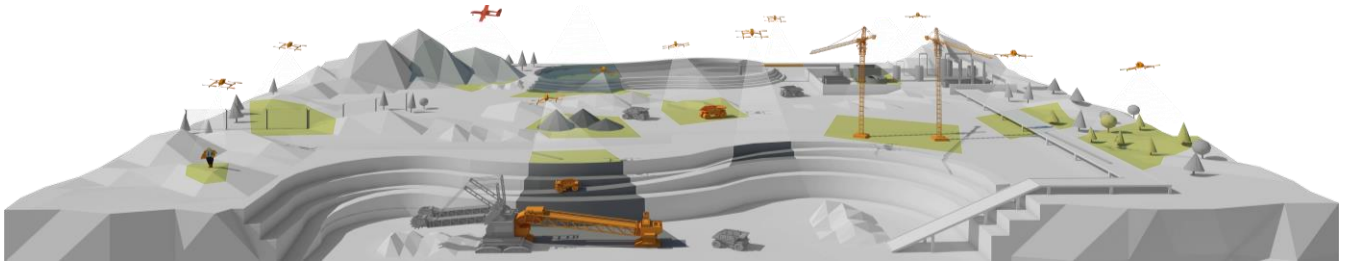
Enhanced Vision - drone powered transformation to improve productivity and safety

Resources & Mining

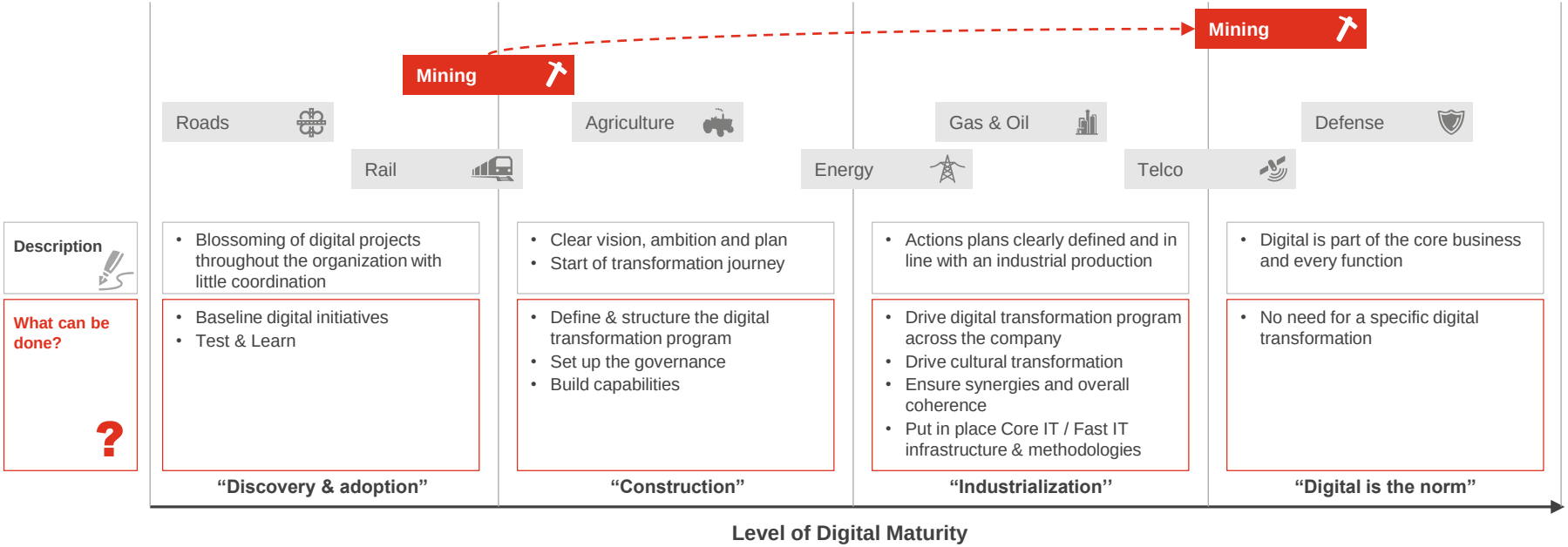
Enhanced Vision through drones and advanced image analytics

1. With the high uncertainty in the resource prices, the mining industry has been late to adopt innovations, compared to other asset heavy industries. The key aspects of the process stayed the same over last decade
2. Today, with the recovery on the markets, the entire industry is under pressure to achieve a breakthrough in productivity. Global leaders started to implement digital mine strategies and observed significant gains in productivity and safety
3. The starting point to unlocking the new productivity potential is related to acquiring better data in order to fully understand the resource base, optimize processes and track the performance
4. Drones and advanced image data analytics are one the key technology enablers impacting the productivity and safety in the digital mine
5. This document presents the benefits of them in the mining production process and PwC digital transformation methodology to support our clients in leveraging the technology to produce more with less



Confidential information for the sole benefit and use of PwC's client.

