Document No.:	SA-001A-24
Version:	V5.0
Date of Issue:	30-JUL-2024

MOSS Business Case

MOSS
Miner Operated Survey System

NSS

Executive Summary

This business case presents a comprehensive overview of the Miner Operated Survey System (MOSS) and how it can optimize development operations.

With past clients, MOSS has contributed to:

- ~10% overbreak
- Significantly decreased cycle time
- Safer development cycle
- Real-time understanding of compliance to design
- Month-End time optimization

Company Overview

- Founded in **1989**
- Selling **MOSS** since **2017**
- MOSS has an install base of more than **100** units globally

Our Clients

GLENCORE · RioTinto · AGNICO EAGLE · BARRICK · Newmont · KOMATSU
VALE · FRESNILLO · JAGUAR MINING INC. · IMPALA CANADA · NORTHERN STAR RESOURCES LIMITED · PAN AMERICAN SILVER
AngloAmerican · NORNICKEL
newgold · FIRST MAJESTIC · SHANTA GOLD · FORAN · ILION ONE METALS · Gowest

Our Services

Underground Software

- Miner Operated Survey System **(MOSS)**
- MOSS Augmented Reality **(MOSS AR)**

Leica Geosystems Reseller

- Total Stations & Multi-Stations
- GNSS Systems
- 3D Laser Scanners
- Survey Supplies
- Disto & Lino
- Detection Systems
- Construction Lasers
- Levels

Exyn Technologies Reseller

- ExynAero
- ExynPak

Services

- Lidar Scanning Services
- Surveying Services

Comparative Analysis

MOSS

Surveyors (1) Workflow

1. Advance permanent control (Every few rounds for QA)

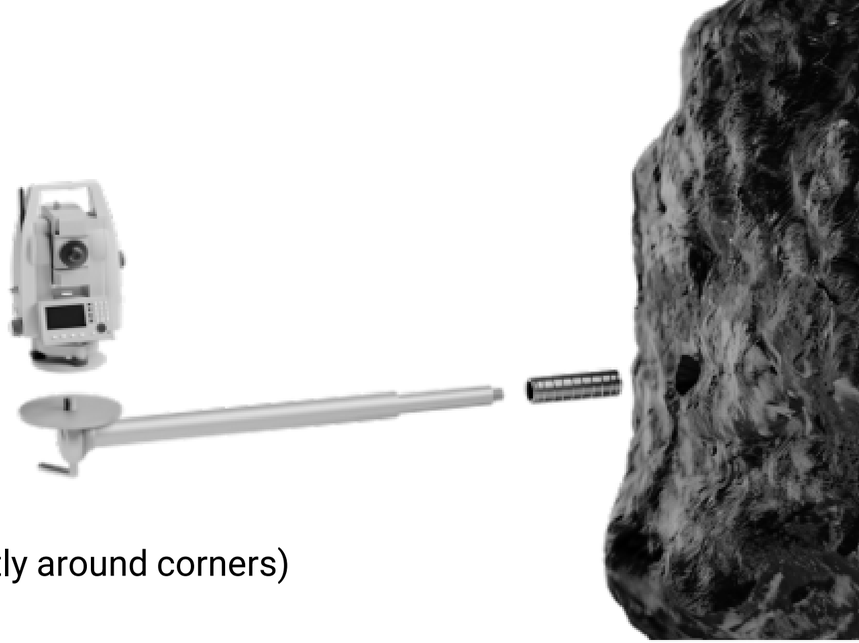
Miners Workflow

1. Set up total station and resect. (5min)
2. Execute face profile, centerline, crankline, grade line and face markup (5-10min)

Data Collected with Each Markup

To reap similar benefits to MOSS, the following workflow must be executed with traditional survey methods.

