
IDEAS
AT WORK
Improving the future though
innovation and technology.
Highland Valley Copper
Teck
STUART MARCUS
Teck

Cover: Highland Valley Copper Operations.

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Carmen de Andacollo Operations.

ABOUT TECK

Teck is a diversified resource company committed to responsible mining and mineral development with business units focused on steelmaking coal, copper, zinc and energy. Headquartered in Vancouver, British Columbia (B.C.), Canada, we own or have an interest in 12 operating mines, one large metallurgical complex, and several major development projects in Canada, the United States, Chile and Peru.

We have expertise across a wide range of activities related to exploration, development, mining and minerals processing, including smelting and refining, safety, environmental protection, materials stewardship, recycling and research.

OUR STRUCTURE

Steelmaking Coal	Copper	Zinc	Energy
OUR BUSINESS UNITS			
We are the world's second-largest seaborne exporter of steelmaking coal, used to create the steel for building our modern world.	We are a significant copper producer in the Americas. Copper is an essential part of modern technology, found in everything from smartphones to electric cars.	We are one of the world's largest producers of zinc, used to protect and extend the life of modern infrastructure.	We are building an energy business to provide the energy that powers society.
OPERATIONS & MAJOR PROJECTS			

• Cardinal River
• Steelmaking coal sites in B.C.
  • Fording River
  • Greenhills
  • Line Creek
  • Elkview
  • Coal Mountain
	• Highland Valley Copper
	• Antamina
	• Quebrada Blanca (including Quebrada Blanca Phase 2 project)
	• Carmen de Andacollo
	• NuevaUnión
		• Red Dog
		• Trail Operations
		• Pend Oreille
			• Fort Hills
			• Frontier

RESEARCH & DEVELOPMENT HUBS

Our research and development hubs cover diverse technology and innovation initiatives. This includes assessing the effectiveness of current technologies as well as developing new breakthroughs to meet tomorrow's needs.

Teck has four Research and Development Hubs; based in Trail, B.C., Richmond B.C., Vancouver, B.C., and Mississauga, Ontario. Each Hub supports a broad range of R&D initiatives that study ways we can improve and add value across the full mining process, from exploration methods and productivity improvements to more environmentally friendly practices and practical new consumer uses for ores that we mine.

Blast movement monitoring technology at Highland Valley Copper Operations.

OUR FOCUS ON INNOVATION & TECHNOLOGY

From early prospectors to today's digitally-connected mines, the story of mining is a story of reinvention, driven by new ideas. Ideas for how to find new deposits, process ore more efficiently, enhance the safety of our workforce and protect the environment. These ideas have made our modern mining operations safer, more sustainable and more productive than ever before.

Today, the pace of change in mining is getting even faster. New advancements such as automation and digitalization are increasingly being introduced across our operations. At the same time, challenges such as declining ore quality, increasing energy requirements, as well as rising community and regulatory expectations create the need for new technological solutions.

At Teck, our focus is identifying those ideas that have the greatest potential to improve our business. We then put those ideas to work across every aspect of our business to strengthen safety, enhance environmental performance, improve productivity, and help grow our business and create new markets for our products. We are also building upon our long history of ingenuity and invention and forming partnerships with leading-edge companies from within our sector and beyond, to strengthen our culture of innovation.

By putting ideas to work, we can ensure a strong future for Teck, for our shareholders, for our employees, and for the communities where we work.

Solar facility that supplies power to Quebrada Blanca Operations.

OUR HISTORY: 1902 –

1902

Built the first electrolytic lead refinery at our Trail Operations

1917

Led development of the differential froth flotation method for processing ore, now an industry standard

1929

First use of aircraft prospecting in the Northwest Territories, opening the area up for exploration

1970

Teck has a long history of innovation and early adoption in the mining industry that stretches back over 100 years. Many of our ground-breaking technologies and techniques have been widely adopted around the globe.