Although the mining industry has been slower with adoption of new technologies, we believe that it is ready to leapfrog over other heavy asset industries



Confidential information for the sole benefit and use of PwC's client.

While many players in the mining industry explore automation and data analytics, the innovators have already started embedding it in daily operations

Maturity model of digital mine concept implementation in mining sector:

Basic

- Machine control and guidance
- Manual geological analysis - 2D geospatial data
- No data integration

Intermediate

- Manual geological analysis – 3D geospatial data
- **Drone solutions in test phase**
- Basic data integration

Automated Systems

- Advanced fleet management solutions
- Initial autonomous trucks
- **Initially implemented drone solutions in limited number of use cases**
- 3D imaging technologies

Autonomous Systems

- Autonomous hauling
- Autonomous dozing
- Autonomous drilling
- IoT solutions
- Central and remote site management
- **Drone technologies implementation**
- Fully comprehensive data strategy

Confidential information for the sole benefit and use of PwC's client.

Introduction of drone technologies and advanced image analytics brings significant improvements for mining industry

2 days vs 2 weeks to survey an entire site

Over 25% increase in accuracy of extracted volumes and stockpiles monitoring

Up to 23% reduction in costs of geospatial data acquisition annually

Up to 92% decrease in number of life threatening situations

Real time control over 100% of site and production assets

Up to 62% decrease in number of personnel required on the site

Confidential information for the sole benefit and use of PwC's client.

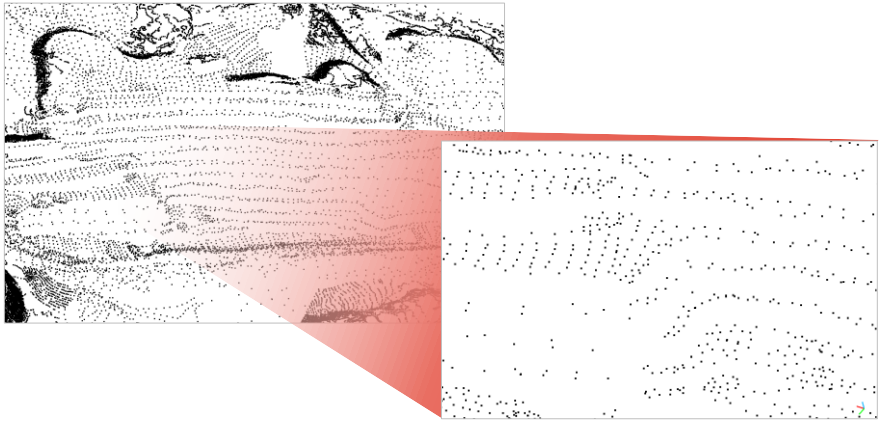
To unlock the productivity and safety potential it is necessary to implement our Enhanced Vision transformation across the entire production life cycle

	DESIGN	DRILL	BLAST	LOAD	HAUL
Enhanced Vision	• Up-to-date and accurate maps and 3D models of the terrain • Automated flights for cyclical monitoring • High-end visible, hyperspectral and LiDAR sensors • Creation of accurate materials for future mine reclamation	• Accurate projected drilling coordinates based on updated mine models • Field works observation • Adherence to design instant control • Machinery and people safety monitoring	• Hazardous zone monitoring and detection of objects in restricted area • Real-time video streaming • Rock fragmentation analytics and detection of oversized debris • Hyperspectral geochemical analysis	• Support in loading planning • Blasted material mapping and volumes estimation • Loading progress monitoring and reporting • Loading area safety monitoring • Support of machinery and staff scheduling	• Feeding road planners with up-to-date maps • Optimization of the routes and analysis of slopes • AI algorithms for dangerous objects detection • Image-based trucks damage detection

Confidential information for the sole benefit and use of PwC's client.

