Implicit ore delineation

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INTRODUCTION

Mineral resource estimation requires *accurate* geometric models of irregular 3D orebody boundaries that are created using and *efficient and flexible* modeling techniques.

The objective of this study was to compare the efficiency, flexibility and accuracy of an alternative, *"implicit"* geometric modeling approach (employed by Leapfrog™ software) to those of traditional *"explicit"* contour methods used by industry-standard general mining software packages (GMPs) such as MineSight®.

Implicit modeling is based on a fast method of global interpolation using Radial Basis Functions.

METHOD

Geometric Modeling

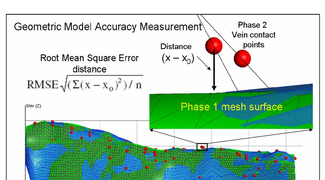
Preliminary (phase 1) and follow-up (phase 2) surface drilling information outlining the Doris Hinge vein gold deposit was provided by the Miramar Mining Corporation. A total of 80 different geometric models of the Doris Hinge vein were created using only the phase 1 drill hole hanging wall and footwall vein contact points.

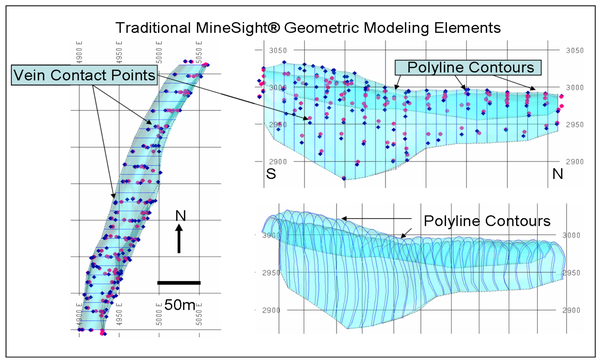
One model was created using the traditional, contour modeling method using MineSight® software. A total of 79 implicit models were created using Leapfrog™ software. Implicit models fall into two categories: semi-automatic and interpretation. Semi-automatic models are generated using only drill hole contact points. Interpretation models incorporate subjective geological interpretation in the form of digitized polylines.

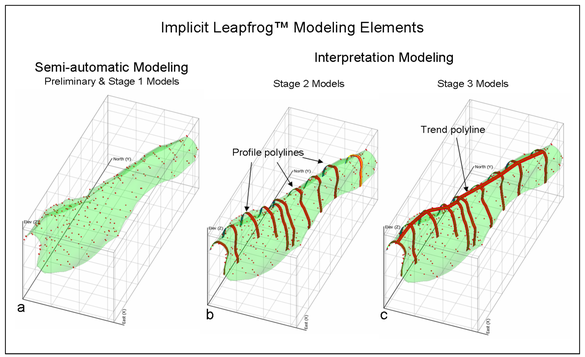
Model Evaluation

Modeling efficiency was measured my recording the time required to perform each step of the geometric modelling process.

Model accuracy was determined by measuring the perpendicular distance between the nearest triangle (vertex, edge or face) on the geometric wireframe model surface and the follow-up, phase 2 hanging wall and footwall vein contact points.







RESULTS

Efficiency

The explicit reference model required nearly eight hours to construct. In contrast, the seventy-nine implicit models created in the study, on average, required only 13 minutes each to create. In the time it takes to create one single model using the traditional method, between 30 and 40 implicit models could be produced.

Traditional (MineSight®) Modeling Efficiency

	Time (hours)
Importing data / project set-up	**0:30**
TIN (10) creation/revision	1:00
Contour (32) digitizing	2:10
Contour Refinement	4:15
Contour linking / model validation	0:30
Total modeling time (single model)	**7:55**

Implicit (Leapfrog™) Modeling Efficiency

	Time (hours)		
	Isometric Models	Semi-automatic Models (Preliminary, S1)	Interpretation Models (S2, S3)
Importing data / project set-up	0:30	0:30	0:30
Polyline digitizing			0:20
Total preparation time	**0:30**	**0:30**	**0:50**
Model set-up	0:04	0:06	0:08
Model run	0:03	0:03	0:05
Total modeling time (per model)	**0:07**	**0:09**	**0:13**

Flexibility

The traditional model was inflexible in that one subjective interpretation was built into a single deterministic model. Hours of work is required to regenerate the model using a different interpretation. Multiple implicit models reflecting different geological interpretations that are conditional to the same data were generated in minutes.

Accuracy

The implicit method generated a wide range of geometric models with accuracies that were comparable to that of the MineSight® model.

The measured RMSE distance accuracy of the traditional MineSight model was 2.06m.

Implicit (Leapfrog™) Modelling Accuracy

	Root Mean Square Error (RMSE) distance (meters)			
	Isometric	Maximum (least accurate)	Mean	Minimum (most accurate)
Preliminary Modeling Semi-automatic models (27 models)		3.06	2.58	2.29
Stage 1 Modeling Semi-automatic models (16 models + 1 isometric model)	3.48	3.12	2.36	2.15
Stage 2 Modeling Interpretation models (16 models + 1 isometric model)	2.27	2.40	2.15	2.05
Stage 3 Modeling Trend / Interpretation models (18 models)		2.15	2.09	2.03

CONCLUSIONS

The implicit method of geometric modeling is as *accurate* as the traditional modeling method.

The implicit method is *efficient*, which allows for the creation and continuous update of multiple geometric models in a fraction of the time required to construct a single model using traditional techniques.

Implicit modelling is much more *flexible* since it allows incorporation of multiple geologic interpretations that are conditional to the same data.

The new *"conditional geometric modeling"* workflow used in this study provides a series of accurate models that represent a range of geologically-realistic orebody boundaries that can be used in mine planning or for quantifying the uncertainty of resource estimations.

Implicit resource and reserve models can be updated with new drilling information on a daily, rather than a semi-annual or annual basis. Maintenance of *"evergreen"* geometric models provide for regular mine production/reserve reconciliations that increase the efficiency of mining operations.