Monopod & Wallmount System (Widely Used)



Surveyors (2) Workflow

1. Surveyors prepare area for miners (20-25min, repeated approx. every 15 metres or more frequently around corners)
    - Install Wall-Bar station
    - Install Backsight station

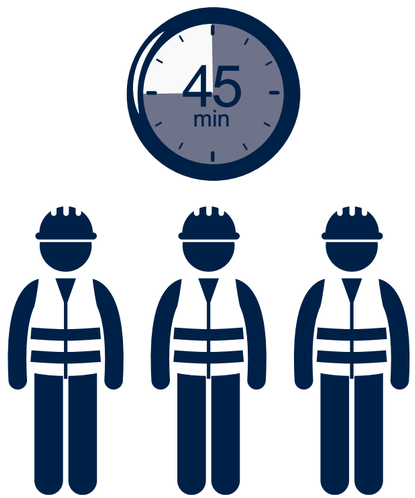
2. Surveyors perform outline pickup (15min, repeated approx. every round and monthly for month end purposes)

Miners Workflow

- Set-up total station on wallbar station (5 min)
- Backsight the “backsight” spad (5min)
- Set to zero and turn the angle provided by surveyors
- Shoot line and grade (5 min)
    - While developing around a corner, extra time required to measure left/right offsets with a scale (5 min)

Survey Cycle Comparison

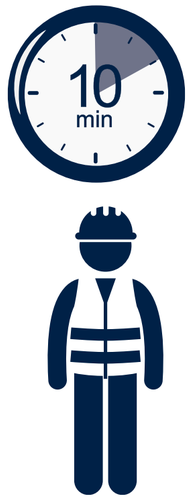
Wall-Bar Survey Cycle



~45 min/round

VS

MOSS Survey Cycle



10 min/round

Survey Cycle

With MOSS:

Surveyors can be leveraged for more critical tasks and allocated to different areas throughout the mine

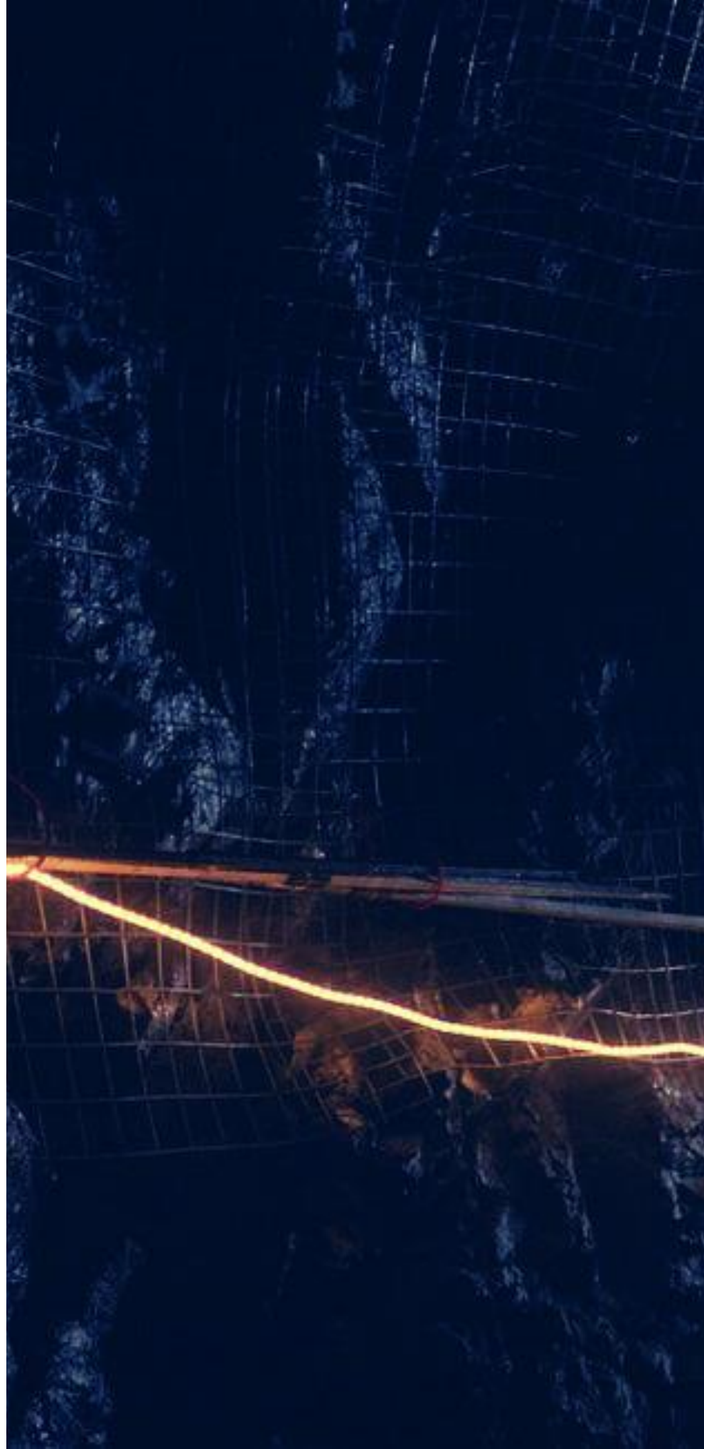
- Surveyors no longer need to advance survey services for miners
- Surveyors advance permanent control behind miners for QA