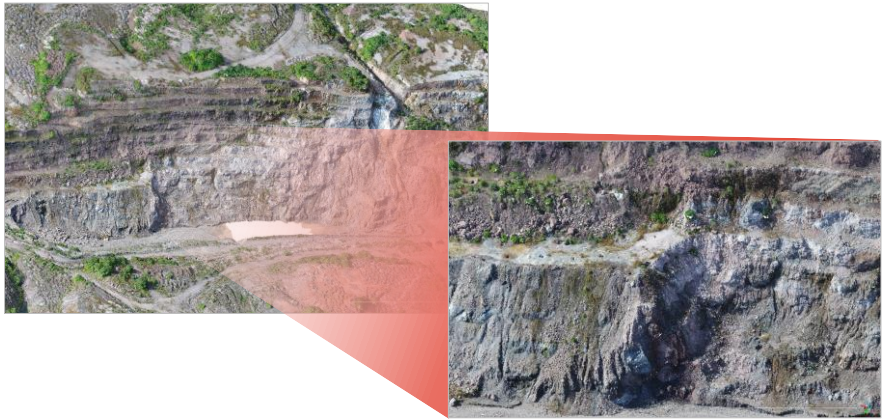
3D drone surveys provide data of unprecedented level of detail enabling creation of true digital twin of the mine for the better planning, prediction and simulation

Traditional solution



- **2 weeks** of surveying
- **Low level** of detail
- Surveyors operating in **unsafe** environment with **difficult access**
- **Selective** representation of the site

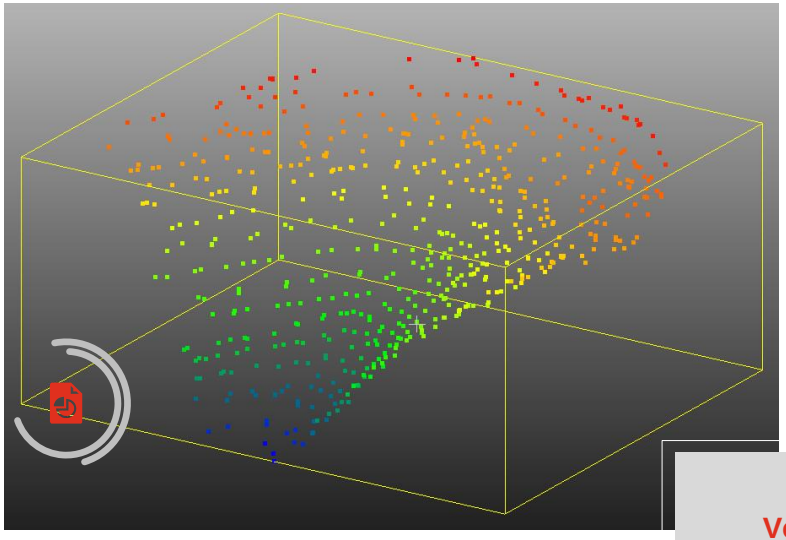
Enhanced Vision solution

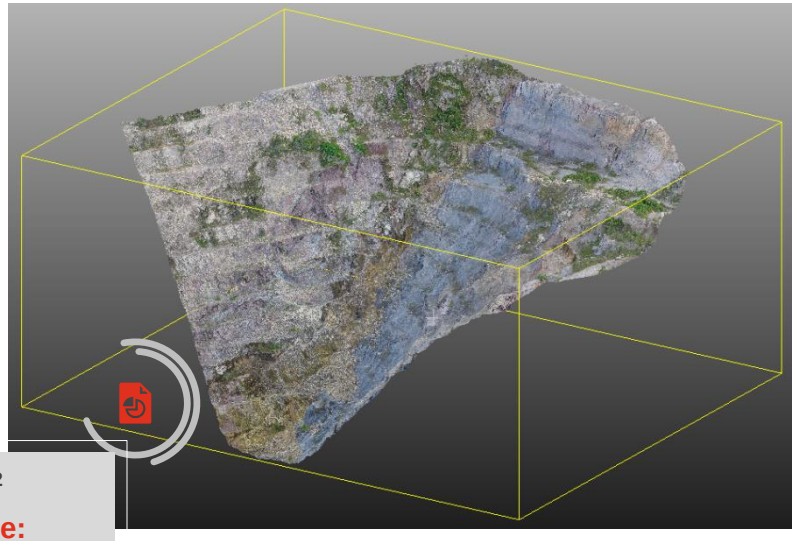


- **2 hours** of flying + **2 days** processing
- **Extremely high** level of detail
- Drones reach **any area** without compromising human safety
- **Complete and detailed** digital twin of the site

Confidential information for the sole benefit and use of PwC's client.

