



# AI

GUIDE FOR  
MINING



“

When you combine the words data and mining together you might think IT and technology focused initiatives aimed at extracting value from data in the enterprise. But sometimes we actually mean applying the power of data and intelligence to the actual mining industry, where the primary value being extracted are resources from the earth. Even in this very physical of industries, artificial intelligence and machine learning are being applied to increase the efficiency, effectiveness, environmental and safety concerns, and other aspects to help continue to make mining a valuable enterprise.

”

**-Forbes**

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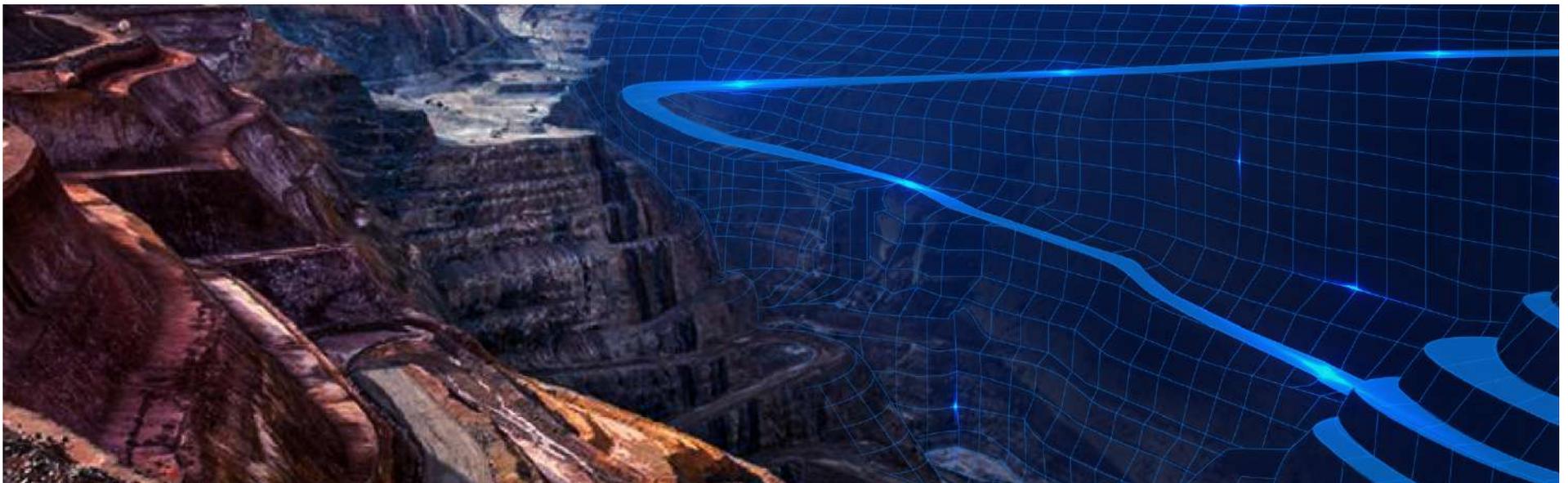
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# I. Introduction

## Mining Is An Incredibly Intense Enterprise

The barriers to entry are high, the investment is high, the risk is high, the logistical difficulty is high, the amount of waste and environmental impact are high, the negative perceptions of it are high. No matter how you look at it, the challenges facing the mining industry are legion.

And it is not getting easier. Increasing regulations and increasing legislation combined with the maturity of existing mines and an expanding population base means it is becoming more and more difficult to extract a profit. All of the easy operation hacks to increase production and decrease expense have already been implemented and accounted for.



# II. Challenges Faced by the Industry

## Legacy technologies and techniques

Mining equipment is expensive, mine owners want to get as much out of their investment as they can for as long as they can. Mining is a lifelong career and a lifestyle, its generational, most mining professionals got into mining because they grew up in a mining town or their family did it. Once they are in, they stay there, that means there are a lot of practices that are still being used simply because "thats how its always been done " or "thats how I learned it." Change is hard.

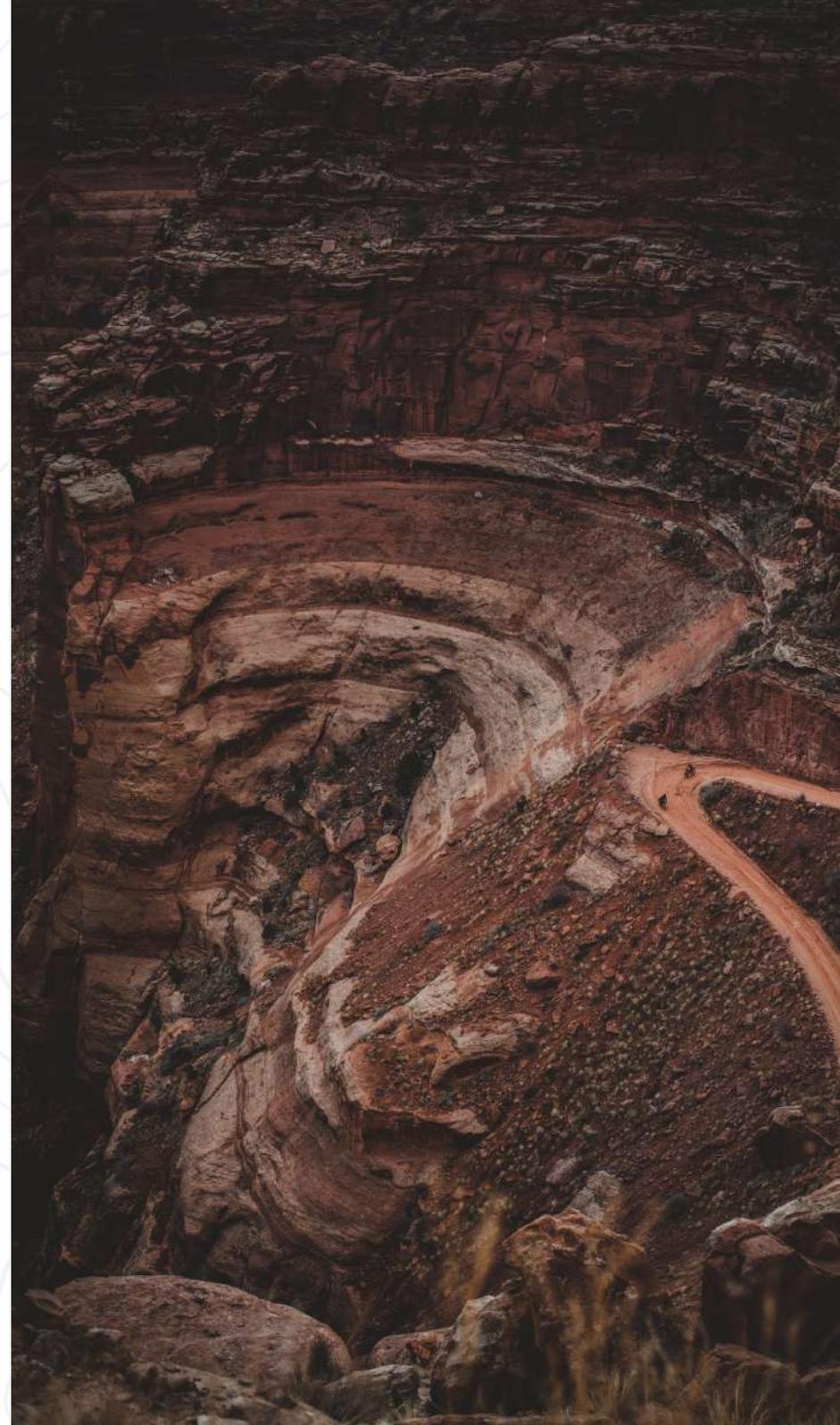
**“Lets face it, the mining industry is going to have to have to come to terms with some difficult truths if it wants to stay ahead in the coming years.”**

## Harder to reach deposits

Mining has been ongoing pretty much since civilization began. The easy to reach deposits have been exhausted. Now we have to mine deeper than before, in more remote and inhospitable regions with significant logistical challenges, or go after deposits that are close to population centers- all of which will require significant planning and effort to make economically viable

## Innovative wariness

Possibly the biggest hurdle faced by the mining industry is a general wariness towards practices necessary for driving innovation. The Industry is risk averse to begin with then add to it the competitive nature and IP protectionist tendencies and it is hard to open up enough to partner with an outsider to push forward innovation.