1931

Early emissions control developed for Trail Operations, recovering what was a pollutant — sulphur dioxide — and turning it into marketable fertilizer

1937

Walkie-talkie invented by Teck's Donald Hings to connect aircraft pilots and ground exploration teams

1946

Pioneered the use of airborne magnetic surveying to find new ore deposits

1960's

Developed leading helicopter-borne electromagnetic survey system

OUR HISTORY: 1971 –

1979

Sullivan Mine pioneered new technology for treating acid rock drainage, now an industry standard

1980

Patented and marketed a technology to reduce the size of lead acid batteries – such as car batteries – by 25%.

1981

Construction of our Polaris Mine in the Arctic marks the first time a mine processing facility was fully constructed aboard a barge and floated to its destination

1992

Developed the CESL process – a breakthrough low-emission refining process for copper ore

2017

2001

Patented method for making low-alpha lead for integrated circuits created at Trail Operations

2008

Formed a joint venture to pioneer underwater mine exploration with Nautilus Minerals

2014

Researched, piloted and implemented treatment technology to remove selenium from mine-affected water

2015

Partnered to develop the SunMine in B.C., the first solar power facility built on a reclaimed mine site

2016

Our Fording River Operations was the first mine in Canada to pilot LNG-fueled haul trucks

2016

First mining company to use sensors mounted on a shovel bucket that can tell ore from waste rock

2017

Machine learning deployed to identify maintenance problems before they happen at our sites

OUR APPROACH TO INNOVATION & TECHNOLOGY

Foreman and haul trucker driver at Highland Valley Copper Operations.

Our approach to innovation and technology is focused on four key pillars: Safety, Sustainability, Productivity, and Growth. These pillars have the greatest potential to contribute to our business and deliver the greatest value for our employees, our company, our communities and society. These pillars are supported by the ongoing digitalization of our operations and activities.

SAFETY **PRODUCTIVITY** **SUSTAINABILITY** **GROWTH**

DIGITALIZATION

SAFETY

Safety is a core value at Teck. Nothing is more important then the health and safety of our workforce. We work to identify new ideas, technologies and approaches that can improve our ability to identify risk, mitigate exposure to hazards and help to keep our people safe.

Over the past decade, we have improved our safety performance while also making our business more productive and sustainable. This is thanks to the work of thousands of employees who have contributed their ideas and their leadership to make every aspect of our work safer. By developing and implementing new ideas, technologies and practices, we believe we can achieve our vision of everyone going home safe and healthy every day.

Line Creek Operations.

Case Study

> "New proximity detection technology allows operators to know the exact location of every piece of equipment."

FOR MORE CASE STUDIES ON SAFETY, GO TO TECK.COM/IDEASATWORK

Operators in the High-Tech Driver's Seat

Teck has deployed a remotely-controlled dozer and backhoe at our Coal Mountain Operations to access areas which would be hazardous for an onboard operator.

The dozer and backhoe are driven by an operator using a joystick system, in a custom-built control cab that has a view of the operating area. The operator can also see what the dozer sees via four cameras mounted on the machine, and a series of monitors in the control cab.

Sensors provide real-time information on the grade the machines are operating on, and will automatically stop if it senses the grade is becoming too steep.

The remote dozer and backhoe are currently being used to access steelmaking coal in an area that was deemed unsafe for humans due to a geotechnical fault. This represents the first use of a remote system in mine operations in British Columbia and is making our operations safer and more productive.

PRODUCTIVITY

Our focus on continually improving productivity is foundational to our success. For more than 100 years, we have deployed news ideas, technologies and approaches that have increased efficiency, extended mine life and supported jobs and economic growth.

New technologies and ideas are creating unprecedented opportunity to make our operations even more productive; to give our people new tools to do their work more efficiently; and to tackle the challenges facing our industry.

By embracing technological change and fostering a culture of innovation across our company, we are identifying and deploying new ideas and new tools faster than ever before to make Teck a more productive, safer, more sustainable and stronger company.

Smart shovel technology at Highland Valley Copper Operations.

