CASE STUDIES

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UNDERGROUND MINING

SURFACE MINING

CASE STUDY

TECHNOLOGY AND INNOVATION AT GOLD FIELDS ST IVES

RCT's long-standing relationship with Gold Fields saw the parties recently collaborate to address production bottlenecks through the implementation of RCT technology and increase production output and worker safety.

RCT's ControlMaster® Surface Solution was commissioned allowing St Ives to operate remotely from the surface during firing times in a safe environment. Through surface remoting, St Ives also found that there was no downtime with their trucks between shifts. The increase in productivity from a trucking perspective was very noticeable.

Through the utilisation of ControlMaster® Guidance System, St Ives operation was able to achieve greater speeds, consistently high production and less damage – due to technology which assists in avoiding walls and major obstacles.

St Ives' next development phase under consideration with RCT includes:

- Independent Guidance – where the operator in the cabin activates a button to move the loader from the stockpile into the stope. The operator will resume manual control to load the bucket. The button is activated again for the loader to return on its own, autonomously, on guidance to the stockpile.
- MultiMachine – where one operator on the surface can remotely control two loaders underground from two different levels.

For St Ives, the objective of this phase is for further efficiency and increased operator safety for their underground mine.

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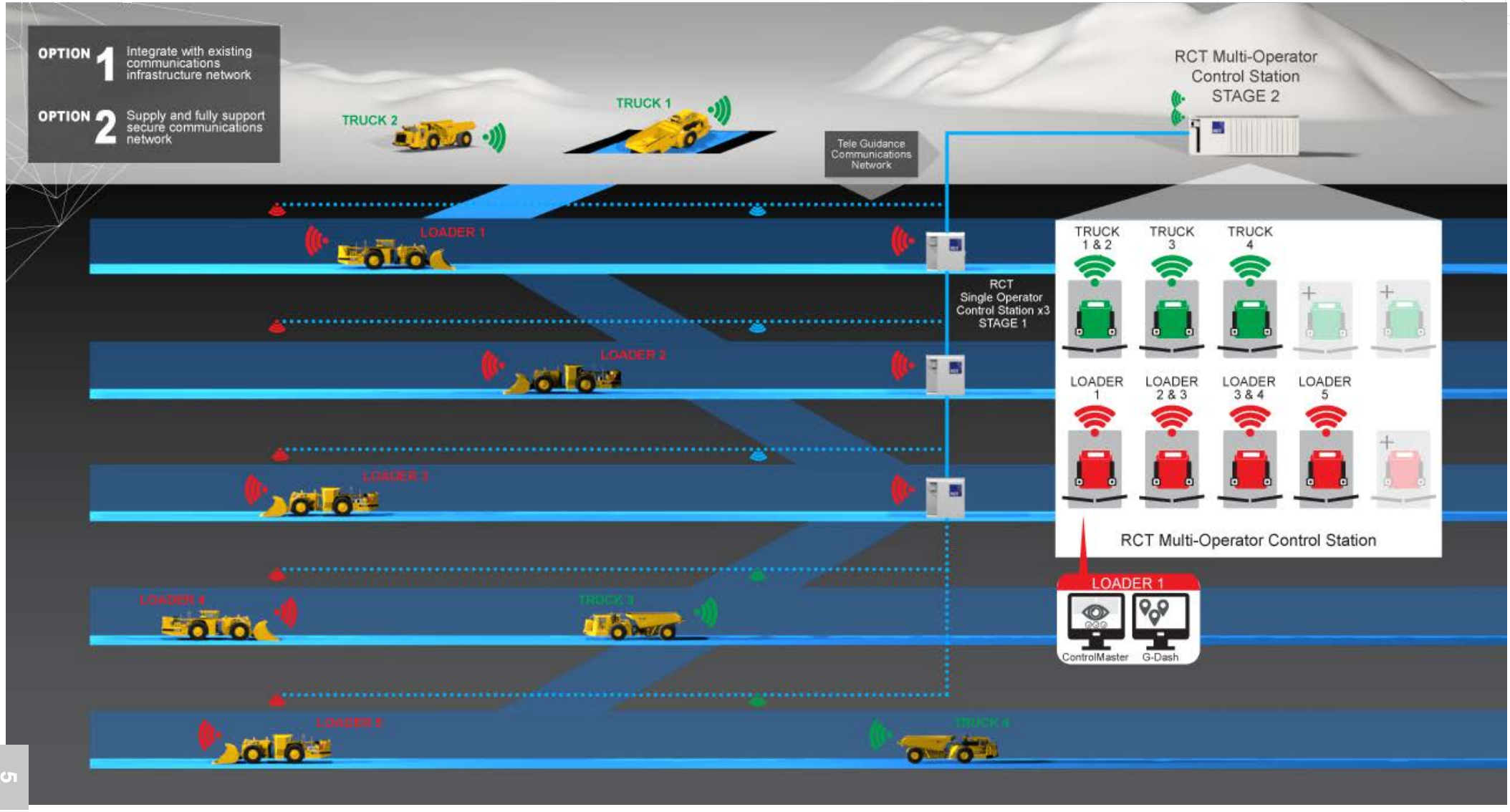
Automation options and developments for Underground Mining

The image below represents automation options and developments which can be implemented in an underground mining environment.

- Options of single or multiple operator control stations.
- Multi-machine control by a single operator.
- Integration to existing communications network.
- New communications network implementation.



CASE STUDY

MANDALAY RESOURCES – COSTERFIELD GOLD MINE

In addition to accessing tight areas within the mine, by operating the loader on Guidance and Teleremote systems it was also able to safely access the majority of the ore that remained in the stope void after drilling and blasting took place.

ACCESSING THE INACCESSIBLE TO FURTHER DRIVE PRODUCTIVITY

OVERVIEW

Canadian-based company Mandalay Resources prides itself on creating exceptional shareholder value through the acquisition of undervalued assets that can: become rapidly cash generative, self-fund exploration, establish and maintain high operating margins and return cash to shareholders.

As current owner and operator of the Costerfield gold-antimony mine, Mandalay used RCT's Smart Technology to help deliver value at its site in Victoria, Australia.

The Costerfield mine has a "narrow vein operation" so it is critical that the drives are kept to a minimum width to minimise ore dilution for ore processing efficiency. However, this made reaching the ore in some areas of the mine quite difficult.

In addition, the site's drilling and blasting practices aimed to maximise recovery by throwing the ore towards the draw point, however this only enabled a 75 per cent ore recovery to be achieved. The remaining 25 per cent of the ore within the stope void was out of safe reach of the loader under manual operation as the loader's operator cab was not permitted to go past the brow of the stope.

In order to realise the value of the ore left in blind uphole stopes, a remote loader was implemented at the site.

SOLUTION

RCT's Guidance simulator was used to review Costerfield's mine site plan layout on several of its drives. It was upon reviewing this footage that several critical, tight areas within the drives that had previously been scaled back were in fact accessible with machines equipped with RCT Smart Technology.