Miners become independent from surveyors

- MOSS allows miners to advance temporary control
- Development can continue without relying on surveyors
- Eliminate Survey interruption (shut down equipment)

Miners and design team have a live view of actual vs design layout

- Miners no longer need to measure angles on prints
- Surveyors no longer need to provide backsight angle to miners
- Surveyors execute month-end without needing to return to active headings



Operational Impact of MOSS - Parameters

“Standard” Operating Mine

Parameters	Total	Units
Height	5.5	m
Width	5	m
Break (Length of round)	4	m
Current Mine Overbreak	20%	
MOSS Overbreak	10%	
Delevopment Metres / Year	2500	m
Current Development Cycle Time	24	hrs

“Standard” Developing Mine

Parameters	Total	Units
Height	5.5	m
Width	5	m
Break (Length of round)	4	m
Current Mine Overbreak	20%	
MOSS Overbreak	10%	
Delevopment Metres / Year	6000	m
Current Development Cycle Time	24	hrs

To adjust parameters for specific mine sites, please reach out to info@nsscanada.com

Operational Impact of MOSS - Assumptions

Bolting & Screening Materials

- Normet D Bolt (2.4m, 22mm) - Back and Walls – **80** bolts
  - Screen Mesh Plate 12” x 12”
  - **2** Fast, **2** Slow Resin Cartridges

- Split Set (FS46) - Face - **10**
  - Split Set Plate **- 48mm**

- Screen 6' x 11' **-** #6 gauge - **12** Back and Walls, **4** Face

Note: Bolting to grade line (1.5m)

Operational Impact of MOSS - Assumptions

Mucking Cycle

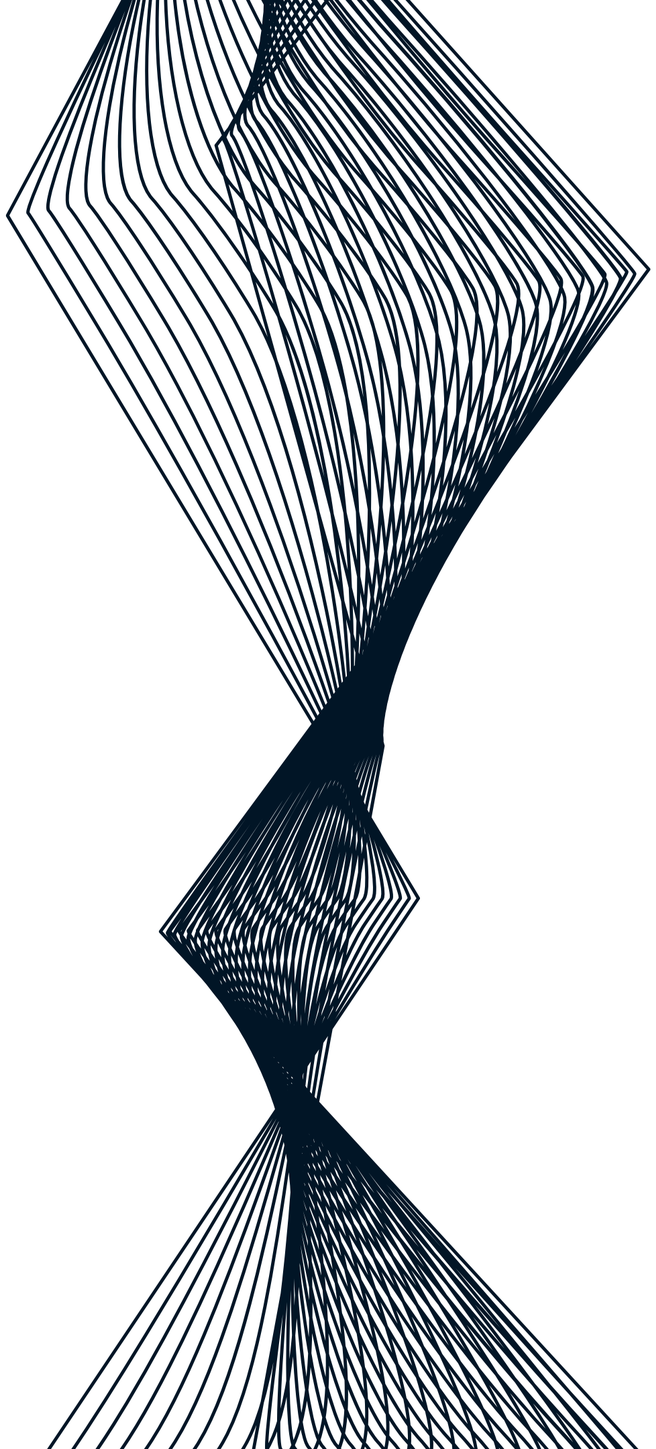
- Type of LHD (14T LHD, 8 Yard bucket)
- Average 1 way mucking distance (150m)