Case Study

Building a Smarter Shovel

Most people think of a shovel as a pretty basic tool – you use it to move stuff from one place to another. But what if the shovel was smart? What if it could analyze and know exactly what it was carrying? That's the idea behind a new mining technology Teck is pioneering to improve productivity and sustainability at our operations.

To make a shovel smart, we mount sensors on the shovel bucket and use x-rays to tell the difference between waste rock and valuable ore, one shovel load at a time. The sensors, combined with analytics, provide real-time information to determine whether the load is worth sending to the mill for processing, or for handling as waste rock. Decisions that were once a matter of informed estimates can instead be based on real-time data, leading to improved mill productivity, reduced energy use and lower water consumption.

"With these smarter shovels, we're sorting the wheat from the chaff with more precision than ever before," said Bryan Rairdan, Technical Services Manager at Highland Valley Copper Operations. "This technology helps us use less energy, create fewer emissions and improve productivity. In fact, smart shovels have the potential to create hundreds of millions of dollars in value."

Teck partnered with MineSense for the first full-scale trial of the bucket-mounted ShovelSenseTM technology in 2017 at our Highland Valley Copper Operations in British Columbia. The sensors are now in use on one shovel, and additional shovels could be considered for later in 2018.

To see more innovations in action, visit teck.com/ideasatwork/case-studies

"This technology helps us to use less energy, create fewer emissions and improve productivity."

FOR MORE CASE STUDIES ON PRODUCTIVITY, GO TO TECK.COM/IDEASATWORK

SUSTAINABILITY

Responsible resource development guides our approach to business. Innovation and technology are helping to improve our environmental and social performance while also making us a safer and more productive company. This work includes better ways to manage water quality, reduce greenhouse gas emissions, and control dust, while also improving air quality and energy efficiency.

New ideas, new tools and new technologies have the potential to further enhance how we responsibly interact with the environment and communities. By embracing innovation and technology, and bringing ideas to life, we are working to continually improve our sustainability performance.

Water testing near Greenhills Operations.

Case Study

90% of selenium and nitrate is removed from the water through these organic processes.

FOR MORE CASE STUDIES ON SUSTAINABILITY, GO TO TECK.COM/IDEASATWORK

Using 'Bugs' to Clean Water

Millions of new employees have joined our workforce in the Elk Valley region of British Columbia: organic microbes. These microscopic 'bugs' are helping us to improve water quality and responsibly manage environmental impacts.

Water from precipitation and runoff flows through rock piles left over from mining and can carry substances such as selenium into the local watershed. If concentrations of these substances are too high, it can affect sensitive aquatic populations.

To address this challenge, Teck has developed and piloted saturated rock fills, a new technology that involves using organic microbes – or 'bugs' – to treat mine-affected water. So far, the pilot project has found that approximately 90% of selenium and nitrate is removed by the microbes in saturated rock fills.

Saturated rock fills are just one of the R&D projects underway to augment our approach to water quality management in the Elk Valley and help us to protect water quality in the region. Learn more at teck.com/elkvalley

GROWTH

Continuing to grow our business depends on accessing new ore deposits to supply minerals, while also finding new uses and markets to drive demand. As high-quality mineral deposits become harder to find, innovation and technology will play an increasing role in ensuring the continued supply of the metals and minerals society needs.

At the same time, developing new applications for the metals and minerals we produce can support breakthroughs in other sectors, and create new demand for our products.

Across Teck, we are exploring to find these new ideas to enhance the value of our products, discover new ore bodies, and continue to grow our company for the future.

Augmented reality technology

Case Study

> "During a virtual tour, users can fly over the site to view geological models and planned facilities."

FOR MORE CASE STUDIES ON GROWTH, GO TO TECK.COM/IDEASATWORK

Digital Bird's Eye View: Virtual Mines Create Real Value

We now have the ability to use virtual reality to build entire operations and support the future of our business without even leaving the office.

Exploring for new deposits and planning for new mines is essential to the continued growth of our business. These activities also generate enormous amounts of data – geology, drill hole information, infrastructure plans and much more. Normally, much of this information exists solely on paper and spreadsheets until it is eventually transcribed or digitized. Typically, that data is accessible to a limited audience and only by specialized software.