Impressed with this verification, Mandalay chose to install RCT's ControlMaster® Guidance and Teleremote systems to its Sandvik LH203 which would substantially increase ore recovery.

In addition to accessing tight areas within the mine, by operating the loader on Guidance and Teleremote systems it was also able to safely access the majority of the ore that remained in the stope void after drilling and blasting took place.

The operator is able to control the loader from the safety of a RCT built operator control station located underground.

RESULT

Implementing RCT's ControlMaster® Guidance and Teleremote systems on the loader allowed operators to successfully navigate the previously inaccessible narrow drives with ease, all while avoiding contact with the walls; eliminating machine damage.

The operators' ability to switch from Guidance to Teleremote mode to load the once unattainable ore in the bucket from the stope, helped to increase production substantially.

In addition to minimising machine damage and increasing productivity, the systems have evolved a safer mining method. The operators are now able to control the loader from the comfort and safety of the operating station located in supported ground.

The introduction of ControlMaster® Guidance and Teleremote systems increased ore recovery to 95 per cent in blind uphole stopes at the Costerfield mine site.

It was Mandalay's first project with RCT, but not its last. Following on from the overall success of the project the client has decided to progress with a second full Teleremote and Guidance systems to be installed onto a second loader, along with a second new operating station.

The second unit is scheduled for delivery in early July, 2016.

COMMENTS

RCT Account Manager Geoff Steele said both site management and production people were extremely pleased with the results.

"The loader can access the stope areas very successfully under Teleremote and Guidance systems."

"Apart from improving ore recovery from previously inaccessible areas, Mandalay is pleased to give our staff the opportunity to learn new skills of operating Teleremote loaders, in the air conditioned environment of the Teleremote Operator Cabin. This improves safety outcomes for our loader operators because the Sandvik LH203 loaders are currently open cabin loaders." said Costerfield Operations Mine Manager, Melanie McCarthy.

ABOUT RCT

RCT is an innovative smart technology company with the expertise to evolve entire industries. We design, manufacture and deliver technology and service solutions to support clients around the world in multiple sectors including mining, industrial, agricultural and civil. With over 40 years of success, RCT leverages knowledge and insight to provide clients the advantage of measurable value – increased profitability, productivity, efficiency and safety.

Since the 1970s, RCT has traversed all corners of the globe. Our team has grown to 150+ committed people working with clients in over 64 countries worldwide, from Australia to Africa, Asia, Russia, North America and Latin America.

With our unique way of viewing the world, intelligent solutions and backed by exceptional support, service and training, RCT is a global leader in smart Guidance, Teleremote and Remote Control automation solutions for the mining industry.

We continue to listen, see, think, create and evolve solutions that lead to better profitability, productivity and safety for our clients.

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CASE STUDY

STRENGTHENING SAFETY CULTURE AND INCREASING MINE PRODUCTIVITY IN CHINA

"Operators now conduct all Teleremoting from a converted delivery truck. The bright blue vehicle is fitted with climate control, high-tech video equipment and is lit with red light to protect operator's eyes. The portable vehicle now travels to all stoping areas underground, but allows operators to control the loader from a safe area, within the security of the laser barrier system. This ensures no other personnel can enter the remoting area which further increases workers' safety."

OVERVIEW

In 2014, Canadian miner Eldorado Gold decided that its underground White Mountain gold mine in north-eastern China, was going to become fully reliant on Teleremoting for its stope ore extraction.

"This decision was based on improving both safety and productivity by using well-known technology not yet established in China," said White Mountain's General Manager, Warren Uyen.

White Mountain uses the longhole open stoping mining method through large primary stopes (filled with cemented hydraulic fill) and secondary stopes (with predominately rock fill), targeting between 800K to 950K tonnes per year.

Prior to implementing RCT's Smart Technology, the site used handheld Line-of-Sight (LOS) equipment. Due to regulatory requirements in China, this process required two workers – one remoting and one to manually operate the bucket.

"White Mountain struggled to maintain optimum productivity due to the continual changing between manual and [LOS] remoting," Mr Uyen said.

As well as affecting productivity, there were also safety considerations.

"LOS always had the potential for one operator to enter the remoting area if procedures weren't strictly followed," he said.

Due to the remote location of the mine, the management at White Mountain also wanted to be completely self-sufficient in terms of servicing and maintenance of the RCT system.

RCT SOLUTION

To help improve productivity and safety, RCT's ControlMaster® Teleremote system was selected. It was fitted to White Mountain's R1700 loader by an RCT technician and RCT software was tailored and converted to Chinese text for the Teletransmitter.

RCT worked with the White Mountain team to co-create the design of a customised truck frame to house the remote control station, the integrated RCT station chair, dual monitors, and the laser protection barrier system.

Operators now conduct all Teleremoting from a converted delivery truck. The bright blue vehicle is fitted with climate control, high-tech video equipment and is lit with red light to protect operators' eyes. The portable vehicle now travels to all stoping areas underground, but allows operators to control the loader from a safe area, within the security of the laser barrier system. This ensures no other personnel can enter the remoting area which further increases workers' safety.

The loader is designed as a "plug and play" system, meaning it arrives on location, ready to set up in advance. It then utilises a battery power pack installed on the back of the truck, which gives it up to five days of continuous power. In the event of the batteries becoming low, the operator is alerted and simply disconnects before driving to the workshop where another spare power pack is ready to go and can be replaced in under 30 minutes.

In addition, the loader is also fitted with semi-automation, so when it is tramming within the remote area it can steer itself with laser guidance at speeds up to 10 kilometers per hour.

RCT also delivered a two-week, comprehensive training package for operators and technicians to ensure staff were completely self-sufficient at maintaining the systems. Training included diagnostic scenarios and was integral to helping the White Mountain team achieve its goal of being completely self-sufficient in terms of maintaining and servicing the system. However, RCT still provides offsite technical and troubleshooting advice, if and when required.

"By utilising RCT's ControlMaster® Teleremote system at the site, productivity increased substantially; achieving a record of nearly 6,300 buckets in one month, which is equivalent to more than 60,000 tonnes of ore."

"[It] reduces operator fatigue and virtually eliminates impact damage to the machine hitting the walls."
White Mountain's General Manager, Warren Uyen

RESULT

The ControlMaster® Teleremote system was not only the first system of its kind to be used in China; it was also a huge success, improving productivity as well as safety at White Mountain.

"White Mountain was the first Chinese mine to embrace the available hardware and technology and integrate it into the primary ore extraction tool," Mr Uyen said.

By utilising RCT's ControlMaster® Teleremote system at the site, productivity increased substantially; achieving a record of nearly 6,300 buckets in one month, which is equivalent to more than 60,000 tonnes of ore.

"The perceived benefits in productivity were estimated between 25-30 per cent, meaning the system would pay for itself in less than six months," he said.

"However, actual data shows productivity gains of more than 35 per cent."