Bolting Cycle

- Type of bolter (Boom Bolter)
- 7 bolts per hour

Maintenance

- $650k in LHD parts annually (~$200/engine hr)
- $240k in bolter parts annually (~$180/engine hr)



Operational Impact of MOSS – Forecast Savings

Total Savings

Operating Mine

Total Savings ($)	
Total MOSS Savings / Metre	$ 227
Total MOSS Savings / Round	$ 909
Total MOSS Annual Savings	$ 536,000

Developing Mine

Total Savings ($)	
Total MOSS Savings / Metre	$ 227
Total MOSS Savings / Round	$ 909
Total MOSS Annual Savings	$ 1,331,000

Break Even

Operating Mine

Break Even	
Days to Break Even	210
Metres to Break Even	1354
Rounds to Break Even	339

Developing Mine

Break Even	
Days to Break Even	84
Metres to Break Even	1354
Rounds to Break Even	339

- ***Break Even calculations based on <u>3 units</u> of MOSS (average amount of units purchased)***
- ***Please Note: <u>ONLY</u> materials and maintenance savings are considered for Break Even calculations***

Operational Impact of MOSS - Initial Investment

Implementation Cost

Cost Varies

(Dependent on Site Location & Duration of Implementation)

- Field Technician Services (Daily)
- Training
- On-Site Demo

MOSS Fixed Cost Per Site

(Design Software)

$40K

+$8.8K Annually

- 2x Ramp Layout modules (design) - $20,000 each
- 2x CCP's* - $4,400 each

** = Recurring annual fee*

MOSS Cost Per Unit

(Hardware + Operations Software)

$89K

+$7,920 Annually

- Panasonic Tablet & Case - $7,645
- Leica Robotic Total Station (TS16 P Series) - $45,600
- Ops License - $36,000
- Ops CCP* - $7,920

** = Recurring annual fee*

**Prices vary based on site location, travel, training time/days as well as # of units purchased. NSS suggests 1 unit per Jumbo Drill.*

Operational Impact of MOSS - Time

Cycle Time Savings

Operating Mine

Cycle Time Savings		
Mucking		
Mucking Cycle Time Savings per round	16	min/round
Mucking Cycle Time Savings per metre	4	min/metre
Annual Mucking Cycle Time Savings	167	hrs
Annual Mucking Cycle Time Savings	7	days
Ground Support		
Ground Support Cycle Time Savings per round	70	min/round
Ground Support Cycle Time Savings per metre	17	min/metre
Annual Ground Support Cycle Time Savings	728	hrs
Annual Ground Support Cycle Time Savings	30	days
Survey		
Survey Cycle Time savings per round	32	min/round
Survey Cycle Time savings per metre	8	min/metre
Annual Survey Cycle Time savings	330	hrs
Annual Survey Cycle Time savings	14	days
Total		
Total Cycle Time Savings / round	2	hrs/round
Total Cycle time Savings / metre	29	min/metre
Total Annual Cycle Time Savings	1225	hrs
Total Annual Cycle Time Savings	51	days