Teck has partnered with Victoria-based technology company LlamaZOO Interactive to create "virtual twins" for mine planning and community engagement for our projects. The immersive virtual reality experience brings people to the site without having to travel there, and allows them to see aspects of the proposed mine that they couldn't otherwise see.

During a virtual tour, users can fly over the site to view land holdings, geological models, existing and planned facilities, infrastructure that needs to be built – the scale of it – and topography of the mine site and surrounding area. Users can also advance through the different phases of mine development during the virtual tour, including the post-closure and reclamation landscape. And the ore body itself – hidden deep underground – can be fully viewed in three dimensions.

Virtual reality is helping our stakeholders better understand proposed projects and associated reclamation and mitigation measures. It is also helping to enhance mine planning, from productivity to environmental measures, and support reclamation planning.

OUR FOUNDATION IN DIGITAL TECHNOLOGY

Drone technology at
Carmen de Andacollo Operations.

Digital technologies are transforming our industry and contributing to improvements in every step of the mining process. Harnessing the power of these digital technologies is foundational to Teck's approach to innovation and technology, and underpins our work to improve safety, sustainability, and productivity.

Every day our operations generate terabytes of data about every aspect of work – from truck and shovel productivity to energy use to air quality. Digital technology gives us the ability to track, analyze, and put this data into the hands of our people in real time, helping them to communicate, to make decisions, to identify challenges, and to develop solutions. Our digital foundation is built on four aspects.

CONNECTIVITY

DATA ANALYSIS & MACHINE LEARNING

PARTNERSHIPS & COLLABORATION

DIGITAL WORKFORCE

CONNECTIVITY

For more than a decade, Teck has used integrated digital systems and operating technologies to connect our sites, people and equipment. We have a company-wide approach and strong digital foundation that is the backbone of our digitally enhanced operations.

Shovel operator heads up display technology developed by Teck.

DATA ANALYSIS & MACHINE LEARNING

We generate terabytes of data at each of our operations – data from both connected equipment and connected employees. Analysis of this data, powered by machine learning and artificial intelligence, is helping us to develop new ideas to improve safety, sustainability and productivity.

Maintenance underway at Greenhills Operations.

Case Study

"Teck is using big data to predict the unpredictable and fix problems before they happen."

Machine Learning for Maintenance

A vehicle breakdown at a mine site usually ends up costing both time and money, and can have an impact on productivity and efficiency. Some breakdowns are well understood and can be prevented through proper maintenance. But some are seemingly random and can't be planned for – until now. Thanks to an innovative use of machine learning, Teck is using big data to predict the unpredictable and fix problems before they happen.

Since 2011, we have used sensors and data to monitor the health of haul trucks at our steelmaking coal operations, as well as manage preventative maintenance and repairs. Now, with the help of artificial intelligence, we're going a step further.

Through our partnership with Google Cloud and Pythian, we are unlocking new insights from the millions of data points generated by our mobile fleets. Issues that were previously unpredictable, such as potential electric failures, are now being identified by machine learning algorithms before they happen. We are also modelling and predicting remaining life span of our trucks, determining wear and tear, identifying abnormal failures, and enhancing alarm and notification systems.

Machine learning for maintenance is helping to minimize unplanned maintenance, reduce overall maintenance costs and extend equipment life. It is estimated that at one site alone there is potential for over $1 million in annual savings from implementing this program.

PARTNERSHIPS & COLLABORATION

Teck works closely with companies locally and globally on strategic partnerships where we can leverage each other's experience to advance shared technology objectives.

These partnerships have helped to develop and implement ground-breaking technologies, such as an open-source fleet management system, the first electric semi-autonomous drill systems, a virtual-reality mine and the first shovel-mounted ore sorting technology which uses sensors to separate valuable ore from waste.

These strategic partnerships have proven extremely beneficial across our sector as we collectively work with communities, governments and other stakeholders to meet, and exceed, new standards in sustainability and productivity.