## **Increasing compliance requirements**

The government is constantly passing additional regulations and requiring additional compliance from mine owners. The fees for non-compliance are increasing and the potential repercussions for violations are momentous. Mines are having to add significant overhead to ensure compliance.

## **Declining deposit quality**

The best deposits, the most valuable, biggest bang for your buck deposits are gone, now we have to work harder for poorer quality constantly improving and investing in our extraction techniques.

## **Changing perceptions of mining**

The public opinion of mining is changing, becoming more negative- focusing on the harm caused rather than the necessity of the industry. Its becoming harder to lure new talent all while fighting off the bad press.

## **Increasing Liability**

It seems nearly every week news of another large lawsuit is being filed against some mine or another. litigation and settlement expenses are reaching astronomical rates.

# III. Seizing the Opportunity

Modern technology- Artificial Intelligence, smart and automated tools, and the Internet of Things is allowing huge leaps forward in other industries and can do the same for mining. Not just at HQ, but actually on the ground.

IoT allows a connectivity and ease of data transfer never before imagined. Smart and automated tools are significantly reducing the time and drudgery of tasks that used to take hours of manual labor and gathering unbelievable amounts of data that simply wasn't feasible before. Now add in AI and all of that data can be combed through in seconds.

Algorithms generate models and predictions almost instantly. Insights that would have taken weeks of grueling calculations now take at most a few hours.



Legacy technologies & techniques

**Modern Technology**

Declining Deposits

**Modern Technology**

Increasing compliance requirement

**Modern Technology**

Harder to reach deposits

**Modern Technology**

Increasing liability

**Modern Technology**

Collaborative wariness

**Cognitive Behavioral Therapy**

## One Mine's Challenge is Another Mine's Opportunity.

The changing technological environment offers the perfect opportunity for the willing and able- the hurdles are clearly labeled and understood. Simply implement the solution and then market it.

# IV. The **Advantages of Implementing Artificial Intelligence**

Industry leaders are already incorporating new technologies into their workflows and reaping the benefits.





## Increase efficiency

AI identifies inefficiencies in your workflow and allows you to correct them. It can monitor situations for you and alert you if there is a deviation so that you can focus your resources elsewhere. AI identifies patterns in the data allowing it to predict outcomes so that you can plan ahead, and so much more.



## Near-instantaneous data

A smart sensor connected to the IoT can upload data gathered immediately to the cloud for access anywhere within seconds of encountering it. Automatic integrations can transfer data from system to another automatically. Drones can take pictures of a site in a fraction of the time it takes to scan it. Calculations and models that would take humans days to complete take AI microseconds.



## Increase collaboration

Automatic integrations allow data and insights to be shared easily across teams. Cloud based solutions allow multiple users to access and view the same data at the same time from anywhere, working together to make the best decisions possible.



## Save time

Drones can map a site in minutes saving the days a traditional terrestrial mapping effort would take, algorithms perform calculations in seconds rather than hours or days, imagine all the more important work you could be getting done in the time the automation saves you.



## Gain access to insights

Because AI can be trained to look for patterns and make predictions based on what it "sees" it can comb through mountains of data, that would be overwhelming or cost prohibitive for a person, to find even the smallest patterns in minutes. People can use these predictions to modify their decisions, or to test various scenarios to determine the best outcome, letting the machines do the heavy lifting.



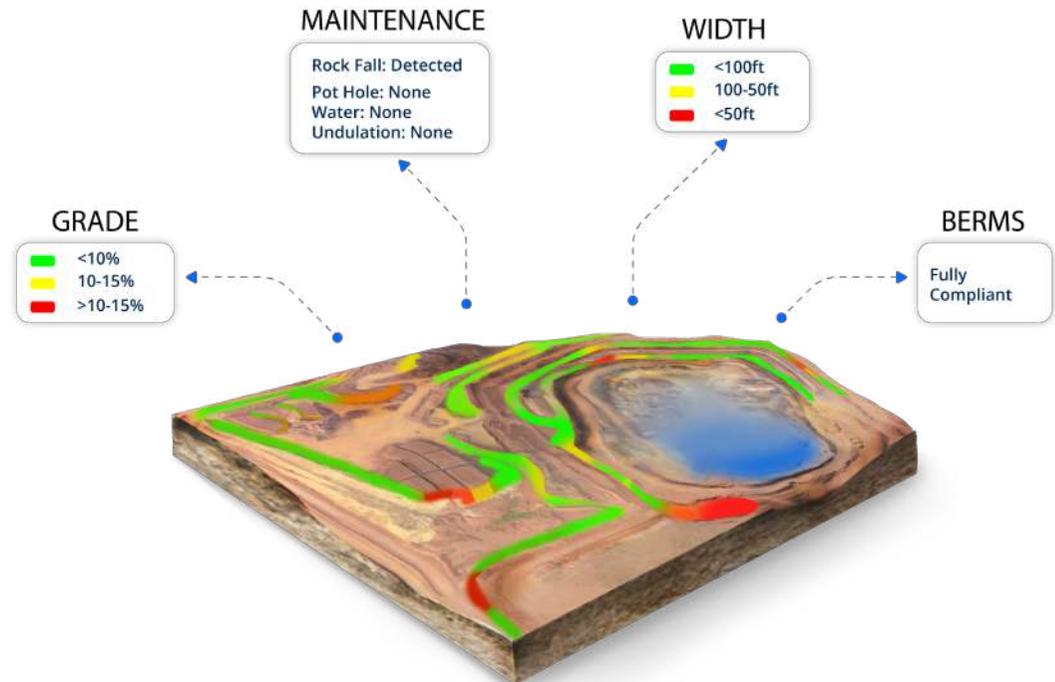
## Maximize your workers

Remove the drudgery from your workers' jobs and use them for what really matters- creating value.



## Reduce errors

Algorithms don't get distracted or disinterested, they don't get tired, they don't have sloppy handwriting. Using software to do complicated computations or automating processes takes out inconsistencies and risk of errors.