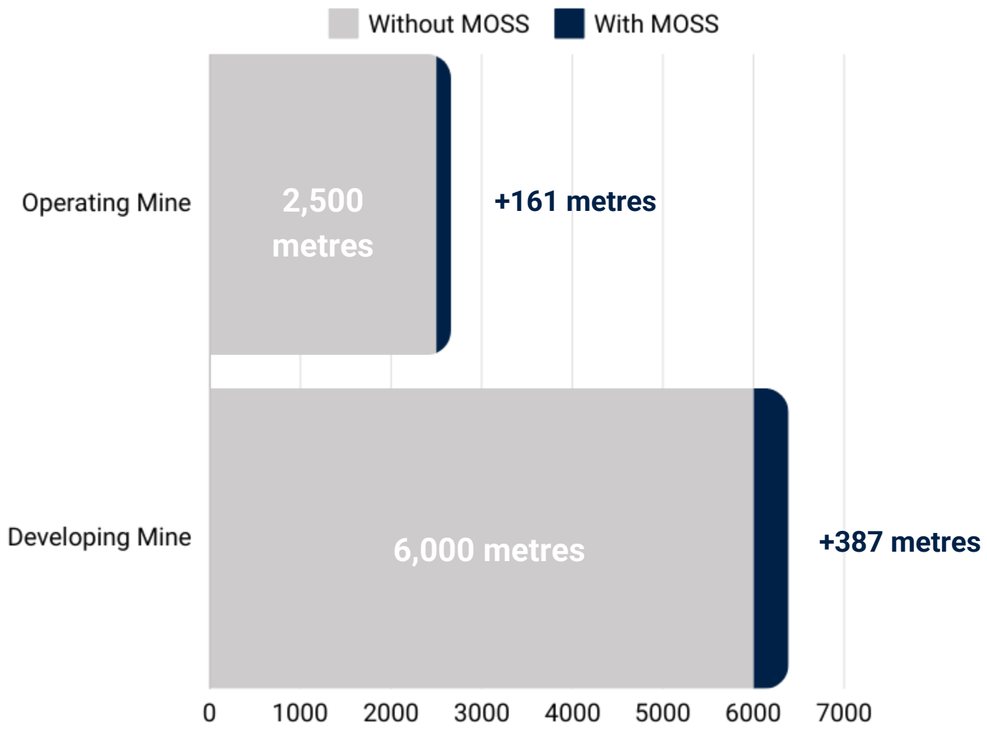
Developing Mine

Cycle Time Savings		
Mucking		
Mucking Cycle Time Savings per round	16	min/round
Mucking Cycle Time Savings per metre	4	min/metre
Annual Mucking Cycle Time Savings	401	hrs
Annual Mucking Cycle Time Savings	17	days
Ground Support		
Ground Support Cycle Time Savings per round	70	min/round
Ground Support Cycle Time Savings per metre	17	min/metre
Annual Ground Support Cycle Time Savings	1748	hrs
Annual Ground Support Cycle Time Savings	73	days
Survey		
Survey Cycle Time savings per round	32	min/round
Survey Cycle Time savings per metre	8	min/metre
Annual Survey Cycle Time savings	792	hrs
Annual Survey Cycle Time savings	33	days
Total		
Total Cycle Time Savings / round	2	hrs/round
Total Cycle time Savings / metre	29	min/metre
Total Annual Cycle Time Savings	2941	hrs
Total Annual Cycle Time Savings	123	days