Teck also participates and funds over 25 different research and development consortia, including research chairs for the Natural Sciences and Engineering Research Council of Canada (NSERC) and university research initiatives. We are a founding member, and the only mining company to be part of the Digital Technology Supercluster, a consortium of over 200 leading-edge companies collaborating to advance projects that will create breakthroughs in areas including natural resource development.

We also work with MIT at their Center for Information Systems Research in Cambridge on digital transformation techniques and technologies.

DIGITAL WORKFORCE

We use technology and tools to enhance our people and make their work safer, more efficient and more rewarding.

For example, we use a standardized platform in our mobile equipment across the company so that operators everywhere can access the tools they need when they need them. We are also working to visualize complex data to enhance real-time decision-making.

Case Study

Enhancing Shovel Operations with Real Time Data

When trying to accomplish something really big, effort can be everything. That holds true for mining, where the effort needed to dig is a major factor in cost, time and efficiency. Previously, directly measuring that effort has been all but impossible.

Using sensors mounted on shovels, Teck developed a ground-breaking method to measure the ease or difficulty of the digging conditions for a given shovel, and we are using that measurement to continuously improve performance at our mines.

This measure – called 'digability' – is analyzed to determine the optimal balance in our blasting. Using the digability measure helps to reduce explosive use, blasting costs and equipment wear. It also helps to maximize the productivity of our shovels – reducing costs and improving environmental performance.

Digability was first piloted at Teck's Elkview Operations in British Columbia and was proven to reduce explosives consumption and therefore nitrates – a component in blasting – by 9%. This technology is now being implemented at additional Teck operations and will be expanded further through 2018.

Teck is also pioneering new methods to provide key operating data to shovel operators in real-time using a heads-up display. Like the cockpit of a fighter jet, the heads-up display will appear on the glass in front of the operator and show operational information to guide their work and maximize efficiency.

OUR CULTURE OF INNOVATION & TECHNOLOGY

Employees at Fording River Operations.

Our approach to innovation and technology starts and ends with our people and fostering a culture where employees are encouraged to bring ideas forward, test innovative approaches and implement technologies that can help make us a better company.

We promote a bias for action among our employees, and use a streamlined approach to support the development and fast adoption of those technologies or innovations that have the greatest potential to improve how we do business.

We also look for opportunities to partner and bring in fresh perspectives and ideas from outside our company. We provide opportunities for our employees to collaborate and share ideas, and we recognize failure as a vital part of the creative process.

FOSTERING A CULTURE OF INNOVATION

SCANNING FOR OPPORTUNITIES

We are continually assessing new and emerging technologies to identify those that have the greatest potential to improve safety, productivity or environmental performance in our business. That includes partnering and collaborating with leading-edge technology firms and our peers in the resource sector.

Teck maintains a dedicated team to scan and facilitate action around new technologies and innovative opportunities. Multi-disciplinary teams help drive analysis on the benefits of new technology and plan for testing, trials and pilots.

PILOTING

We fast-track new technologies or innovations with the greatest potential to improve how we mine to the piloting stage and determine feasibility, effectiveness and benefits at our operations.

Upcoming Technology Pilots:

- Frontier Project: Tailings dewatering for faster reclamation
- Quebrada Blanca Phase 2 Project: Spectral core scanning for greater efficiency
- Elkview Operations: Semi-autonomous drills for reduced downtime
- Big data analytics and machine learning to predict and avoid equipment failures

