the Top Hammers and the drill bits are manufactured. The factories are almost fully automated, and robots perform the type of work that gives people repetitive strain injuries. The one thing all Atlas Copco factories have in common, whether production lines or unit assemblies, is good organisation, clean work areas and smooth operations. The workplaces are also free from noise except, according to Björn, when Sweden is playing Norway in football. All the facilities work on a Just In Time (JIT) inventory system, centrally controlled so space is utilised efficiently.

On the way out of the factory, we ran into a man who shook my hand and thanked me for coming. I assured him the pleasure was all mine. Later I learned he was the founder of Secoroc, acquired by Atlas Copco – the modesty!

As a business manager for foreign countries, Björn is very knowledgeable about other people's cultures. His parting gift to me was a handsome Atlas Copco hunting knife, with the instructions: *"If someone pulls a knife on you, now you can say – **Hey mate, dat's not a knife. DIS is a knife.**"*



Now DAT'S a knife!

With thanks to Björn and Sture.

Clean hands, cool head, warm heart – a philosophy to live by

The presentations I received on service, quality, marketing and the corporate philosophy left a big impression on me, and the source of the company's competitive advantage and ability to maintain standards became immediately apparent.

Safety and Health

Health and safety in our industry are commonly grouped together in a single acronym and job description; safety being the primary concern and health being something more individual and private (though inroads have been made by Beyond Blue). At Atlas Copco, safety and quality are the domain of technical experts, engineers, production specialists and a very impressive document system, while *health* is managed by a psychologist. Health is concerned with the effect of shift work, winter darkness, lighting, office configuration and job satisfaction, with depression and other maladies treated as legitimate illnesses. Atlas Copco and Scandinavia seem to be miles ahead of the world.

First in mind, first in choice

In terms of service, Atlas Copco has a vision to be the best service provider in the mining industry, and a plan to make this happen. Regardless of where in the world a machine is sold, the company aims to visit it at least once a year, ideally through a single representative over the machine's life. Through this, the company can ensure that the initial investment is delivering long-term value, with proper maintenance and spare part availability. Reman Solutions, part of the service portfolio allows a customer to send a worn part to the company, who replace it immediately with a remanufactured one. The broken part is then placed back in the remanufacturing cycle.

The company invests heavily in research and development (R&D), as well as quality. The audits that both the machines and the company's suppliers are subject to, are extensive and constant. These standards are the primary reason the company has won numerous sustainability awards and global sustainability listings. *Sustainable Productivity* is certainly not just a slogan.

Leaders are not born

The human resources strategy is behind the high calibre of staff and management within the company. It can be summarised by the phrase '*Leaders are not born, they are grown internally*'. 83% of all management appointments come from within the company, through the internal job and project market. Employees receive job security and diverse opportunities for training and promotion. '*We believe the person closest to the problem is also closest to the solution*', explained Jennica, Human Resource Manager in the Örebro headquarters. The strict business codes of practice and long term managerial training is the reason all employees from diverse cultures and corners of the industry uphold the same model of behaviour. The philosophy is simple: **Clean hands, cool head, warm heart** – a great creed to live by in a relatively small and turbulent industry. *With thanks to Daniel, Jennica and Jaspreet*

Kiruna, Sinking



Dude... where's my sled?

Swedish Lapland, well into the polar circle looks like a Christmas card by November. The sun skates the horizon for a couple of hours and the twilight casts a pink glow on the white landscape. Deep green conifers poke their heads playfully from the snow, and the bells on the huskie sled go 'jingle, jingle, jingle'... until the huskies decide they can navigate better than the driver and a lot of shouting and barking ensues!

The first thing I did on leaving the Kiruna airport was fling myself into the nearest snowdrift.

"Australian" explained Anja, my Atlas Copco travel buddy, to curious bystanders. Soon we were dashing through the snow on a big sled pulled by twelve dogs, smartest at the front, strongest at the back. After this, we went to see the Ice Hotel under construction. This begins each year in late October, using pristine blocks of ice the size of small cars harvested from the Torne River, and stored in a nearby warehouse from the previous March. The entire construction only represents five seconds of flow from this river, held together by 'Snice' – a mixture of snow and ice with similar properties to concrete at sub-zero temperatures. The hotel began as an ice sculpture gallery 1990, and grew to include rooms, eventually becoming a world famous work of art. Each winter, sculptors from around the world travel to Swedish Lapland to build the ice suites, the bar, the reception and the ice church, and every spring their work vanishes forever. Interestingly, this year the 'Hotel' had to comply with standard regulations and install smoke detectors and a sprinkler system.