Loader operator safety also increased significantly as miners now conduct bogging operations from within a custom-built cabin located about 500 metres from the potentially hazardous stope area.

"The added and most important benefit was the removal and control of personnel from the work area," Mr Uyen said.

Fitting the loader with semi-automation, further improved the operators' working environment.

"[It] reduces operator fatigue and virtually eliminates impact damage to the machine hitting the walls," Mr Uyen said.

"Meanwhile machine data is transmitted back to the remote control station, so if any critical faults are detected, an alarm sounds and a message appears on the operator's screen – just as if they were in the cabin."

Mr Uyen said the Teleremote system continues to improve as operator and maintenance skills improve.

"This successful model can be transferred to any site," he said.

"The operators do not want to go back to the old system."

"As global leaders in machine control and automation, RCT was delighted with the opportunity to provide Eldorado Gold with China's first Teleremote system at White Mountain," said RCT Executive Director and Chief Executive Officer, Brett White.

"We look forward to continuing to empower their operators and improve safety and bottom line performance," he said.

This project was completed using RCT's standard "off the shelf" offer, which was customised to suit particular circumstances, procedures and site operations. All RCT products can be adapted to be fit for purpose in mining environments globally.

ABOUT ELDORADO GOLD

Eldorado Gold is a leading gold producer with mining, development and exploration operations in Turkey, China, Greece, Romania and Brazil. The company currently operates three gold mines in China: Jinfeng, Tanjianshan and White Mountain. Eldorado's success to date is based on a low cost strategy, a highly skilled and dedicated workforce, safe and responsible operations, and long-term partnerships with the communities where it operates.

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CASE STUDY

SURFACE TELEREMOTE AND GUIDANCE SOLUTION AT PERILYA

The Teleremote Solution assisted productivity and reduced the health and safety risks to operators at the mine

"The key strength of the tele chair (Surface Control Unit) is that it enables hot seating, between day and night shift operators, within a matter of minutes…"

REQUIREMENT

Increased productivity and a means to minimize risk were the primary objectives for Australian base metals mining and exploration company, Perilya.

Perilya recognised the benefits of innovation and technology in achieving the best outcomes for their Broken Hill operation.

In order to reach their targets of increased productivity together with a significant increase in safety, RCT was enlisted to develop and implement a series of remote control solutions. This included the implementation of RCT's Line-of-Sight remote systems as an introductory solution with the ability to upgrade as required. RCT's Teleremote and then Guidance solutions were the natural progression from the Line-of-Sight technology and Perilya took up the opportunity in early 2011 as they saw the benefits of further increases in safety and productivity.

RCT SOLUTION

Perilya was able to benefit from increased production on the implementation of RCT's ControlMaster® Guidance Solution. The Solution allows for the steering, braking and throttle of the machine of the loader to be automatically controlled with required intersection inputs via the existing Teleremote joystick. The Solution also allows for the selection of higher gears where required, maintaining an optimal tramming path to improve the overall speed of tramming cycles, resulting in more tonnes moved.

The ControlMaster® Surface Control Underground Teleremote System was then installed to further increase productivity and reduce the health and safety risks to operators at the mine. Here underground equipment is controlled from a specifically designed Control Station situated on the surface. Apart from the immediate health and safety benefits for the operators, considerable time was saved during shift change over as no underground travel time was required during shift change overs.

"The key strength of the tele chair (Surface Control Unit) is that it enables hot seating, between day and night shift operators, within a matter of minutes compared to the use of conventional underground tele cars" said Michael Liyanage, Mining Engineer at Perilya's Broken Hill operation. "It can take operators up to 1.5 hours to catch the cage down, after blasting fumes have cleared, travel to the crib room, travel to the job, do a pre-start and 3TC."

Both the RCT Surface Control Underground Teleremote System and Guidance Solutions implemented at Perilya allowed the mine to achieve greater machine serviceability of their underground equipment. Damage to the equipment was minimized through the laser technology available in the Guidance Solution which provides real time assessments of current mine conditions and maintains a safe distance from the drive walls. With reduced downtime and less requirement for repairs, Perilya was able to get more use out of their equipment.

Perilya now has the opportunity to install additional Surface Teleremote Control Stations at a lower rate as the engineering and development costs were absorbed in the initial unit outlay.