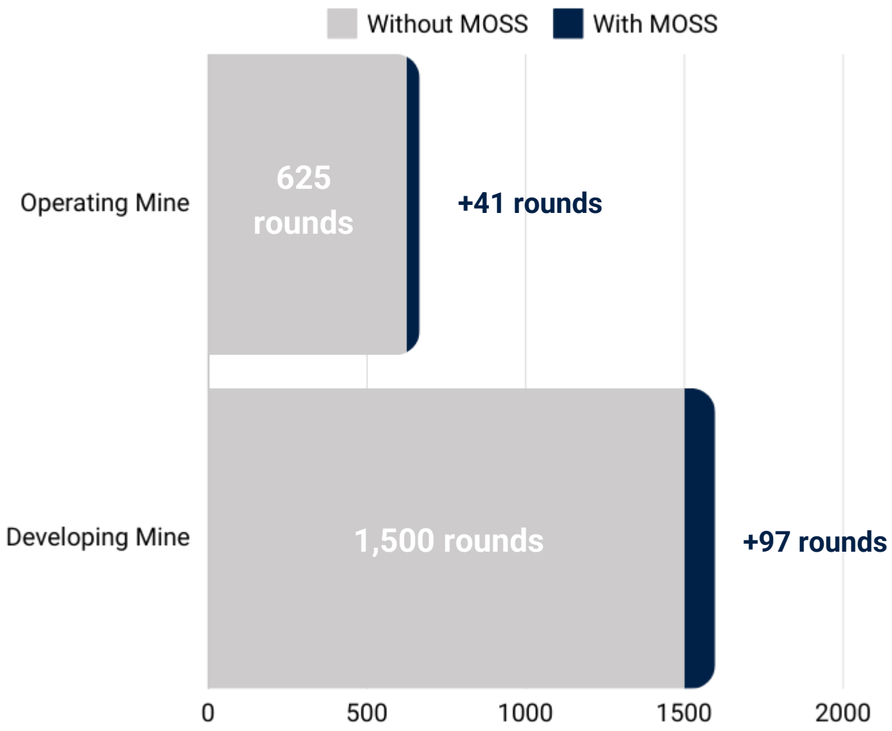
Operational Impact of MOSS – Development Rate

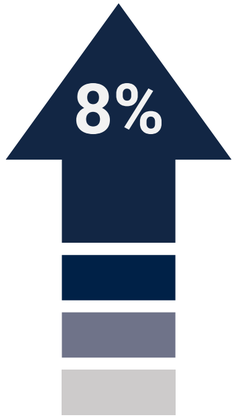
Development Rate Increase

Annual Metres



Annual Rounds





Increase in Development

The most important thing to come out of the mine is… The Miner

Safety

- Since 2000, **10 workers** have died in underground mines in Ontario as a result of falls of ground or rockbursts.
- **5** of these fatalities occurred in active development headings

Time reduction in active development heading with MOSS

Time Reduction in Active Development Headings	
Mucking	8%
Bolting	8%
Surveying	76%

Entire Development Cycle	8%

Safety - Deviation From Design

Deviation From Design

- Secondary Stoping
  - Developing too close to potentially undetonated powder from primary stoping
- Undersized Pillars (Collapse)

Geological Structures

- Developing near faults
- Exposing wedges
- Water bearing structures

Conclusion

MOSS Reduces:

- Overbreak
- Cycle Time

MOSS Eliminates:

- Number of workers in active development headings
- Development cycle interruption
- Survey Dependency
- Month-End rework
- Deviation from design

Opportunity Savings

In ground support materials and maintenance parts alone, MOSS saves the standard operating mine **$536,000** and the standard developing mine **$1,331,000** annually.

MOSS reduces development cycle time by **2.0** hours per round.

MOSS reduces risk of injury or fatality in active development headings by **8%**

Unaccounted Opportunities

- **Schedule Opportunities**
  - Critical path savings
  - Ability to work in other areas
- **Ventilation Reduction**
  - Minimum velocity reduction
  - Reduced primary haulage time
- **Geology**
  - Channel sampling
- **Secondary Haulage**
  - Truck haulage
  - Waste flow system
  - Skipping

The Future of Mining – What's Next?

MOSS AR

- Wearable technology allowing a virtual real-time overlay
- Fully 3D information display via Microsoft HoloLens II
- Reduces markup time down to 5 minutes

Partnered with Komatsu

- Creating value together
- Integrating MOSS into Komatsu’s drill rig control systems
  - Removing all physical interaction with development face

Save Money, Save Time, Save Lives.

Thank You

MOSS
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NSS

The Future of Mining

705-222-3246

info@nsscanada.com

nsscanada.com