The 25th Ice Hotel takes shape



My favourite husky

As if snow, huskies and ice hotels were not enough, the next day I saw the mine site of all mine sites.

The average decline is a dark hole into the earth, usually a single lane of rough, sometimes wet gravel and mud, with haul trucks roaring up and down in intermittent radio contact. The Kiirunavaara decline is a well-lit, two lane, sealed highway with the equivalent of street signs on all turn-outs. There are no haul trucks, and traffic is controlled centrally through GPS tags on the vehicles. Each year the mine receives 24,000 guests and tourists for a wide variety of purposes, including competitors co-operating on safety initiatives. The visitors centre is 540m underground on the old loading level, which also contains a large theatre and cafe.

The ore body is a curious, high-grade, linear magnetite body, dipping sixty degrees directly beneath the city and sandwiched between two separate igneous units. Its exact genesis is still in dispute, and although the deepest level of the mine is at 2000m, there is no indication of where the pipe ends.

LKAB mine the deposit with a full electronic fleet that includes many Atlas Copco machines. One of the most impressive things, aside from the 'bottomless' ore body and the 75 women working underground, is the transportation systems, the rail portion of which uses zero net energy.

Sub-level caving is the predominant ore extraction method, and all the blasts are detonated simultaneously at 01:30 each morning, leaving four hours for the ventilation system to disperse the fumes before day shift. The ore drops straight down an ore pass to the train beneath. After processing at one of three Kiruna plants, ten trains (soon to be 13) of 100 wagons, weighing 8500 tonnes in total are loaded underground, and roll downhill to Luleå (Sweden) or Narvik, (the ice-free Norwegian Harbour) feeding energy back into the grid. Unloading these trains takes 13 seconds – the bottom drops out of the car, and the smelter-ready magnetite pellets fall into huge silos below.

Because blasting has fractured the rock between the ore body and Kiruna directly above, the city will shortly be moved, house by house, or in the case of the old wooden church, plank by plank. Kiruna is sinking, so just like Grängesberg, it will simply be moved.

A nice touch for the geologists was collectable samples: the original loader bucket from the mine sits next to the cafe, full of diamond cores and small rocks representing all the levels of the deposit, as well as a scoop and LKAB sample bags. *'Take as many as you want'* said Marina, our guide.

Standing in the Special Area of security in Dubai Airport a week later, explaining that the magnetite pellets and long, cylindrical metallic cores were not weapons (despite what they looked like on the X-ray), I momentarily regretted my enthusiasm!

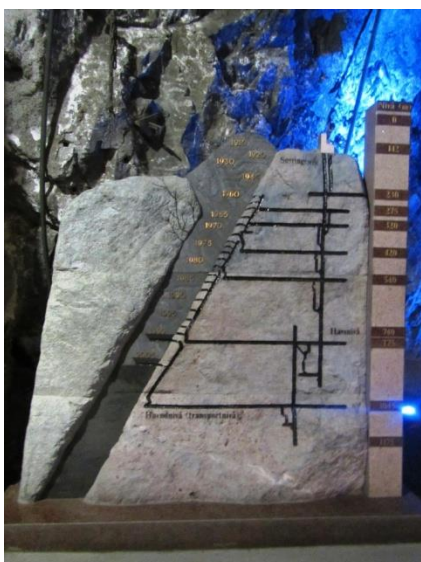
With special thanks to Anja, who co-ordinated my whole trip and gave up her weekend and several evenings to show me around.



The 'take as much as you want' bucket



Kiirunavaara receives 24,000 visitors each year



A scaled model of the deposit with the years beside each stope, made from representative rocks



The LKAB logo, representing the two main deposits Luossavaara (L) and Kiirunavaara (K), made of representative diamond core sections!

Nacka Test Mine – a nice place to work

Nacka test mine is *right* underneath Stockholm, excavated by Atlas Copco machines straight into a high-grade gneiss, full of abrasive quartz. They were testing a boomer prototype the day I arrived.