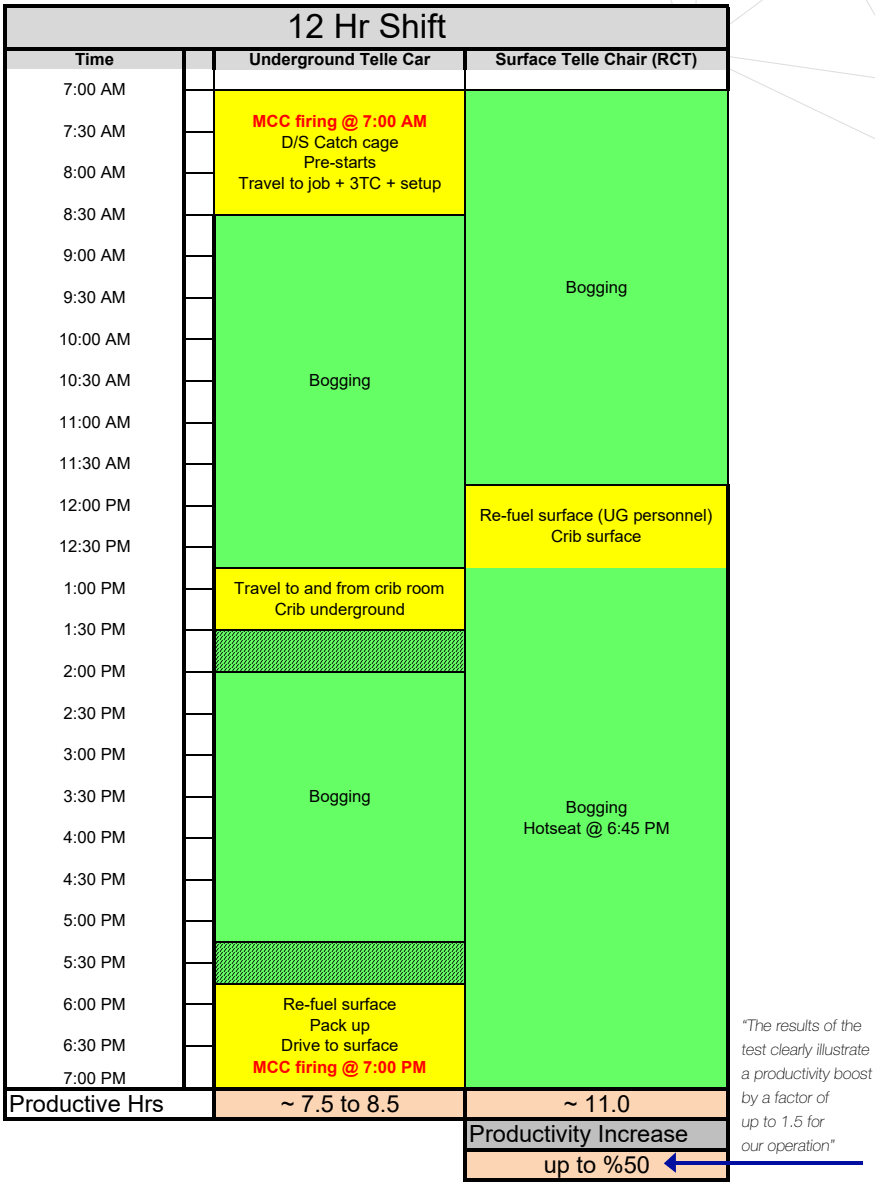
OUTCOMES

- Increase in productivity with increased operational hours as reported by Perilya
  - Using the conventional Teleremote/Guidance Solution
    - total productive hours = 7.5hrs to 8.5hrs
  - With RCT's Guidance Solution operated from the Surface Control Unit
    - total productive hours = up to 11hrs.
  - With RCT's Guidance Solution, increase in mechanical utilization was between 25% - 50%

Tramming speeds were increased significantly with the Guidance Solution allowing the loader to navigate its own way along the path, resulting in more tonnes moved

- The loader was able to travel at significantly faster speeds along the tramway due to the laser assisted navigation resulting in faster tramming cycles and more tonnes moved.

- Time savings
  - Up to 2 hours due to the rapid changeover of equipment operators during the shift transitions



"The results of the test clearly illustrate a productivity boost by a factor of up to 1.5 for our operation"

  - Approx. 1.5hrs for breaks – no need for the operator to drive to crib area
  - Between 1-1.5 hours per blast with no need for the operator to move to a safe location and for the dust to clear
  - Avoid downtime for servicing and refuelling, this is conducted one every 24 hours and scheduled with the operator's lunch or smoke breaks.

- Health benefits - reduced exposure to DPM (Diesel Particulate Matter), dust and noise
- Safety benefits - operator located on the surface with reduced vehicle interaction
- Reduction of the number of light vehicles underground, with a reduced requirement for surface controllers to go down to the machine for pre-starts, and then operating the machine/s on Tele Guidance. Light vehicles cost money to run and maintain, they are a very large budget item on any mine (up to $80k to purchase alone)
- Less opportunity for error with reduced human intervention

ControlMaster's Guidance Solution increases the general tramming speed on underground machinery

Sub level Teremote control cabinet

- Four camera output used for the operator to view the "Live" Guidance image to gain machine location/perspective to walls in high dust Teleremote operation. Guidance video output (what the Guidance Solution sees by means of the laser) through the fourth camera input of the Teleremote transmitters giving the operator more of an understanding of what the Guidance Solution does and how it works. The Guidance view also provides the operator with accurate information on how far the machine is from the drive wall when using Teleremote to load and unload the bucket.

In order to compare the perceived benefits of RCT's Surface Control Underground Teleremote Solution against the Teleremote/Guidance solution currently used at Perilya's Broken Hill operation, Perilya conducted a productivity study on both setups. To achieve a fair comparison and to provide realistic results, these were conducted on the same drive over a distance of 150 metres with varying experienced operators.

The results showed significant efficiencies gained with RCT's Surface Control Underground Teleremote Solution with between 880 and 1300 tonnes moved over a 12 hour shift (80 - 121 buckets), while the use of the conventional Teleremote/Guidance solution resulted in 550 – 880 tonnes moved (50 – 80 buckets).

"The results we have seen at Perilya provide further compelling evidence of the distinct productivity benefits of our Guidance Solution," commented Bob Muirhead, MD at RCT. "This clearly illustrates how to minimize the cost of using an LHD – lowering the costs of moving material by moving more tonnes, more consistently, over a longer period of time and with no damage to machinery."

CLIENT COMMENTS

"The results of the test clearly illustrate a productivity boost by a factor of up to 1.5 for our operation," said Mr Liyanage. "From a business perspective, Perilya is achieving significant benefit for its investment in RCT's Guidance Solution to maximize productivity and utilization."

"Perilya is satisfied with RCT's service and plans to investigate further opportunities to automate its operation."

RCT COMMENTS

"These overall production gains have been achieved by the customer through the implementation of policy, procedural improvements and processes to optimally drive the high use of RCT Surface Control Guidance Solution. I was informed that they run the machine on Surface Control – Guidance/ Teleremote for approximately 22 out of 24 hours!" said Adam Gough, Account Manager – NSW Hard Rock.

RCT'S CONTROLMASTER SURFACE CONTROL GUIDANCE SOLUTION

The ControlMaster® Guidance Solution has been designed to increase operational efficiency and productivity by reducing impact damage to the machine while increasing the general tramming speed.

The ControlMaster® Surface Control Underground Teleremote Solution allows the operator to control the underground machine while located in a specially designed room at the surface of the mine. The ControlMaster® Guidance Solution reduces the risk of collision with the walls and major obstacles while keeping the loader on the optimal tramming path.

While the ControlMaster® Guidance Solution currently provides significant efficiencies for large and small mining operations worldwide, RCT is committed to constantly innovate through its continuous improvement programme. The recently released version 2.3 has extended the system's capability with the inclusion of articulation calibration and control for more accurate steering, and improved collision prediction and cuddy handling, to further improve the operation of the machine under Guidance control.

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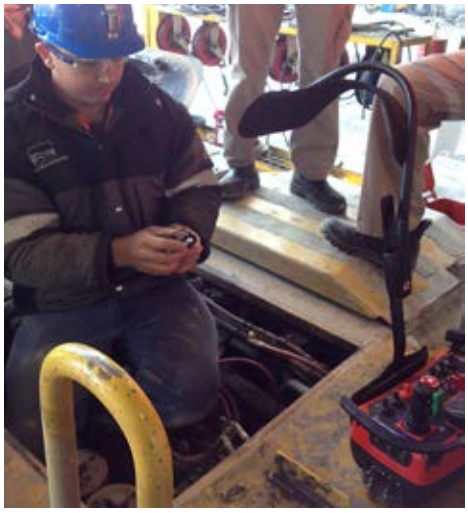
CASE STUDY

JINFENG GOLD MINE TO DOUBLE OUTPUT OVER THE NEXT 2 YEARS WITH RCT'S REMOTE CONTROL SOLUTIONS



RCT's Field Service Technician, Clarke Holmes with the ATX2200-LS remote control unit

Remote control by Line-of-Sight of the underground loader

REQUIREMENT

Eldorado Gold's target is to double the output at their Jinfeng Gold Mine over the next 2 years. In order to achieve their production target, the company needed to identify a way in which it could continue to mine, safely and efficiently.

The solution is to incorporate a change to the current mining method of "over-hand cut and fill" and to include long-hole open stoping, which requires remote loader capabilities to recover the ore from large unsupported areas.