Aerial data enables immense improvement in accuracy of volume measurements in comparison to traditional survey





Area: 21 858 m^2

Volume difference:
72 597 m^3 / 6,14 %

Dump trucks:
484

Traditional survey volume:
1 255 497 m^3

Enhanced Vision survey volume:
1 182 900 m^3

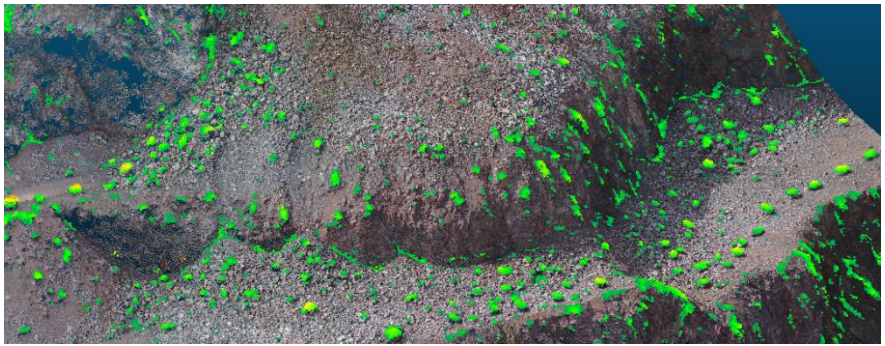
Confidential information for the sole benefit and use of PwC's client.

Aerial real time post blast fragmentation level assessment enables significant improvement of blasting process and decreases risk of injuries

Traditional solution

- **Human eye based inspections**
- Time consuming transportation to blast area (**up to 1 hour**)
- No possibility to optimize blasting process and further mining processes (e.g. load&haul, ore processing)
- Results dependent on worker's experience
- Specialists must reach hazardous post blast areas
- No trusted procedures for assessment

Enhanced Vision solution



- **Live, high resolution images right after the blast**
- **Real time** digital analysis and results on material fragmentation level
- Repeatable and objective results
- Updated results databases allow to optimize further blastings
- Better blasting control improves loading, hauling and ore processing

Confidential information for the sole benefit and use of PwC's client.

Reduced risk of accidents can be achieved by automatic identification of hazardous areas

Traditional solution

- **Human eye based inspections or poor quality data application**
- Assessment dependent on specialist's knowledge and experience or quality and date of data acquisition
- Very little or no automation possible in the process
- Time consuming inspection for the whole site
- Subjective results when based on human eye based inspection

Enhanced Vision solution

- **Automatic calculation of slopes and detection of endangered areas based on up to date data**
- Repeatable and objective results
- Results for the whole site updated automatically
- Highly accurate change detection (up to 5 cm) over time based on 3D drone survey data
- Up to date information about the whole mine can be obtained even every day

Confidential information for the sole benefit and use of PwC's client.

Implementation of Enhanced Vision is performed in following five steps to deliver the tailor-made solution for our Client

Enhanced Vision – Project approach:

1. AS-IS analysis

Activities

- Analysis of current exploration and asset management processes along with use of aerial data and advanced image data analysis
- Analysis of current geospatial data sources, data types and data strategy
- Analysis of current software and hardware used in exploration processes
- Operational workshops for discussion about needs and current approach
- Pilot use cases

2. Design TO-BE model

Activities

- Definition of TO-BE model: changes in organizational structure, expected capabilities, processes, procedures, hardware and software
- Defining implementation scenarios – in-house/outsourced
- Business case calculation

3. Build Solution

Activities

- Analysis of gaps between current state and desired to-be model
- Definition of tasks that needs to be performed to close capabilities gap
- Implementation plan definition

4. Implement

Experience Production

- Project and change management
- Defining standard operating procedures for data acquisition, processing, analysis, management and storage
- Implementation support: knowledge transfer, support in processes description and procedures preparation, support in procurement procedures etc.

5. Operate and Review

Activities

- Automation potential analysis
- AI models implementation
- Continuous improvement

Maturity assessment

Model design

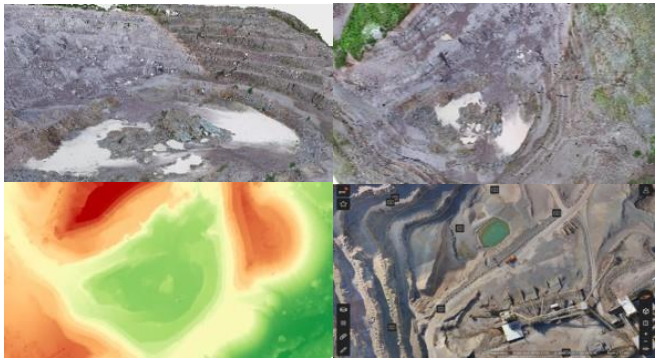
Quick Wins and Full Implementation

Continuous support

Confidential information for the sole benefit and use of PwC's client.