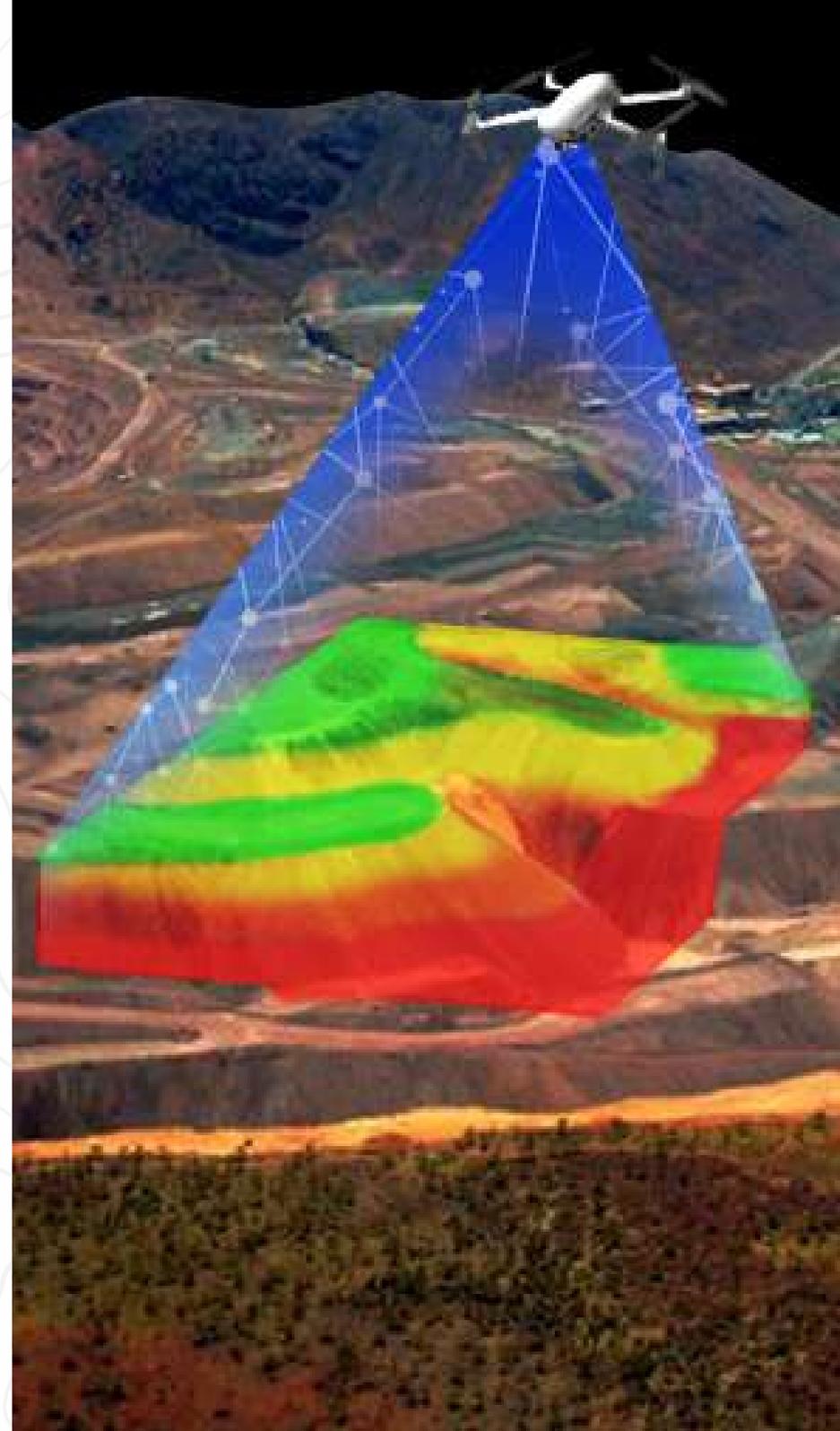


# V. AI Simplified

Artificial Intelligence is a vast term that includes many kinds of technologies with different functions- much like the term mining. Here is a brief breakdown of some of the types of AI.

## Data Analytics

Computer algorithms comb through mountains of data looking for patterns. The algorithms are programmed to identify the pattern, make predictions based on the pattern, and display the data for users in a clear and concise way.



## Machine Learning

Algorithms are trained to reach solutions by executing a series of steps. The more data they are exposed to, the better the algorithms get at quickly identifying and reproducing the correct steps to the solution. The machines "learn" by process of elimination- trying everything until they find a set of steps that works.

## Computer Vision

Algorithms can be trained to identify visual data. Using data from drones, satellites, or other sensors, the algorithms "look" for certain characteristics in the images to identify an object automatically.

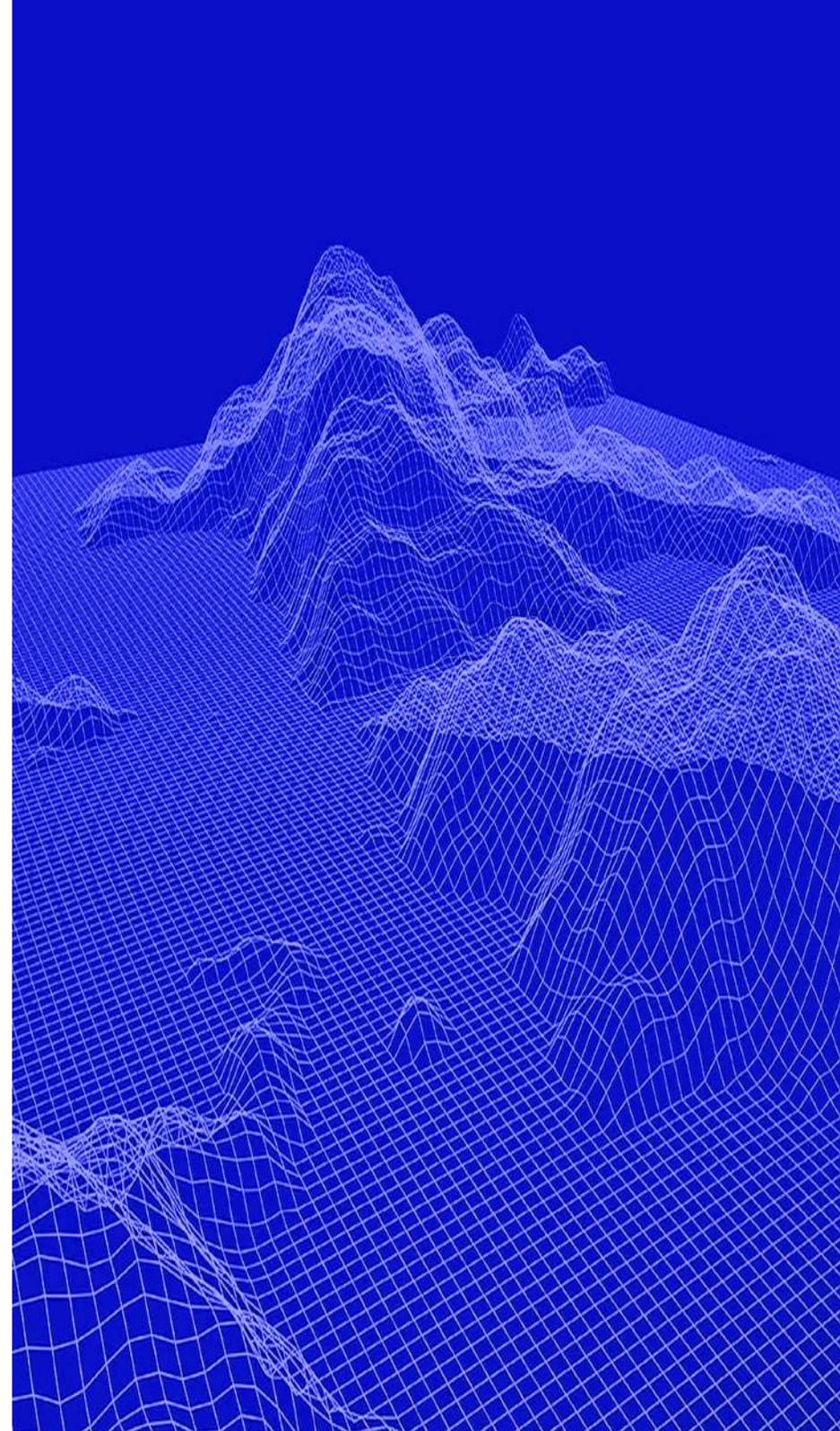
**Because computers carry out tasks much faster than humans, incorporating AI yields significant and immediate benefits.**



# VI. 5 Ways to Maximize Your Data

Success in the mining industry is increasingly about being able to optimize operations at a level never before possible. AI will do that for you.