The Carlin type ore deposit mined in Jinfeng is commonly associated with poor to fair rock types and high grade areas that self-mine, this can jeopardise the safety of the operators and machines.

The ability to continue to mine in these unstable conditions without jeopardising the safety of the operators is the key factor to increasing productivity at the mine. Jinfeng took the first, significant step towards tele remote control with the implementation of RCT's Line-of-Sight control of their Caterpillar R1700 LHD vehicles.

RCT SOLUTION

Where an area is unsupported, such as long hole open stopes, removing the operator from the hazardous area and allowing them to control their machine from a safe location some distance away, allows continued production without exposing personnel to any risk.

The significant safety improvements available through remote control of equipment first caught the interest of Jinfeng mine management resulting in the installation of two ATX2200 Line-of-Sight remote solutions at the gold mine. This allowed them to control their R1700 LHD vehicles from a safe distance and to continue to operate in the unsupported conditions.

The successful implementation of RCT's ATX2200 Line-of-Sight Solutions at the Jinfeng operation heralds the beginning of remote control operation at the mine which is one of the largest foreign owned gold mines in the People's Republic of China.

RCT's team installed the remote control systems at Jinfeng on two underground loaders (LD002 & LD005) and trained 14 Jinfeng staff (including underground operators, underground trainers and maintenance personnel) in safe operating techniques, fault finding and diagnostics of the Line-of-Sight remote system.

Successful completion of the training enabled the operators to control the underground loader LD005 from over 400 metres away using Line-of-Sight control.

The comprehensive operator training included classroom theory and practical operation of the loader on remote control. Eldorado maintenance staff underwent RCT's Level 2 training which allowed them to not only operate the remote loader but to identify potential faults and understand the internal diagnosis software functions and settings.

"Remote control loaders are essential for safe long hole open stoping, and to ensure the safety of the operators," said Jackie Bock, Underground Foreman at Guizhou Jinfeng Mining LTD, "this commissioning and training will enable us to recover ore from places that are considered too high-risk for exposure to our operators."

Training at Jinfeng Gold Mine

OUTCOMES

The comprehensive support and training provided to operators, training and maintenance staff at Jinfeng has empowered them with the skills necessary to gain the most from their Line-of-Sight equipped machines.

With machine maintenance now possible, immediately or as required and on site, machine downtime is minimised and production can continue with minimal interruption. This, together with the ability to continue to operate in the unstable environment, has a significant impact on production with an increase in operations.

CLIENT COMMENTS

With the successful installation and the achievement of positive outcomes from the Line-of-Sight control systems, Jinfeng are now looking at implementing teleremote control to approved machines.

While the benefits of RCT's Automated Mining Solutions were already well known to the Underground Foreman, from his own experience at another operation, its application at Jinfeng provides significant opportunity to increase safety for the operators prior to the operation moving to a new and more productive mining method. "I have seen the benefits of RCT's remote control solutions in other operations so am confident in achieving positive outcomes at Jinfeng," said Bock.

"To further lift our production, we are looking to change our mining method to long hole open stope mining," said Bock. "We have seen the success of RCT's solutions at a sister mine, so we have confidence in achieving successful outcomes here at Jinfeng with the Teleremote Solution."

RCT COMMENTS

The customer has already seen improvements in safety and productivity with the installation of our Line-of-Sight Solution at Jinfeng," said RCT's Account Manager, Shane Smith, "this will provide further efficiencies for the operation. Using Teleremote control of machines removes any risk to the operator, enabling operation in potentially hazardous areas without compromising safety."

RCT is continuing to work with Jinfeng to assist the operation in achieving their target of doubling their output over the next 2 years.

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CASE STUDY

SAFE & RELIABLE SOLUTION TO ASSIST HAUL TRUCK OPERATORS

"The support, development, installation and training were first class without any problems or delays."

NSW Mine Project Manager

"It was rewarding to see such a positive response to the Guidance Solution we implemented at the site; a testament to our focus on safety and efficiency."

Rob Derries,
RCT Custom - Manager

OVERVIEW

A multinational mining operator in New South Wales (NSW), Australia, required a safe and reliable means to assist their haul truck operators in reversing their trucks down an extended distance of a tunnel created by their Tunnel Boring System (TBS).

The efficient removal of large quantities of rock bored by the highly effective TBS was critical to the success of the operation.

RCT installed their Haul Truck Guidance Solution to allow the operator to reverse the haul truck quickly and safely along the length of the drive without unnecessary stress or machine damage.

Health and safety, together with efficiency, were the key drivers for commissioning RCT, which led to the development of a number of specialised solutions for both underground and surface mining operations.

At the NSW mine site, the haul trucks had to be reversed along the length of a significantly long tunnel to load large quantities of rock waste arising from the rapid boring, and then driven out in a forward direction once loaded.

The issues to be addressed included safe reversing over an extended length of time, together with navigating both in forward and in reverse along the narrower floor width, due to the tunnel shape.

SOLUTION

The semi-autonomous Guidance Solution was engaged by the operator in the haul truck at the entrance to the tunnel, and disabled on leaving the tunnel – reverting to full manual control.

The assistance of laser technology enabled the haul truck to remain on the centre path of the tunnel as it reversed towards the loading point. The operator engaged the truck in reverse direction and only had to provide timely inputs (left/right) at pivotal points.

The system was also designed to detect the correct loading position and safe distance within the tunnel, on every cycle. The on-board laser technology for real time feedback was ideal for this application as no additional infrastructure installation was permitted in the tunnel.

The Guidance technology increased operator effectiveness when maneuvering the haul truck within the tight confines of the tunnel. It reduced the need for machine servicing and machinery damage, significantly increased tramming cycles, and reduced the risk of driver fatigue. Second or higher gears were used as reliance on operator expertise and reaction was reduced.

RCT's Guidance Solution was designed to meet the safety and reliability levels as outlined by the NSW client - and has the capability for future extension to teleremote and full automation. It can be fitted to many makes of articulated haul trucks as required in the future.

RESULT

- Greater productivity
- Reduced operator error and fatigue
- Faster tramming speeds while reversing along the tunnel
- Reduction in machine downtime and machine damage
- Removal of large quantities of rock waste from faster Tunnel Boring Equipment
- Increased operational efficiency and safety

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CASE STUDY

TELEREMOTE DOZERS INTEGRATED TO SITE COMMUNICATIONS NETWORK

RCT and Roy Hill have joined forces to ensure safety at the prominent mine site.

RCT and an Australian Iron Ore company have joined forces to develop and implement a world first for Tele Remote Dozer operation ensuring long term machine productivity and operator safety improvements at the Pilbara mine site.

Roy Hill's multi-billion-dollar iron ore project is now home to the first dynamic multiple Geofence package to have been successfully interfaced to fixed and mobile asset elements within the boundaries of the Coarse Ore Stockpile (COS), and RCT is proud to have played a big part in this momentous achievement.

