



Presented at the FIG Working Week 2023,
28 May - 1 June 2023 in Orlando, Florida, USA

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IMPROVING VOLUME RECONCILIATION USING DRONE TECHNOLOGY IN THE OPEN PIT MINING INDUSTRY- A CASE STUDY

Authors: Ebenezer Owusu Dapaah
Stephen Djaba



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Presentation Outline

- Introduction
- Objectives
- Methodology
- Discussion of Results
- Conclusion
- Recommendation

Introduction

- Material extraction in surface mining is usually done in phases characterized by several pushbacks
- The idea is to reduce the risk of the operations by targeting the orebody to bring cash forward
- The initial cuts leave behind deep holes and high interfaces that serve as receptacles for loose material (reel material) from the subsequent pushbacks

Introduction

- The reel-down volume will be accounted for at the upper benches as mined, but in reality not hauled, so anytime they are mined at the lower benches after the pushback gets there, they should be accounted for and treated differently agreement in the contract being used for mining
- These materials are either mined for free or at a discounted rate depending on the terms of the agreement in the contract being used for mining.
- Whether it is mined for free or paid, it is still accounted for to enable truck factors to be rationalized if the ratio of reel down and in-situ materials is quite significant.

Introduction

- Sometimes, for rate determination and payment purposes, there is the need to split the volumes if more than one contractor generated it, as was the case of this article
- Classical terrestrial surveying methodologies have been used previously but they have their own challenges and limitations hence the need for this stud
- The deployment of a vertical take-off and landing drone (VTOL) produced a reasonable reliable later that is discussed in this article

Objectives

The objectives are as follows:

- Estimate the volume of reel-down material introduced into the bottom of the pit by the contractor month-by-month basis
- Estimate the total monthly reel-down material mined
- Reconcile the reel-added and reel-mined figures

Methodology - ASBUILT

- True representation of the pit surface including backfills, sheeting material, internal dumps, rock buttresses for geotechnical purposes and reel-down materials
- This is the real data acquired after every drone survey but truly it does not give a true representation of how the pit was mined
- Such surface cannot be used for model depletions and it will be erroneous to use it for volume estimations as it could result in double accounting hence the need for an asmined surface.

Methodology - ASMINED

- Contrary to asbuilt, an asmined surface describes the pit as it has been mined out without any backfilled and or reel material captured
- This is usually generated through editing after the initial surveys and it can be very complex and cumbersome if it involves drone data
- It is the surface used for model depletions and Life of Mine (LOM) estimates

Methodology - ASMINED

- The reel materials are introduced into the asmined surface; it serves as a reference that enables the reel material to be properly quantified