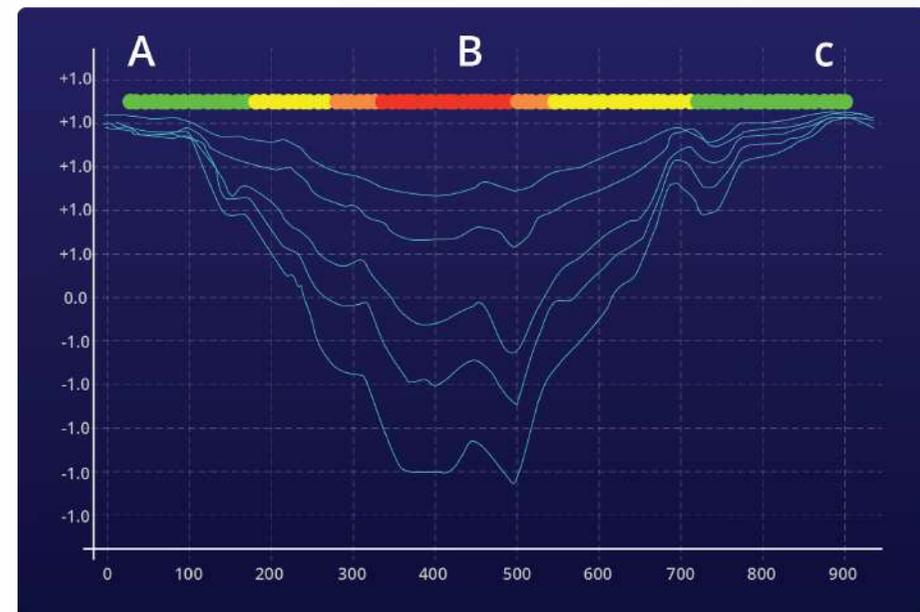
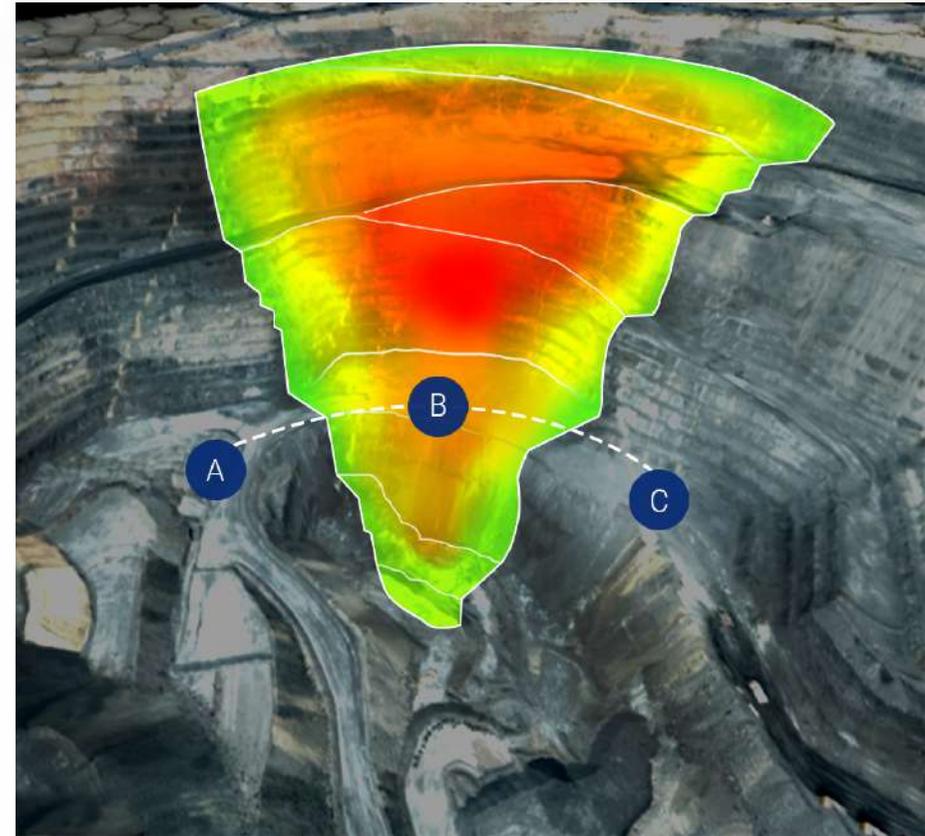
AI allows you to adapt to the changing skills of workers, ensure optimal resource use, automate and speed up time consuming laborious tasks, monitor and measure progress and compliance, and so much more. In fact, there is so much more it took us 7 pages just to touch on a few points.



## 1

## Map and Monitor Your Site Near Instantly

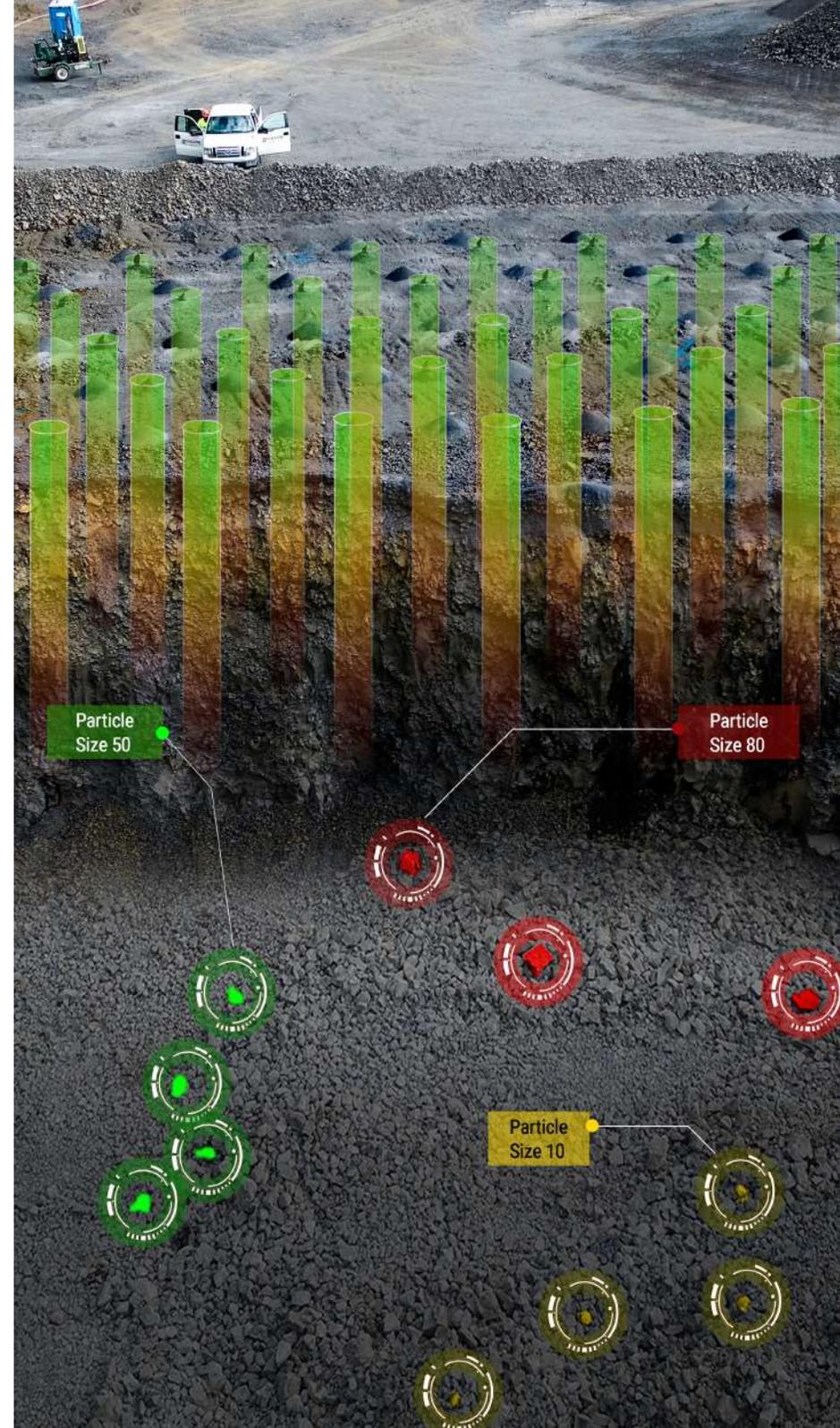
- **Site surveying and mapping** - Plan your site using photogrammetry and digital twins, get 2D and 3D maps, survey grade topographical maps, with gps tagged data near instantaneously.
- **Site Monitoring** - using Strayos photogrammetry you can get accurate and detailed 2D and 3D maps of your site within minutes of flying a drone or satellite data updates. Allowing the most current gps tagged data of your site for operations overview gives you near to real time information to maximise your workflows, planning, and response rates
- **Deposit prediction** - Strayos' prediction AI uses hyperspectral imaging data from satellites and drones to predict deposit locations allowing you to plan your exploration in advance.
- **Geometric Reconciliation** - Map your existing site and compare it to your planned site. Identify and quantify any variations in haul roads, benches, slopes and more, track mine and bench productivity and progression. Plan your operations around what is, not what should have been.



## 2

# Perfect Extraction- Better Drilling and Blasting

- **Measure While Drilling** - Strayos automatically integrates with your smart drill allowing for instant transfer of shot plans to your drill and drill reports to Strayos. Track, map, and model drilling deviations, depth, drill rate, percussion, and more allowing your blaster to adapt their blast as needed for best results.
- **Blast Design** - layout your shot on the 3D model and modify as needed to get your best blast. Plan for optimal resource use, use less explosives, spend less time drilling, plan for amount of material needed and size of bench, obtain optimal fragmentation. Incorporate Measure While Drilling data or boretrak data to perfect your blast.
- **Bore Hole Deviation** - Monitor and measure your drill holes with Boretrak data integration and Collar Deviation AI then adjust your shot plan as needed.