The Geofence technology was successfully and safely interfaced with two D11T CAT dozers and the radial stacker infrastructure, including the boom which can be manoeuvred in multiple directions.

Both dozers were equipped with RCT's ControlMaster® Teleremote solutions which removes the operator from the machine and relocates them to an operator station equipped with vision package from the area; allowing them to control all machine functions from an ergonomic, safe environment.

In addition to the five cameras on the dozers, six PTZ cameras were installed at the site on the COS stacker, tertiary crusher infrastructure and two mobile communications trailers to give operators greater spatial awareness during operation.

The decision to install a virtual perimeter around the dozers stock pile area was to safeguard operators and to ensure the machines can operate in the same area seamlessly without any risk of collision with the fixed stacker infrastructure or the dozers falling into vaults or driving off the stock pile boundary.

The interfacing of all the dynamic elements on the one site was achieved in partnership with SITECH's Collision Detection technology – Trimble GNSS and RCT Custom – a team dedicated to creating and delivering adaptable, bespoke integrated solution from the company's existing technology.

There were a large number of factors that had to be taken into consideration for the Geofence to work effectively.

Multiple workshops and risk assessments were carried out, both independently and most importantly collaboratively to define the Geofence boundaries or virtual perimeters within each element which included the two dozers, the movement of the stacker boom and the five vaults. The boundaries were also designed to be configurable with the correct level of authorisation in the system, allowing flexibility for the operators.

The SiTrack software was designed to provide the Geofence boundaries, monitor all interactions and provide alerts within the boundaries allowing the RCT system's semi-autonomous control over the two dozers. This was achieved by using High Precision (HP) GNSS equipment to measure and detect the proximity of the moving assets in the potentially hazardous stockpile to an absolute accuracy of around the +/-25mm range. While the software utilises the accuracies of these solutions, it had to be teamed with a bespoke software solution to provide the operator with the ability to control the dozers, semi-autonomously operating with RCT's ControlMaster® Teleremote system in order to avoid the possibility of collision between the two dozers and other dynamic elements.

RCT Custom worked with SITECH and Roy Hill to develop and deploy the dynamic Geofence system to interface with the ControlMaster® Teleremote solutions to ensure machine functionality is inhibited by the ControlMaster® system at different levels of detection on the SiTRACK system.

The integration resulted in the creation of a variety of configurable Geofence boundaries within the site to prevent fixed assets and the dozers. Each boundary has different zones to alert the operators of potential danger (green, blue, orange and red).

RCT Custom's Project Manager David Wright described the project as challenging and rewarding.

"A number of factors had to be considered throughout the duration of the project including integrating with Roy Hill's technical architecture and communications system and designing and creating a number of engineering solutions to meet the requirements," he said.

CASE STUDY

A WORLD FIRST AT ROY HILL - CONTINUED

The installation, implementation, commissioning and acceptance of the project all involved RCT liaising with numerous departments at Roy Hill including, engineering, operations, mining, maintenance and IT communications teams.

Dozer communications for Geofence Teleremote Control is via Wifi Access Points on each machine, a fixed Access Point on either side of the stockpile and two mobile Access Points on Solar Trailers giving 360 degree coverage of the complete work area. The two fixed Access Points are connected to the Roy Hill Network via fibre optic cable to the process plant communications room which allows ethernet connection to operator stations.

"The process was made easier thanks to everyone's willingness to work together in a collaborative manner" said Mr Wright.

With vision being fed from numerous PTZ and dozer cameras, the dozer pitch/roll machine dashboard information and the Trimble tablet display, Roy Hill decided bigger screens were required to cater to the extensive vision available to operators.

As a result, the operator station went from having two, 24 inch screens and a 17 inch Trimble tablet to, two 40 inch curve screens, with a 32 inch display for the Trimble screen. A Trimble tablet was also relocated to the side of the operator chair.

"The bigger screens provide the operators with a better resolution of what they are seeing; giving the dozer operators a more advanced level of information to assist in daily operations," said Mr Wright.

Carrying out dozer functions via Teleremote control from the operating stations eliminates the risks operators are exposed to at the course ore stockpile and processing plant, reduces operator fatigue and as a result increases productivity. In addition, the Teleremote solution allows for multiple views from the dozer, which in turn allows them to be more efficient throughout the duration of their shift as well as minimising machine damage and overall general wear and tear. The downtime associated with shift changes decreases which further aids productivity as there is more time spent in the "driver's seat."

In addition to the deployment of the solution, RCT delivered training to ensure the operators maximise the solution's potential and appropriate site personnel are familiar with how it works. Operators are now trained in Line-of-Sight (which was deployed at the beginning of the project), Teleremote and the Geofence solution.

A Roy Hill spokesperson said that Teleremote dozers using the Geofence collision avoidance system exemplified what can be achieved through collaboration.

"The Teleremote project had several challenges to be overcome. In particular, the vision package had to be installed within the planned process plant shut intervals – every little step was critical to be rigorously planned for," the spokesperson said.

"The Geofence system has been customised to suit our requirements at Roy Hill. We established the dynamic boundaries for dozers, fixed stacker boom, cone of throw and COS through several risk assessments with key stakeholder's engagement, and RCT were very collaborative throughout this process.

"We engaged dozer operators and trainers throughout the development process. Their feedback has been a key to Teleremote dozer's success."

FUTURE

"We've had very positive feedback from Roy Hill and I'm very proud at what our team was able to achieve," said Mr Wright.

RCT will continue to work with Roy Hill to further develop and upgrade technology for years to come.

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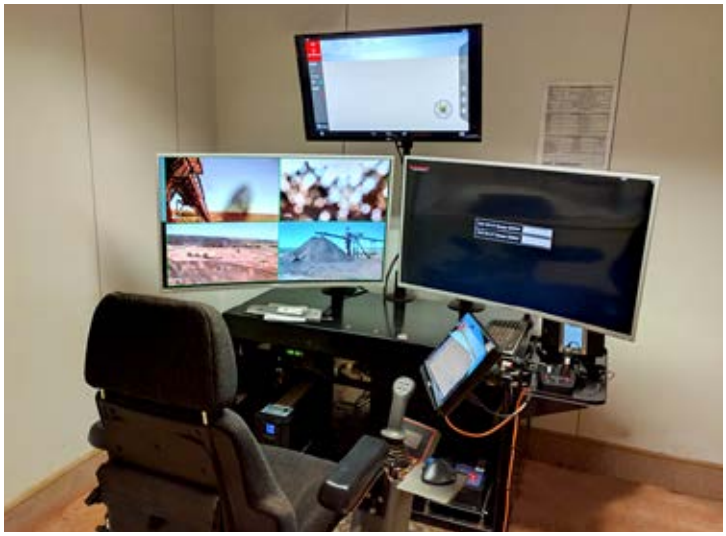
CASE STUDY

A WORLD FIRST AT ROY HILL - CONTINUED



CASE STUDY

CODELCO, HEXAGON MINING AND RCT FORM STRATEGIC ALLIANCE FOR CUSTOMISED AND INNOVATIVE SOLUTIONS

"Codelco are working to improve operational continuity; implementing Teleoperation for mining equipment for safety, and to improve the productivity.