Nacka is not a dark, wet place with noisy machinery. Rather it has Christmas lights, an underground theatre, a restaurant and function centre, a display hall containing the history of the company through photos and stories, a fern garden, a cosy office with a mural of the Stockholm Archipelago in progress, a workshop with a training centre built like a traditional old cottage and my favourite - a museum with old equipment from the mine and a broken fountain assembled Dali-style against a wall painted like a coal stope. These are Lennart

Gustafsson's creations, the chief engineer who says his ideas come from an underground nuclear waste facility that resembled a lovely little village.

There is a new subterranean rail system planned for Stockholm, which will intersect the mine in coming years. Perhaps Lennart's museum will be an attraction for an Atlas Copco station. The Swedish put a lot of effort into designing physically and psychologically healthy workplaces – something often overlooked in countries with an abundance of sunshine.

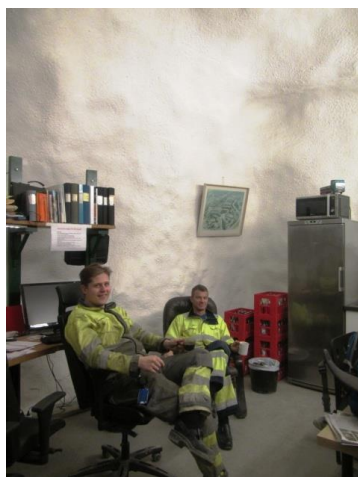
With thanks to Lennart



Lennart in the underground office



The fern garden, created by accident through water seepage and artificial light.



Armchairs in the underground office



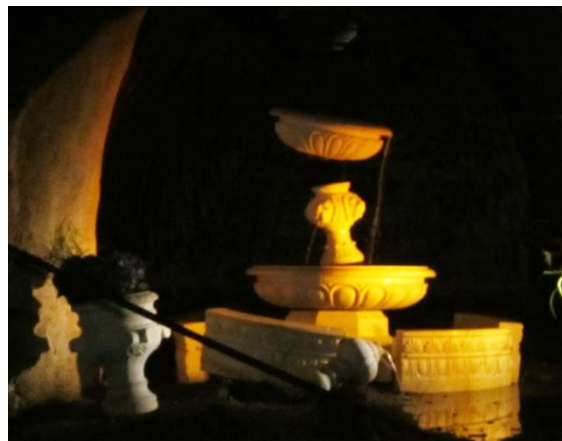
The underground theatre



The underground workshop



Bats outside the window of the underground training room



A broken fountain, reassembled in true Dali style in the museum

Ends and beginnings

The last place I visited before leaving Sweden was Geotechnical Drilling and Exploration (GDE) just outside Stockholm, where I learned about the long-hole rigs, how various countries use reverse circulation and diamond drilling, and the interesting history of the diamond drill, invented by a Mr Craelius, engineer and exploration geologist, in 1886. Strong men manually turned the handles, and industrial diamonds in the drill's crown could penetrate rock up to several centimetres a day. The Craelius Company has a long history with Atlas Copco, who acquired them twice, most recently in 1992.

By contrast, the new generation of rigs will be so advanced they will have simultaneous assay systems, able to terminate drilling beneath the zone of interest.

Peter, the Terracore Product Manager walked me through the workshop, with the tiny Diamek rigs and there it was – the new version of my old friend the Explorax, with its Secoroc hammer from Fagersta, waiting to be shipped to Australia. *This is where it all began*, I thought, hoping to see it again soon in the field.

With thanks to Peter

Final thoughts

How do you say thank you for being sent to Europe and treated like royalty? I am still not sure! Through this scholarship, I received a complete education on the mining industry through presentations, factory tours and access to mine sites. I also met many different people in both Australia and Sweden, with a lifetime of industry experience to share, all of whom upheld the exemplary Atlas Copco values. In the coming year, I plan to undertake research involving Kiirunavaara – a project made possible through this award. In the longer term, I plan to have a career-long association with this amazing company, recommending their top quality equipment to employers and shareholders, emulating their professional ethics, and making their staff and visitors feel

welcome in whatever workplace and country I happen to be. As a student in my mid-thirties, I do not say this lightly: *Thank you for the experience of a lifetime.*