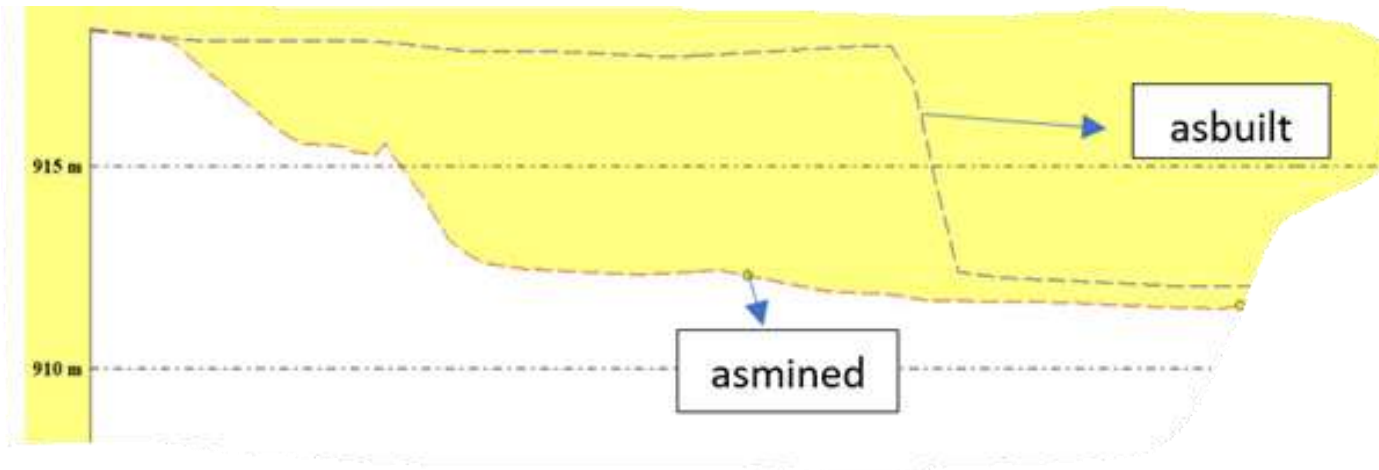


Fig 1 Cross section of a pit Asbuilt and Asmined for the same period

Methodology – FILL AND REEL

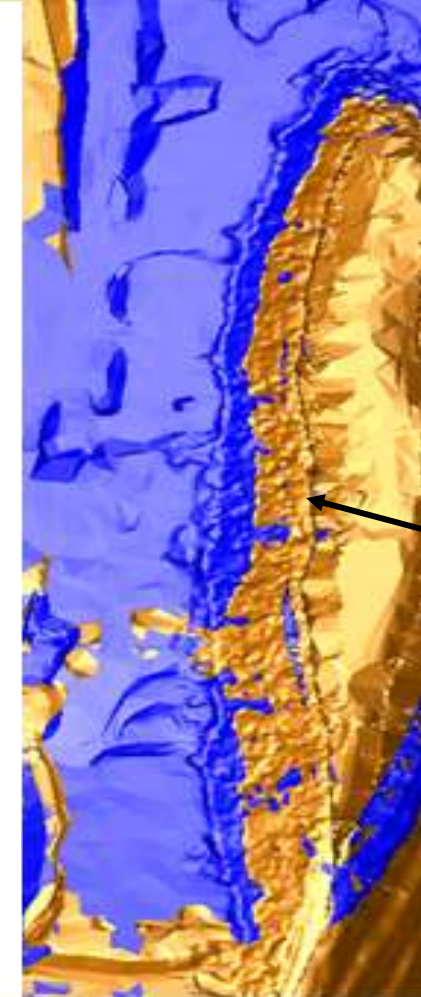
- A fill material is a planned dumping of loose material usually intended for the waste dumps with the permission of the client
- Reel materials are those that are spilled down the pit bottom from operational activities such as blasting and loading
- Generally, fill materials are paid for when rehandled either through volumes or predetermined rates agreed between the client and the business partner

Methodology – Monthly Reel Estimates

- Reel mined within a month is estimated by comparing the previous and current month's asbuilt surfaces generated with the contours from the drone surveys
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Methodology – Monthly Reel Estimates

- Fig 2 shows the DTM of the asbuilt surface (purple) for the previous month and the brown colour is the DTM for the current month under consideration.
- At the end of the month, after mining the upper elevations, the reel-down material increased hence the brown colour overshadowing the blue colour in the direction of the arrow
- A total of 515,494.51 BCM reel material was estimated to have been added into the pit which was eventually mined out.



Brown coloured reel material of current month overshadowing the purple coloured previous month surface

Methodology – Monthly Reel Estimates

- Since Reel material in the pit was caused by more than one contractor, there was the need to split them so three different surfaces were involved.
- These are the asbuilt, asmined and a certain contract close asmined (an asmined that has the closing reel material of a previous contractor at the contract end).
- On a periodic basis, boundaries are generated within the zone containing loose material and surface-to-surface volumes calculated between the two asbuilt surfaces (previous and current month).

Methodology – Monthly Reel Estimates

- However, because of the previous benches, there is almost always a little in-situ volume in the asbuilt volumes which is resolved by deducting the asmined volumes computed with the same boundary as in the asbuilt from the total volume obtained

Methodology – Monthly Reel Estimates

Table 1 Monthly bench-by-bench reel mined for the month of October 2021

FROM ASBUILT			FROM ASMINED	FILL + REEL	FROM FILL ASBUILT	FILL MINED - INSITU		Reel Mined	BCM	
From	To	Cut Vol	In situ Cut Vol	Loose Mined	Contract Close Mined	Contract Close Fill Mined	BCM			
702	705	34485.133	22787.949	11697.184	32398.769		9610.82		2086.364	
705	708	80124.439	38975.186	41149.253	63489.664		24514.478		18634.775	
708	711	40559.056	16718.198	23840.658	31612.322		14893.924		8946.794	
711	714	18575.153	6178.427	10396.726	13304.965		7126.538		3270.188	
714	717	5290.45	0	5290.45	3173.643		3173.643		1916.807	
717	720	2933.612	0	2933.612	1912.478		1912.478		1021.134	
720	723	1808.256	0	1808.256	930.648		930.648		877.608	
723	726	994.528	0	994.528	606.876		606.876		387.652	
726	729	606.711	0	606.711	425.022		425.022		181.689	
							63394.427	46,958.83	35322.951	26,365.85

- On a monthly basis, this estimation has been generated for the pit till the total reel is completely exhausted. After collating the month-on-month reel material mined during the project, the total was 535,906.04 BCM

Methodology – Monthly Reel Estimates

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- Results obtained by the reel mined was about 4% higher than the total estimated reel materials added

Methodology – Monthly Reel Estimates

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- Reconciliation of volumes within +/-5% is acceptable within the industry and especially where the variance is expected since the surface used for the reel addition had rocks of different compaction from the surfaces used for the reel mined.

Conclusion

- In mining, no single volume should be overlooked since every cubic of material moved has a cost implication.
- In this project, not all the volumes discussed here are put up for payment but to ensure the mining physicals are rationalised to prevent any controversies

Recommendation

- Tracking the volume of reel materials added into the pit should ideally be daily because at the lower levels when reel materials are introduced, they could be mined within days or weeks before the monthly tracking is done
- This has the potential to affect the total volume of materials estimated as been mined and this could be the reason why there was a negligible variance between the two results



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