For this reason Codelco worked with RCT in one Teleoperation project - with a Komatsu Wheel-dozer WD600-3 - achieving within the set time, implementation of this functionality and fully satisfying customer and operators requirements. RCT's technology is robust and highly reliable, with a high specialisation of their professionals.

Our idea is to continue with RCT to implement the teleoperation for other production equipment, in order to achieve remote operating of the entire production process."

Norma Vargas, Codelco

RCT Custom provides unrivalled experience, capability and focus to create customised solutions in any situation.

Like many mine sites situated in geographically harsh and climate sensitive landscapes, Codelco's Andina site in Chile is faced with a myriad of challenges – poor visibility; high altitude (4km above sea level); large cliff faces; steep drops; minus 25-degrees Celsius winter weather; slippery, icy surfaces; and annual blizzards, which close the mine until it is safe for employees to return.

Codelco was confronted by the outcomes of a risk assessment which determined that either autonomous or at the very least, teleremote controlled mining had to be implemented.

This was a perfect opportunity for RCT and Hexagon Mining to collaborate and form a solution.

Through this ground-breaking partnership, a customised solution to help Codelco meet operating requirements – to create a safer environment for employees and considerably reduce shutdown time from extreme weather – was achieved by building trust, leveraging skills and co-operating to achieve a successful outcome.

Both RCT and Hexagon Mining were confident their core systems could be engineered together to produce a solution to satisfy Codelco's expectations.

Senior Project Engineers and ControlMaster® Software Engineers from RCT and Hexagon Mining conducted extensive research to adapt and establish new technologies, which would suit Codelco's mine site.

RCT's ATX2200 (teleremote controlled system) and RCT's Muirhead® Speed Limiter were combined with Hexagon Mining's Jmineops Geofencing functionality and Hexagon Mining's SAFEmine CAS and TrackingRadar Object Detection systems. These mining technologies were integrated and installed onto a Komatsu WD600 wheel dozer by RCT and Hexagon Mining field engineers.

With the dozer operated from a safe location – in a stationary, insulated cabin within the site – RCT customised the teleremote installation by utilising the site's existing resources, materials, and a new communication network.

A line-of-sight, portable remote was also included to operate the dozer in a line-of-sight situation (rather than the stationary cabin). This provides flexibility for operating each machine, in multiple applications across the site, if the network is down.

For this pilot project, Codelco requested the system solution be fitted in to an older dozer, and this challenge proved that RCT is able to adapt its solutions to any situation or machine.

The simplicity of using the teleremote system has been highly praised; the easy transition from actually physically driving the machine, to operating it from a safe cabin; feeling safe at work and not having to endure the sometimes brutal Chilean weather, is priceless for the operators.

More notably, positive feedback related to how RCT conducted the whole process.

"Our partnership with RCT was key to the delivery of this functionality for Codelco", said Dave Goddard, Director of Business Development for Hexagon Mining Autonomous. "RCT brought a 'can-do' attitude to the project, and we never had anything less than full confidence in their ability to deliver."

RCT Custom's core focus is to create adaptable, bespoke solutions, and where appropriate, together with partners such as Hexagon Mining, on a project-by-project basis. The solution ensured it was relevant and suited to Codelco Andina's mining requirements.

RCT is advocated worldwide for living its values of always going that "extra mile". The added service of RCT's trainers delivering an on-site training programme and remaining on-site for an extra week to ensure everything was 100% in order, contributed to successful completion of Stage 1.

Codelco has approved RCT to deliver Stage 2, which aims to complete in October/November 2015.

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CASE STUDY - CONTROLMASTER® LINE-OF-SIGHT

ALLIANCE RESOURCES – RIVER VIEW COAL, UNIONTOWN, KENTUCKY

RCT's solution eliminated potential risks as operators can now carry out their job without having to physically sit in the dozer to operate it – avoiding unstable areas and adhering to MSHA's new regulation.

THE IMPOSSIBLE MADE POSSIBLE WITH CUSTOM TECHNOLOGY

OVERVIEW

American–owned Alliance Resource Partners' River View Coal Mine in Uniontown Kentucky is the largest mine of its type in the nation.

The underground continuous mining complex has been in production since 2009 and utilises 18 continuous miners in a room and pillar configuration.

It has a preparation plant on site with a throughput capacity of 2,721 tonnes of raw coal per hour which produces a waste product of coal material. This material (otherwise known as coarse coal refuse CCR and slurry FCR). The CCR is used to construct an earthen dam that contains the FCR that is pumped to the dam. The CCR is hauled to the site and dumped then spread with dozers.

While River View Coal mine's engineer Mark Henshaw said the process wasn't an issue at the site, the Mine Safety and Health Administration (MSHA) ordered the mine pushing CCR into tailing pond to find a solution to remove the operator from the dozer. Although there were a few options available, River View Coal management chose to utilise remote control technology on its dozers.

The client had two dozers in operations, a Caterpillar D6T and a Caterpillar D8R. Management was told by other remote technology companies that adapting a system to the older, D8R dozer was virtually impossible, however, RCT was unconvinced.

SOLUTION

RCT is well-known in the industry for being able to adapt its technology to ANY MACHINE and was therefore keen to rise to the challenge of retrofitting its ControlMaster® Remote Dozer system (ATX2200) to the dozers. A rather challenging job that was successfully completed by RCT's Custom team – a dedicated projects team with the resources and expertise to find the answers to problems and adapt current systems.

While the deployment of the remote system to the D6T dozer was a standard installation, the D8R required a large amount of hardware to be fitted in order to achieve all functions remotely.

RCT Custom Projects Manager John Androvich described the D8R installation as an extremely challenging job; however this didn't discourage him and the team from tackling it head on.

"It was a massive task as the D8R was about 15 years-old so it was all mechanically controlled, whereas most new models we deal with today are now electrically controlled," said Mr Androvich.

The process required a collaborative approach; with the Custom team engaging with RCT's development team, a hydraulics specialist and a machinist to hand-make some of the componentry.

Like every installation, it was integral that RCT didn't alter any of the mechanics or functionality of the machine.

"It was important we maintained the mechanical feel for the operator," he said.

"This involved converting the machine to electric, before converting it to hydraulic and then back to mechanical in some instances."

This project was not only a first for RCT but most likely the first D8R to be put on remotes ever before.

"Because it was our first time we have remoted a D8R, there was no past history available to guide us, which is challenging in itself."

On top of this, the team struggled to find a similar machine close by to test the system on.

"Eventually we were able to locate a similar dozer about 200kms away. However we only had access to it for a total period of four hours, so it was during this small timeframe that we had to do our design."

"Testing the system also posed a difficulty, so we did as much bench testing as humanly possible."