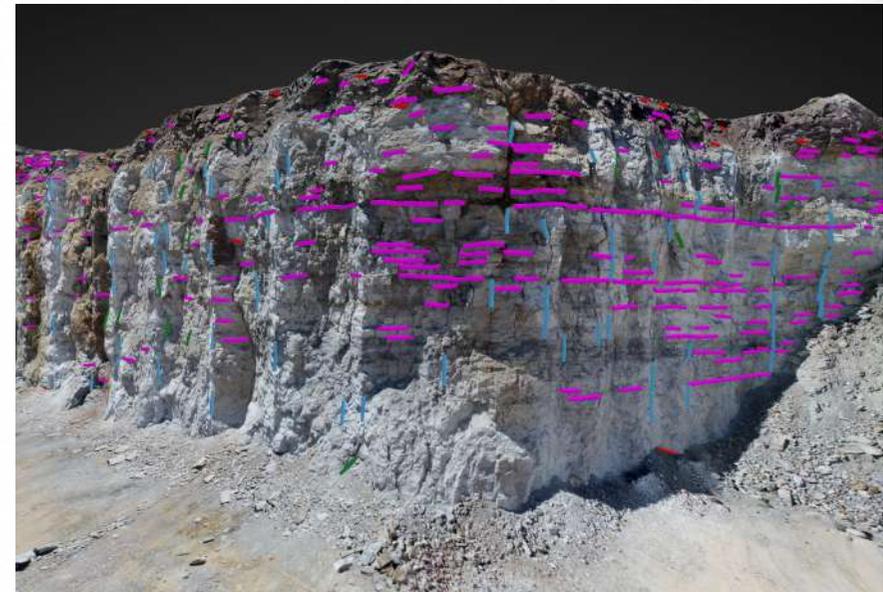
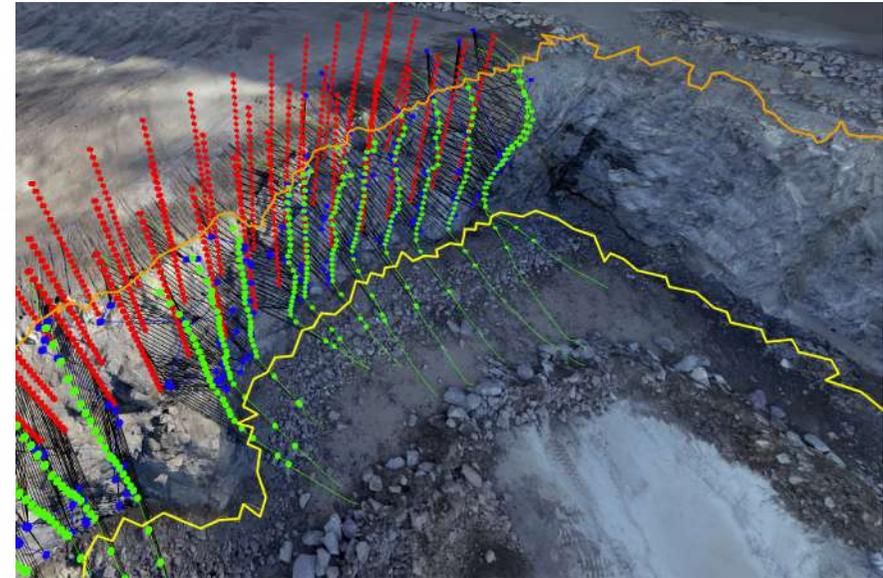


**.Front Row Burden Optimization** - Design your shot plan on the 3D model and the AI automatically calculates your front row burden. Vice versa, input your burden threshold and the AI will help you modify your shot to meet it. Design your best blast.

**Rock Mass Identification** - Automatically detects bedding planes, joints, and discontinuities to better plan your drill and blast.

**Pre and Post Blast Volume Comparison** - compare the pre and post blast volume for enhanced analysis and future operations planning.

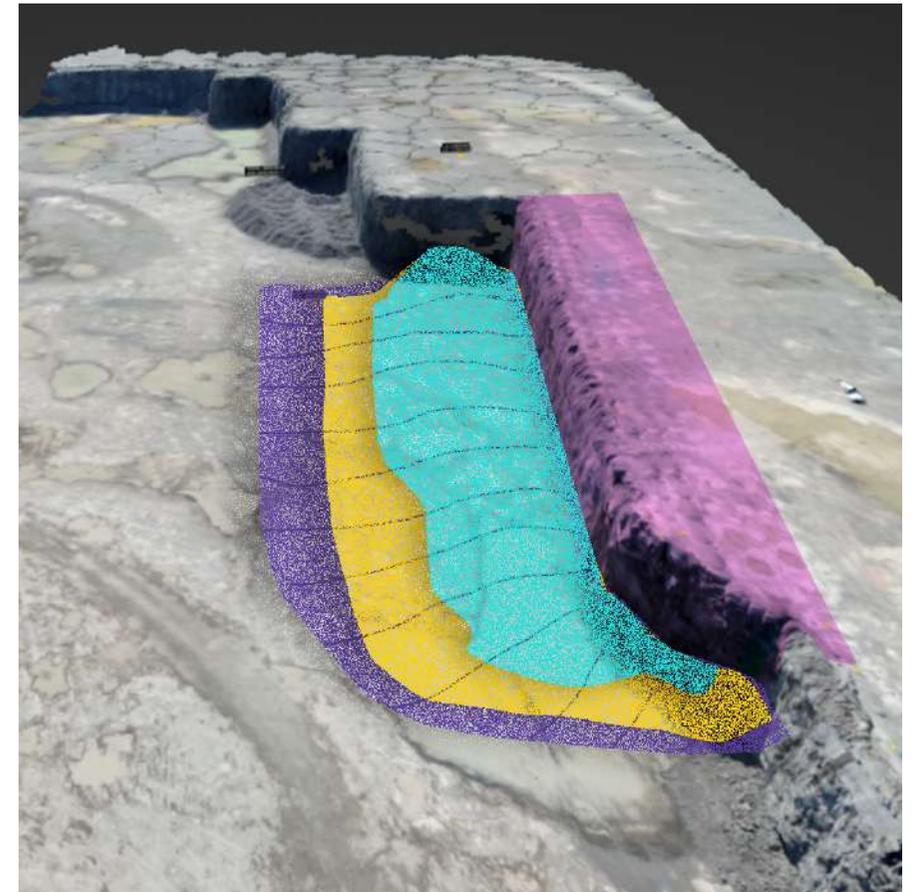
**Boretrak Data Integration** - Integrate your Boretrak data into the 3D model and see the difference- compare to the drill plan and Rock Mass data, adjust your blast based on the holes as drilled.



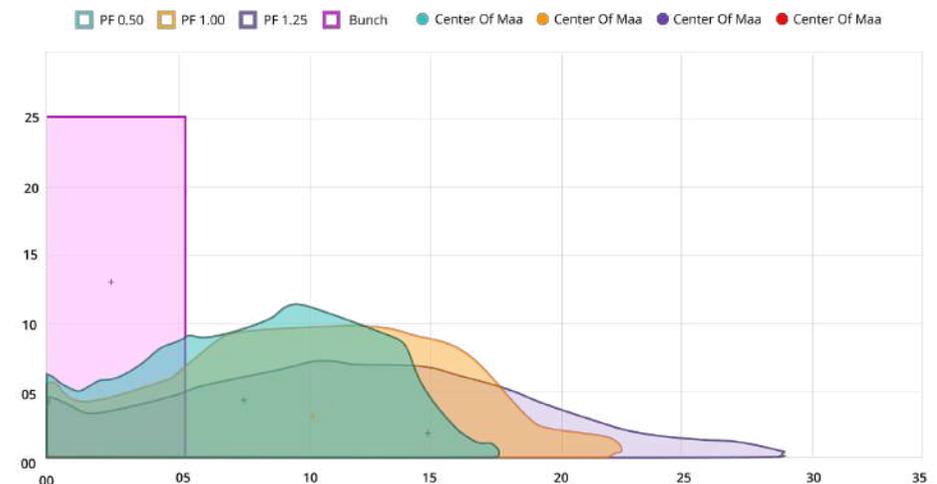
### 3

## Optimize Site Operations

- **Muckpile movement/Cast Blasting Prediction and Planning** - get the muckpile you want, or at least know what you're getting before you blast. Put your rocks where you want them so you know which machines to bring in and where to put them.
- **Fragmentation Prediction, Identification, and Analysis**  
Predict the fragmentation size you'll get before you blast. After a blast the AI automatically detects the fragmentation size and spread. Save on downstream costs like additional processing, increase diggability, and reduce waste from fines.
- **Ore Location Post Blast** - use hyperspectral imaging to find your ore easily and quickly from amid other rocks.