Implementation of Enhanced Vision solutions for mining company in Central Asia

PwC Drone Powered Solutions have applied Enhanced Vision approach in 11 open pit mines for mining company in Central Asia. The project leveraged drones as well as advanced image analytics to optimize operations and manage assets.



The challenge

The client was searching for new ways to supervise the extraction process and improve mining site management. The client had explored several UAV solutions but was not able to efficiently utilize the potential of the technology.

Our solution

Value Delivered
PwC Drone Powered Solutions delivered data, software solution, analytical methods and performed comprehensive knowledge transfer to prepare the client for utilize the data.

Automation
Automatic volumetric measurement of a ore body by implementing data analytics and optimization of manual processes

Impact
Usage of drones, provides data superior from any other way of measurements when it comes to time needed to acquire as well as data precision

Cost saving
The solution will help optimize mine maintenance and running costs

Confidential information for the sole benefit and use of PwC's client.

Implementation of Enhanced Vision solutions for mining company in CEE

Geospatial data gathered with drones was used by mining company in CEE to increase effectiveness of their operations, especially in the area of production supervision and safety. Thanks to Enhanced Vision approach we were able to improve the processess within the company and introduce new applications of geospatial data.

The challenge

The client operating a multi-level melaphyre quarry (trachybasalt) with a processing plant and overburden wanted to increase effectiveness of their operations. The exploration of the melaphyre deposit was carried out with the use of explosive materials.

Cross-sectional analysis of the slope

Landscape park boundaries

3D Model of the mine

Equipment stocktaking

Our solution

Production supervision
The 3D model obtained from drone inspection enabled measurements of the volume of raw materials and monitoring of the production process

Equipment management
Precise image data analyses allowed for haul roads conditions assessment and stocktaking of equipment operating in the mine

Safety assurance
3D modelling of the mine enabled precise monitoring of pit slopes and identification of dangerous areas due to landslides or rocks movements

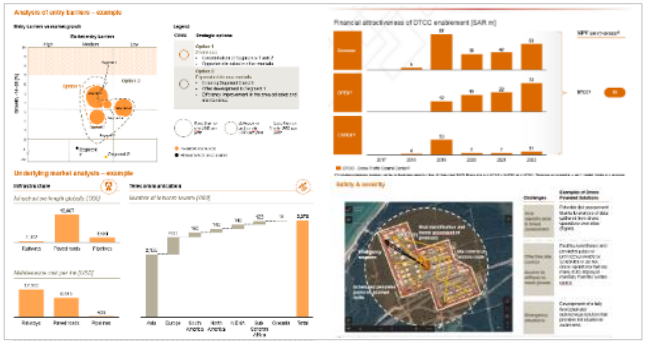
Environmental protection
The environmental analysis enabled controlling of trespassing the nearby national park boundaries

Confidential information for the sole benefit and use of PwC's client.

PwC Drone Powered Solutions is a unique combination of consulting, image data science, machine learning, artificial intelligence and delivery platform

Strategic advisory

Strategic and regulatory consulting, feasibility study for wide scale drone powered solutions implementation



Technology & Operations

Advisory on drone technology integration into operational processes for a specific industry

Delivery software

Data management and delivery platform - PwC Geospatial.App integrates and presents multi-source data

Image data processing and analytics, and machine learning

Image data processing and analytics delivering technical products and analytical reports

Confidential information for the sole benefit and use of PwC's client.

For more information...

Michael Mazur
Partner, Drone Powered Solutions
Tel: +48 502 184 684
michal.mazur@pwc.com

Adam Wiśniewski
Director, Drone Powered Solutions
Tel: +48 501 049 409
adam.wisniewski@pwc.com

Aleksander Buczkowski
Manager, Drone Powered Solutions
Tel: +48 503 781 024
aleksander.buczkowski@pwc.com

© 2018 PwC. All rights reserved. Not for further distribution without the permission of PwC. “PwC” refers to the network of member firms of PricewaterhouseCoopers International Limited (PwCIL), or, as the context requires, individual member firms of the PwC network. Each member firm is a separate legal entity and does not act as agent of PwCIL or any other member firm. PwCIL does not provide any services to clients. PwCIL is not responsible or liable for the acts or omissions of any of its member firms nor can it control the exercise of their professional judgment or bind them in any way. No member firm is responsible or liable for the acts or omissions of any other member firm nor can it control the exercise of another member firm’s professional judgment or bind another member firm or PwCIL in any way.

www.dronepoweredsolutions.com

Follow us @PwCDrone