Mr Androvich credited his experienced team for the success of the job as the mechanical aptitude required to understand the machine was extensive.

"We are lucky to have such an experienced team here at RCT, so we were able to draw on this extensive experience to create something that other remote companies said was virtually impossible," he said.

RESULT

The RCT Custom team adapted the standard ControlMaster® dozer remote system to directly meet the client's requirements.

Both systems allow operators to remotely control the dozers; pushing CCR into the tailing pond, from a safe distance, on stable ground using Line-of-Sight.

RCT's solution eliminated potential risks as operators can now carry out their job without having to physically sit in the dozer to operate it – avoiding unstable areas and adhering to MSHA's new regulation.

RCT has received extremely positive feedback about the job carried out at River View Coal.

"We have been told that the 15-year-old machine is now the preferred machine of use – we got a fair buzz out of hearing that! It's a definite credit to the team," Mr Androvich.

Another one of RCT's strengths is that it documents each project in detail.

"We are now able to reproduce the system for similar machines in the future if required," he said.

COMMENTS

"My overall impression of RCT is that they are a very professional company with a reliable product – I'm very pleased," said River View Coal mine engineer Mark Henshaw.

"The D8R is an older machine and was a much more intense installation – they did a really good job in setting it up and within a couple of weeks it was up and going," he said.

"We are very happy, RCT are very professional and very reliable and cost efficient."

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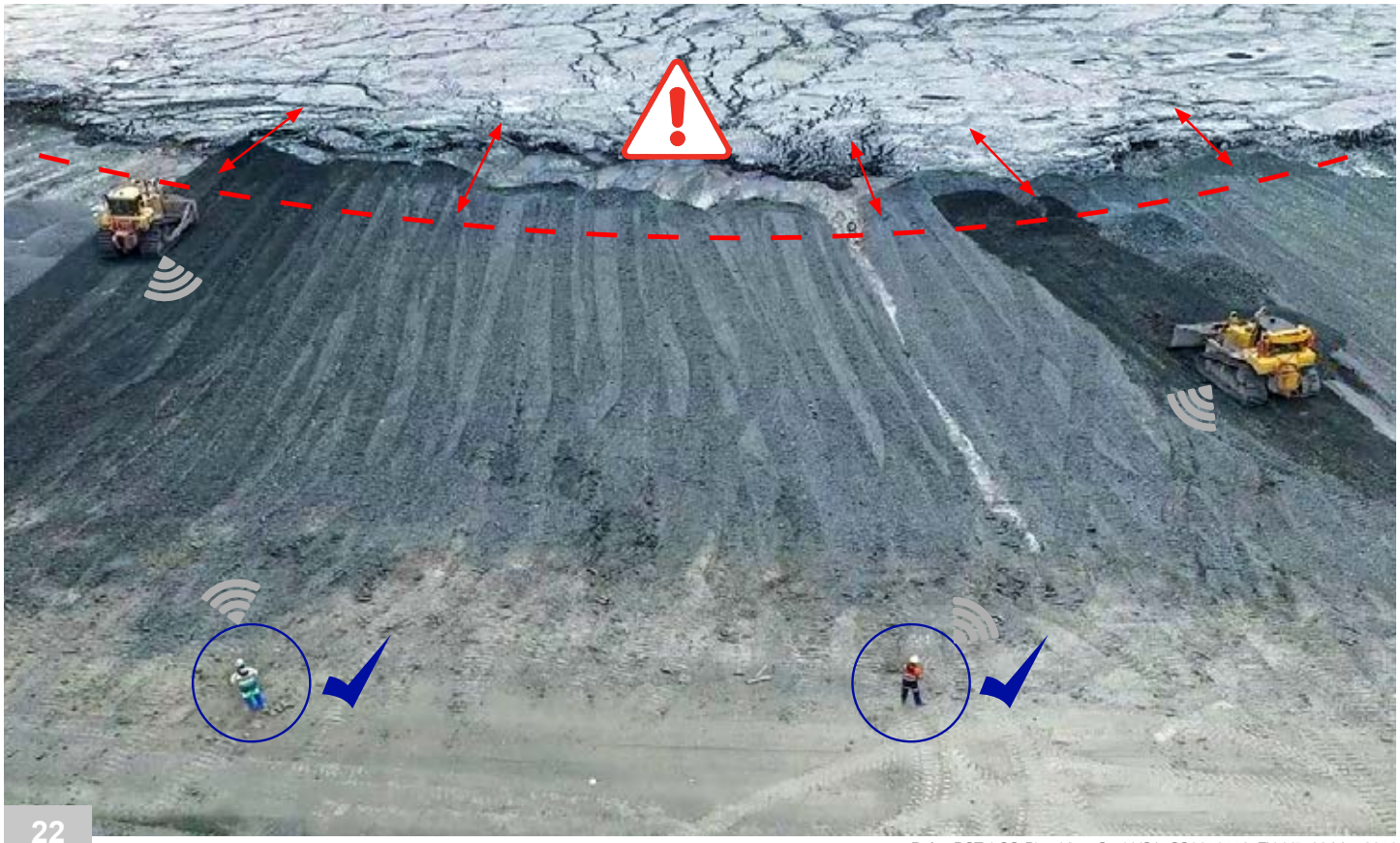

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CASE STUDY

TELEREMOTE CONTROL SOLUTIONS FOR ALROSA

"The solution was required to protect and optimise the performance of both personnel and equipment which was compromised due to extreme environment conditions."

Once more RCT provides outstanding customer service delivering its Automated Mining Solutions to the mining sector, this time at Alrosa's Udachny Open Pit Operations located in Siberia.

RCT was approached by Vostochnaya Technica , the Caterpillar dealer for that region of Russia to provide a solution for Alrosa which would increase the safety and productivity on the operation of four CAT 740B articulated trucks and a CAT 993K loader. The solution was required to protect and optimise the performance of both personnel and equipment which was compromised due to extreme environment conditions. These conditions included freezing temperatures, falls of rock during load, operator's fatigue and many others.

The solution, ControlMaster's® CM2200 Teleremote Control System, was installed into the trucks and a loader, allowing the operator to control the machine from a safe position. The installation of an Operator Control Station allows operators to control the loader and trucks simultaneously from a safe and more productive environment, keeping the operator away from danger with greater overall visibility through RCT's Vision System.

In October 2013, RCT began the successful installation of the solution, while training was conducted onsite to upskill operators and maintenance personnel. The training, which included Level 1 - Safe Operating Procedures, Level 2 - Safe Testing Procedures, Level 3 - Teleremote Communication Systems, and Level 4 & 5 - Internal Programming/Testing & Internal Servicing Procedures, ensured the optimum utilisation of RCT's Teleremote Control Systems once commissioned.

RCT has a strong team able to design, manufacture, supply, install, commission and support the world's best remote control and automation solutions anywhere.

The project was a great success and a satisfying challenge for Remote Control Technologies.

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