Muckpile Prediction Report



- **Optimize your Haul Roads** - Measure their width and plan for traffic needs. Measure their slope and compare it to engine efficiency- see grade recommendations for optimal engine performance. Identify maintenance needs like potholes, rock falls, or undulations. Track water flow and puddles on your site.
- **Stockpile Measurement and Monitoring** - measure your stockpiles frequently to track quantity in and quantity out.
- **Change Detection** - detect changes in your bench, your slopes, your haul roads, your berms and more.
- **Pit Analysis** - Analyse the progress of your pit, compare existing pit geometry to planned design, see and track past blast volumes, and project its life into the future.
- **Cut/Fill Analysis.** Determine how much material has been removed or added to your site.

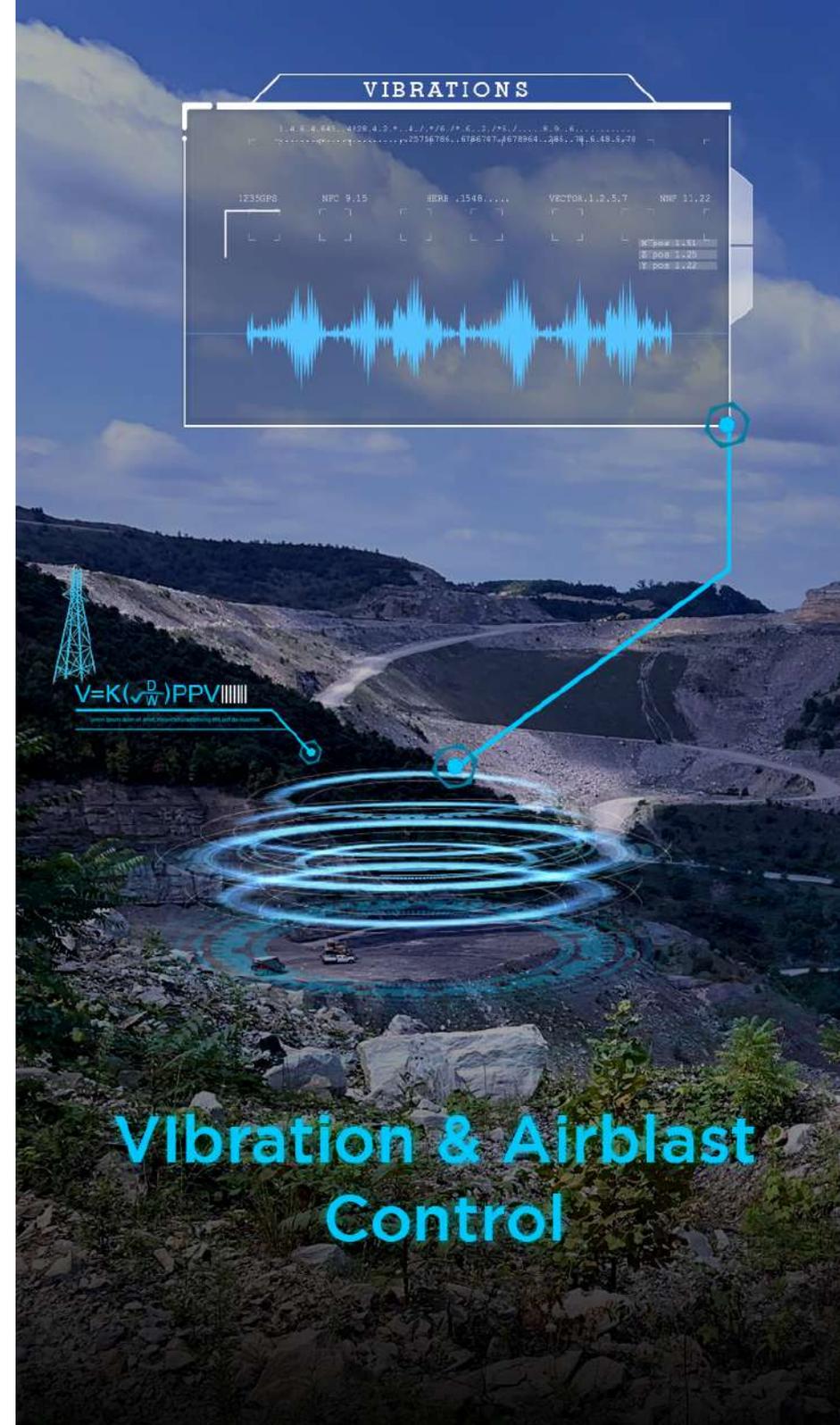


Label	Stockpile Name	Material Name	Volume (yd <sup>3</sup> )	Density (lb/yd <sup>3</sup> )	Tonnage (tons)	Total Value
1	S10	Dry Sand	191.11	2700.261	234.064	\$2,283.40
2	S9	Dry Sand	2302.88	2700.261	2820.404	\$27,273.30
3	S8	Dry Sand	6129	2700.261	7506.359	\$72,586.49
4	S7	Dry Sand	3048.07	2700.261	3733.061	\$38,098.70
5	S6	Dry Sand	2284.82	2700.261	2798.283	\$27,059.39

## 4

## Improve Site Safety and Compliance

- **Model, Measure, and Monitor** – your high wall, your slopes, detect deformations, and predict slope failures as often as you can fly a drone or get satellite data. No more laborious boots on the ground spending hours visually inspecting.
- **Reduce Fly Rock, Vibration, Noise, Air Blasts** – the AI can help you optimise your blast and avoid expensive compliance and liability generating issues.
- **Track your Haul Roads** – the AI will identify your haul roads, measure their slope and width and provide warnings for any sections where the slope is significant or the width is too narrow. They can alert you to any dangerous conditions or maintenance needs and track the direction water flows over your roads.
- **Track your Berms** – the AI will identify your berms and notify you if they fail to meet your specifications or need maintenance.

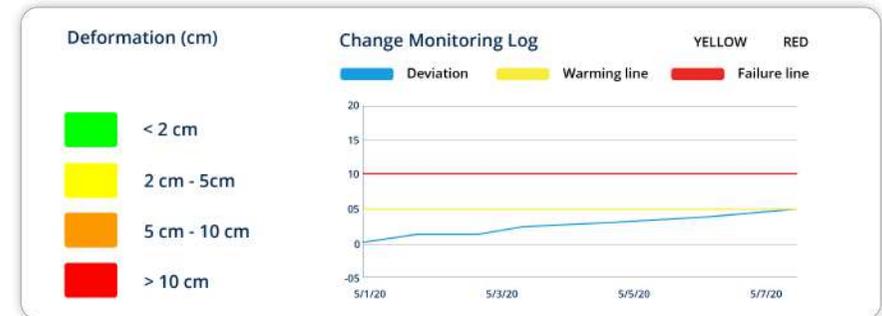


## 5

## Reduce Environmental Impact

- **Reduce Waste** - a more efficient blast means you get the optimal material from the beginning. Don't waste explosives, blast unnecessary rock, ruin your bench, or need to run additional machinery. Save on gas, electricity, wear and tear, and additional materials processing.
- **Monitor Tailings** - use the AI to keep an eye on dam integrity, deformations, and crack formation. Detect water seepage and downstream foliage die off due to leaks or seepage. Monitor water levels, turbidity, seismic events, and more.
- **Plan and Monitor Reclamation Sites** - use the AI to track stability, deformations, seepage, to survey and measure the area to be reclaimed and generate interactive 2D and 3D models for use in planning and maintaining reclamation sites.
- **Habitat and Biomass Monitoring** - use the AI to measure and monitor plant biomass to make sure the site is thriving post reclamation.