IMPLEMENTING

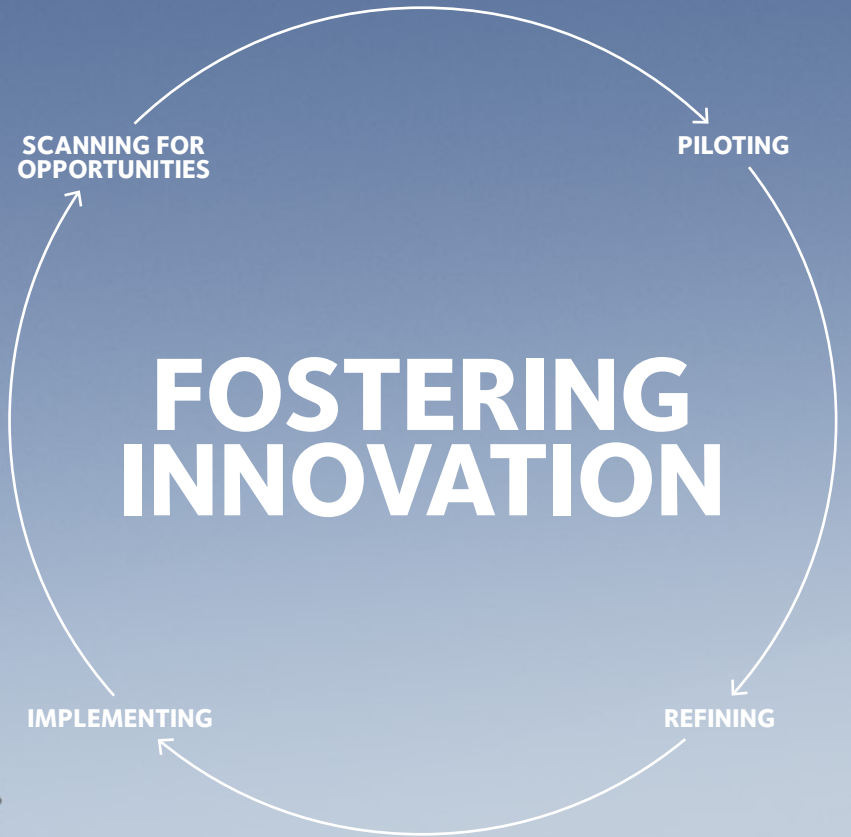
After the pilot phase, we assess each project for scalability and develop a plan to implement the new technology to other key sites across the company.

For example, we piloted shovel payload monitoring at our Greenhills Operations. The sensors – which help our operators load trucks with the greatest efficiency and less maintenance – were then installed across several other mine sites, resulting in estimated savings of over $15 million annually.

REFINING

We continually reassess new technologies to further refine our approach or develop new applications for technologies and practices. We also ensure that learnings are shared across our company. For example, we introduced drone aircraft at our steelmaking coal operations to evaluate blasting results more quickly and safely from the air. Our teams discovered additional uses for the technology, and sharing their learnings has allowed us to reduce costs and improve safety by replacing expensive helicopter flights with drone inspections of pits and waste rock.

FOSTERING INNOVATION



Haul truck at Greenhills Operations.

Refined zinc at Teck Trail Operations.

Case Study

> "Both team members used ingenuity, determination, creativity and many long hours to solve a problem that had been plaguing the plant for years."
>
> – Roelof Helberg, Operating Manager, Electrolytic and Melting at Trail Operations

There's an App for That

Employee-driven ideas are at the heart of our strategy and Teck's culture of innovation. At our Trail Operations in B.C., Process Engineer Sara Fitzel took inspiration from her local ski club in developing a cost-effective way to improve zinc production.

Sara knew that a challenge at Trail Operations was precisely tracking the length of the electrolytic plating cycle for zinc production, which is spread across 560 cells in a plant the size of a several football fields.

Sara also knew her local ski club used an app to track race times, so she decided to create something similar to use at work in collaboration with Sean Rudnitski, Teck Senior Systems Analyst and Programmer.