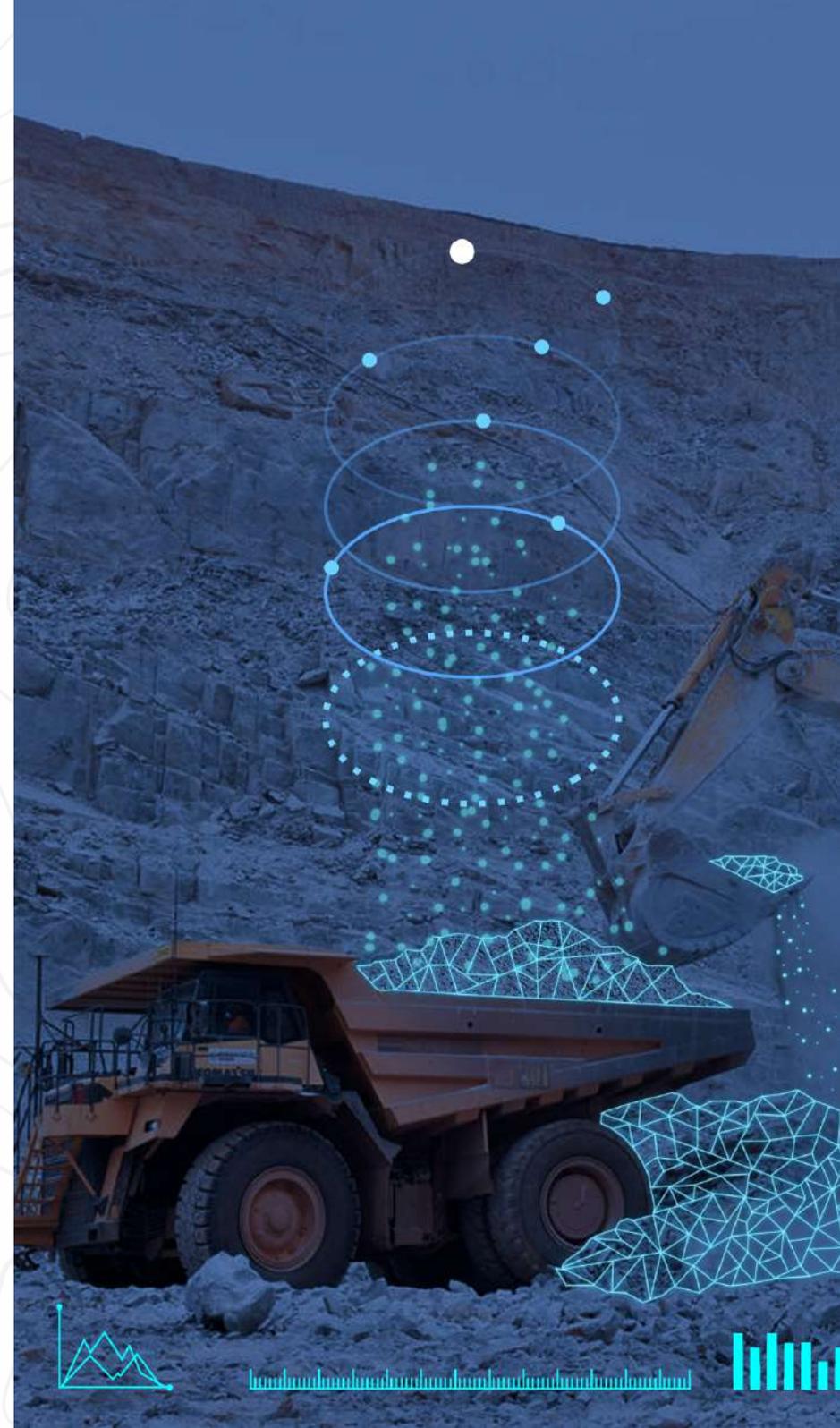
- **Species Tracking** - use the AI to track and monitor individual species- especially the endangered or protected ones.



# VII. AI Implementation Challenges

New technologies can be challenging to understand and implement, that's why its more important than ever to develop key partnerships with trusted experts who can advise you as to the best solutions for your situation. Challenges are only roadblocks if you let them be.

No one can ever say miners aren't up for a challenge, they move mountains for a living after all.



## Challenge 1

# Understanding the Potential of AI Solutions

It can be difficult for people not familiar with the potentials of AI to imagine how implementing it would be beneficial. Often times they can envision a solution for a specific pain point or two, but they must be shown and encouraged to imagine other possibilities.

This requires company willingness to investigate novel solutions, to partner with 3rd parties who can expose their employees to alternate options, and to support their employees while they try out different solutions to find the best one.

## Challenge 2

# Creating an Industry Culture that Embraces AI Solutions and Innovation

Openness and willingness to try new things is paramount to adapting to changing environments. An overly cautious approach to exploring alternative options simply means that necessary innovation will be stifled. Industry Leaders and Company heads need to show their staff that they are not afraid of trying new things or making that leap of faith when needed.

### Challenge 3

## **Creating a Work Environment that Supports AI Solutions**

Changing the perception of AI in the mining industry is all well and good, but it won't make any difference if the companies, sites, and workers are incapable of supporting AI. Investments will need to be made in infrastructure, new machinery and tools, in retraining employees, in hiring technologically skilled workers, and partnering with experts on R&D,

**The ROI will more than make up for any initial implementation costs**

**Those companies that accept the challenge and invite change and innovation are able to quickly adapt to the changing environment and outpace their competition.**

# VIII. From Mine to Mill

## AI Powered End to End Solution



### Mine Planning & Surveying

Photogrammetry, mapping, etc.



### Load & Haul

Haul Road AI, Swell Factor Analysis, muck pile prediction, digability



### Reclamation

slope failure prediction, biomass monitoring, species identification



### Blasting

FRB, blast design, fragmentation prediction & analysis, muck pile prediction, shot plan design, flyrock, vibration, noise, overpressure control



### Processing

fragmentation optimization



### Drilling

smart drill integration, MWD, boretrack



### Geology Analysis

Rock Mass AI, MWD analytics



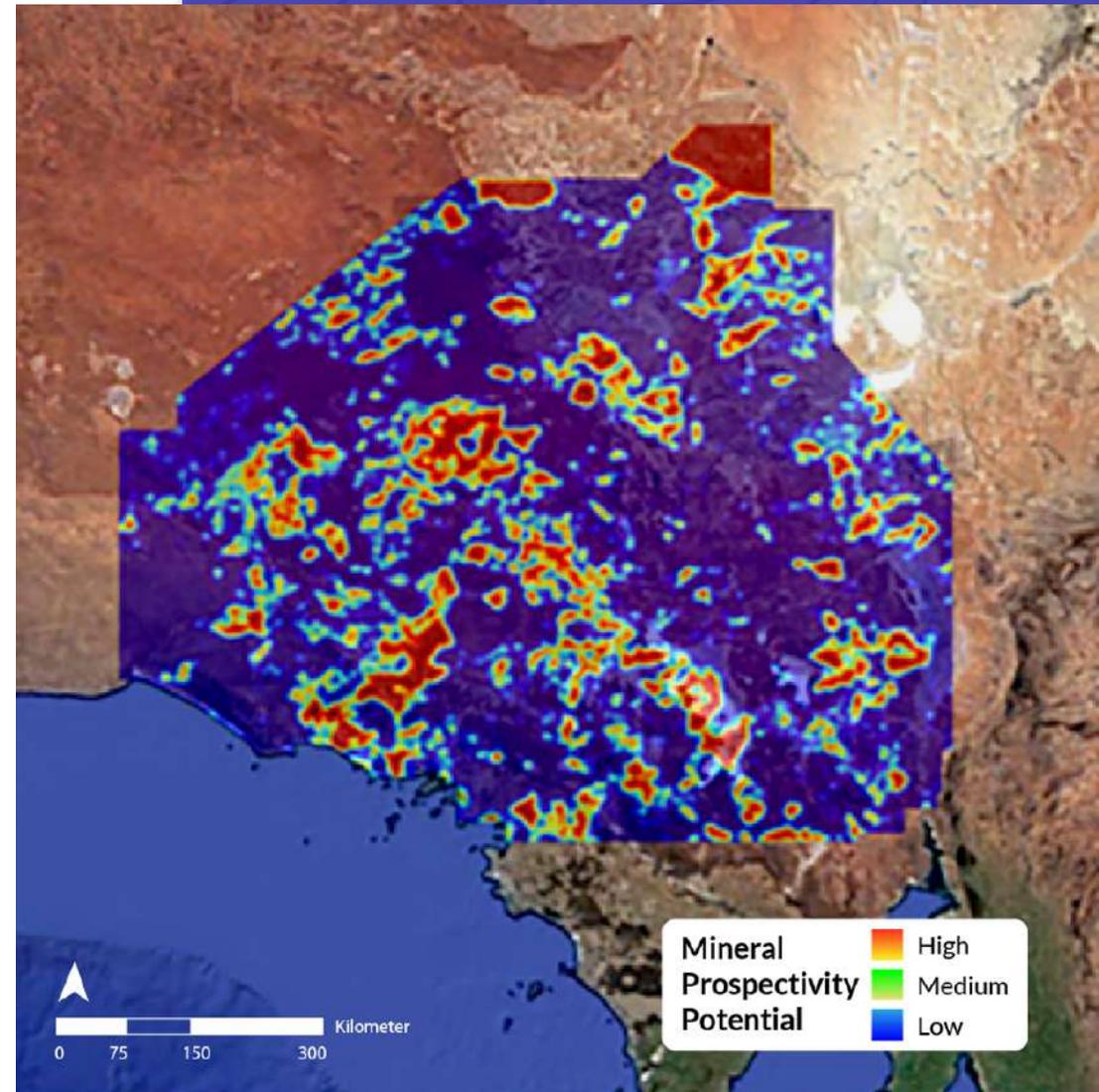
### Reporting

stockpile, pit analysis AI, cut/fill analysis,

# IX. Incorporate AI in Your Workflow in 5 Steps

## 1 Exploration

Just like in exploration for deposits, researching and advance planning can significantly reduce the risk of investing in a new technology. Asking these questions can help to identify where and what types of AI might be a valuable addition to your workflow:



- **What are the pain points for your organisation? What would you like to see improved?** Would you like better fragmentation? would you like to quality check your blasting contractors? or do your berms need constant and frequent monitoring to avoid compliance violations?
- **What parts of your operations would you like more or better information on?** Does your mine site match your planned design? how has my pit changed over time? how does my site geology effect my fragmentation?
- **What are the bottlenecks in your workflows?** Do you have to wait long times for manual inspections or bench mapping? Are you spending alot of extra man hours and machine time because your muckpile shape or diggability didnt match your onsite equipment?
- **What are your company's goals and aspirations?** Would you like to reduce workplace injuries? Be more environmentally friendly? Reduce litigation? Improve public perception? Attract young talent? Reduce costs?



## 2 Collection

AI is only as good as the data it is given. Quality data must be collected and given to the AI in order for it to give you the best ROI. Target the data that can have the greatest impacts on your business, no need to implement new workflows merely for the sake of it.

Create methodologies that are

- **Well-structured**
- **Repeatable**
- **Reviewable**
- **Integrateable**



### 3 Analyzation

Now that you have quality data, you will need to determine the kind of AI best able to take that data to give you the information you want, in the best way. Will you use multiple systems with unique specialities or a general program that can do a little bit of everything, but specializes in nothing.

Pairing with an industry expert here can be incredibly powerful, especially if you need customized solutions or would like to develop solutions that do not yet exist.

**AI is powerful and can be adapted to many different scenarios.**



## 4 Extraction

The AI has analysed the data and now its time for the insights to be extracted. Patterns in the data and predictions can be viewed in a number of ways:

- **2D and 3D maps- often times interactive**
- **2D and 3D models-often times interactive**
- **industry standard and custom reports**
- **Analysis**
- **Predictions**



## 5 Operationalization

Once the data has been sifted through and presented to the user in an easily digestible form, the insights generated can be acted upon and changes to workflows can be implemented immediately to realize the benefits.





# **X. One Company's Journey Adding AI to Their Workflow.**

## **Inspired by a True Story**

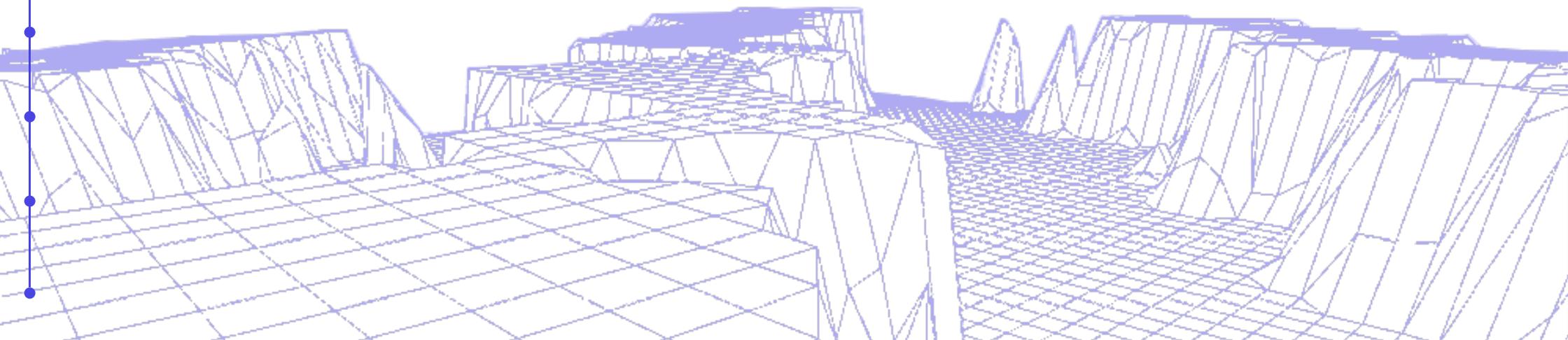
Jon managed a quarry. He faced all the same problems quarry managers everywhere face. His most frustrating problem was fragmentation size. After the blast the sizes were often all over the board resulting in significant waste and additional processing. His muckpile digability was low and his machine cycle time was high. The amount of maintenance required by his sorters and crushers, which admittedly weren't the newest, was a serious issue for him. He was now on his third blasting contractor and seriously considering moving his blasting operations in house.

Jon was discussing his problem with a colleague after work one day. The next day his colleague forwarded a LinkedIn article on AI applications in the blasting industry to Jon. Jon read the article and contacted the article's author. Before the end of the day Jon was on the phone with the CEO of the AI company discussing how to improve his fragmentation results. The CEO and a couple of the company's staff visited the site, listened to the quarry manager describe his problems, and suggested some solutions.

Jon said he would think about it. The CEO and his team went home. Every couple of months Jon received an email from the AI company with updates on the advances AI was making in the mining and blasting industries. The company had added smart drill data integration and processing for Boretrak measuring and tracking. 6 months later Jon read another article on how drones were saving days of manual labor mapping and modeling mine sites.

Jon began reaching out to drone companies making inquiries about incorporating them into his workflow. If he could save time and money on the surveying and mapping part, that would help offset his losses on the poor fragmentation. He liked what he heard and scheduled a demo. He was satisfied with the surveying and mapping. It was saving him tens of thousands of dollars each year and had reduced his time significantly.

He saw a post on LinkedIn about using AI in blasting, it had been written by that same company from a year earlier. Serendipitously the very next day he received an email from the CEO with an article on how to use drones to gather data for shot planning and fragmentation prediction and analysis. He replied to the CEO's email asking for more information.



The CEO scheduled a product demo with him for the very next day, detailing how the software took the data gathered by drones to create interactive 2D and 3D models of the bench. How using the software Jon's team could create model shots to measure front row burden, blast direction, discontinuities in the face that might effect the blast, predict muckpile placement and predict fragmentation size. If they didn't like what they got, they could adjust their shot plan. After drilling the holes, they could use the bore trak module to measure what was actually drilled and compare it to the initial drill plan and then modify the shot accordingly. After the blast, Jon's team could fly the drone again and the software would analyse the fragmentation. The CEO gave Jon a free month long trial.

Jon was blown away. He contacted the CEO again asking what else the AI could do. The CEO smiled, "what do you want it to do?" Jon was stunned, "Why have I never heard of you before?" The CEO replied, **"I'm an engineer, not a marketer."**





# Getting Started With Strayos

Strayos is a software company that specializes in AI solutions for the drilling, blasting, and mining industries.

Our cloud based and stand alone platforms allow users to input data gathered from drones, satellites, laser scanners, lidar, smart drills, and sensors.

With Strayos your data is simple, clear, and actionable so you can put it to work for you immediately, on any device, and from anywhere.

**Strayos is *the* AI solution  
for your end to end Mine to Mill  
optimization.**

**Learn More About  
How AI Can Optimize  
Your Mining Operations**

**Contact us for a free trial at  
[www.strayos.com](http://www.strayos.com)**

**Ground Breaking Analytics, Earth  
Shaking Insights**