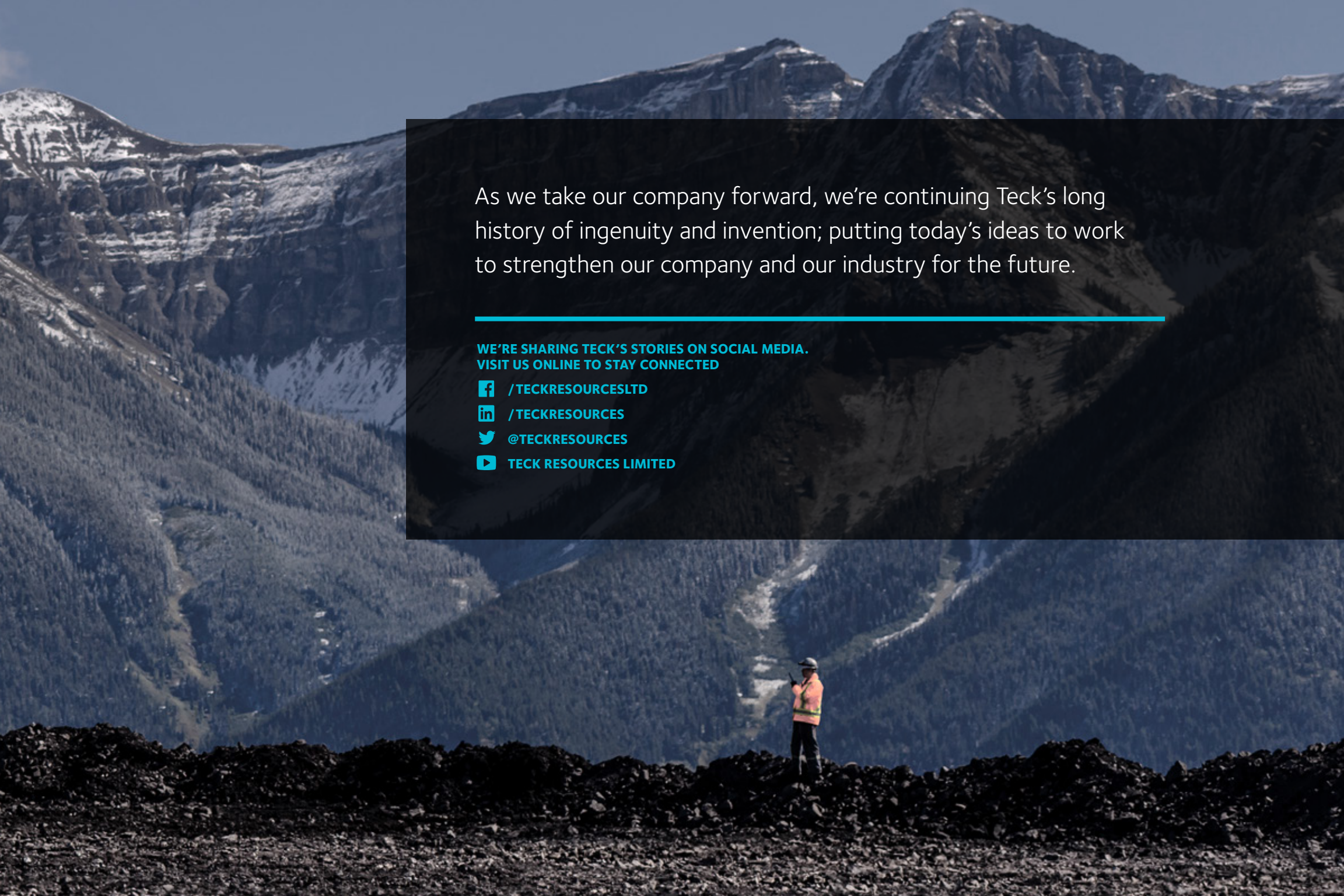
Following some experimentation and lunchroom tabletop demonstrations, Sara and Sean were encouraged to pilot the app in one of the cell houses.

After a successful small-scale pilot, the new system was soon implemented in all cell houses using a custom Teck iPad app. As a result, plating time for zinc was reduced by about 13%, improving overall productivity and saving millions annually.

"Both team members used ingenuity, determination, creativity and many long hours to solve a problem that had been plaguing the plant for years," said Roelof Helberg, Operating Manager, Electrolytic and Melting at Trail Operations.

SMARTER IDEAS FOR A BETTER TOMORROW

Dozer at Greenhills Operations.



As we take our company forward, we're continuing Teck's long history of ingenuity and invention; putting today's ideas to work to strengthen our company and our industry for the future.

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