Mine Planning and Design Series 2026 Online

Customized Corporate Training Available Onsite or Online

- **MINP 401 – Surpac – Resource Modeling, April 27-May 1, 2026 – 5 days**
- **MINP 101 - Whittle Core & Advanced, April 13-17, 2026 – 5 days**
- **MINP 102 - Whittle + Isight – Advanced, April 20-22, 2026 – 3 days**
- **MINP 201- Surpac –Open Pit Mine & Dump Design, May 25-29 – 5 days**
- **MINP 301- MineSched Core + Advanced, June 8-12, 2026 – 5 days**
- **MINP 302- MineSched + Isight Advanced, June 16-18, 2026 – 3 days**

Thanks to Sebastián Balart for the photo of Son en Minera Los Pelambres

MINE PLANNING AND DESIGN - PROFESSIONAL SERIES
GEOVIA Whittle™, Surpac™, MineSched™, and SIMULIA Isight™

MINE PLANNING AND DESIGN SERIES

Location

- **Online and Face-to-Face Courses**

Dates

- **2026 Schedule – See the tables**

Registration Options

Participants can register in a single course, combination of courses, or all the courses in the series based on their interests. Please take note of the registration closing dates. We need to secure classroom and the software assure professional delivery of the courses. All courses are available as online or on-site delivery as per request.

Instructor

Hooman Askari is a professor of mining engineering in the School of Mining and Petroleum Engineering at the University of Alberta, Canada. He teaches and conducts research into mine planning & design and simulation of mining systems. Hooman is a registered professional mining engineer with more than 25 years of operational, consulting, research, and teaching experience in the area of open pit mine planning and design. He consults as the Principal Engineer through OptiTek Mining Consulting Ltd.

OptiTek Mining Consulting Ltd. is an educational partner of Dassault Systèmes.

Registration

For the registration forms. Please contact: registration@optitek.ca

For more information, contact Hooman Askari at: hooman@optitek.ca

Phone: +1 (780) 893-9365

<table>
<tr><th colspan="8">Mine Planning and Design Series – Online - Spanish Interpretation- Mountain Time 8:30AM-5:00PM – Suitable for Africa PM</th></tr>
<tr><th>Course Name</th><th>Course Component</th><th>Dates</th><th>Registration Closing Date</th><th>PD Hours</th><th>Single Course Fee</th><th>Combined Course</th><th>Five Weeks Series Fee</th></tr>
<tr><td>Drillholes to Block Model</td><td>MINP 401-Surpac - Resource Modeling - 5 days</td><td>April 27-May 1, 2026</td><td>April 13</td><td>40</td><td>CA$4,500</td><td>-</td><td>-</td></tr>
<tr><td rowspan="2">Robust Strategic Mine Planning and Optimization</td><td>MINP 101-Whittle Core and Adv. - 5 days</td><td>April 13-17, 2026</td><td>April 1st</td><td>40</td><td>CA$4,500</td><td rowspan="2">CA$6,500</td><td rowspan="5">CA$13,500</td></tr>
<tr><td>MINP 102-Whittle + Isight - Advanced - 3 days</td><td>April 20-22, 2026</td><td>April 1st</td><td>24</td><td>CA$3,000</td></tr>
<tr><td>Open Pit Mine and Waste Dump Design</td><td>MINP 201-Surpac - Open Pit Design - 5 days</td><td>May 25-29, 2026</td><td>May 11</td><td>40</td><td>CA$4,500</td><td>-</td></tr>
<tr><td rowspan="2">Surface Mine Production Scheduling - Tactical Planning</td><td>MINP 301-MineSched Core and Adv - 5 days</td><td>June 8-12, 2026</td><td>May 25</td><td>40</td><td>CA$4,500</td><td rowspan="2">CA$6,500</td></tr>
<tr><td>MINP 302-Advanced MineSched + Isight - 3 days</td><td>June 16-18, 2026</td><td>May 25</td><td>24</td><td>CA$3,000</td></tr>
<tr><td>Simulation of Mining Haulage</td><td>MINP 501-Simulation Modeling using Arena - 5 days</td><td>Nov. 23-27, 2026</td><td>Nov 10</td><td>40</td><td>CA$4,000</td><td>-</td><td>-</td></tr>
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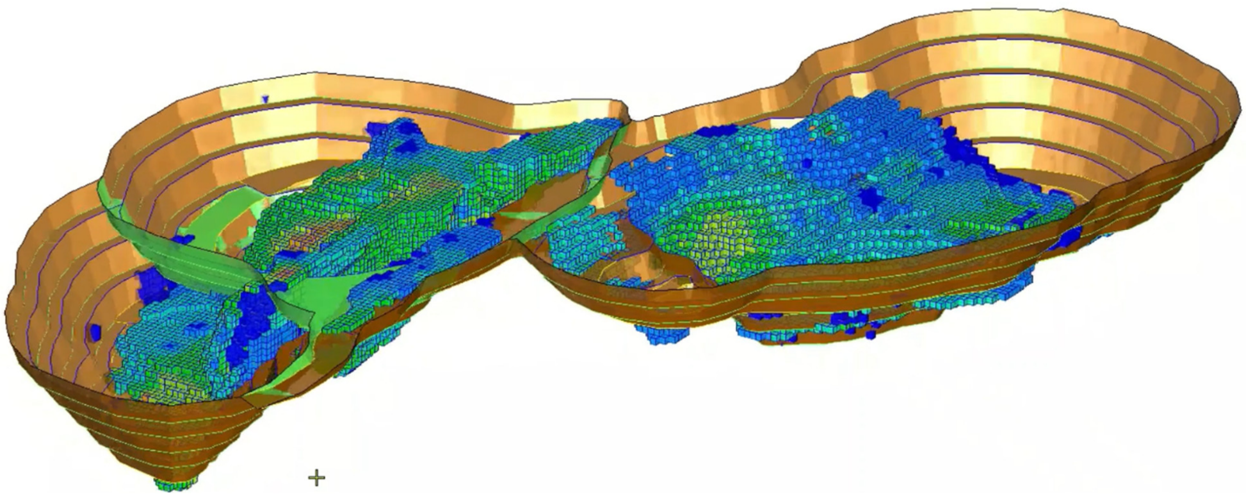
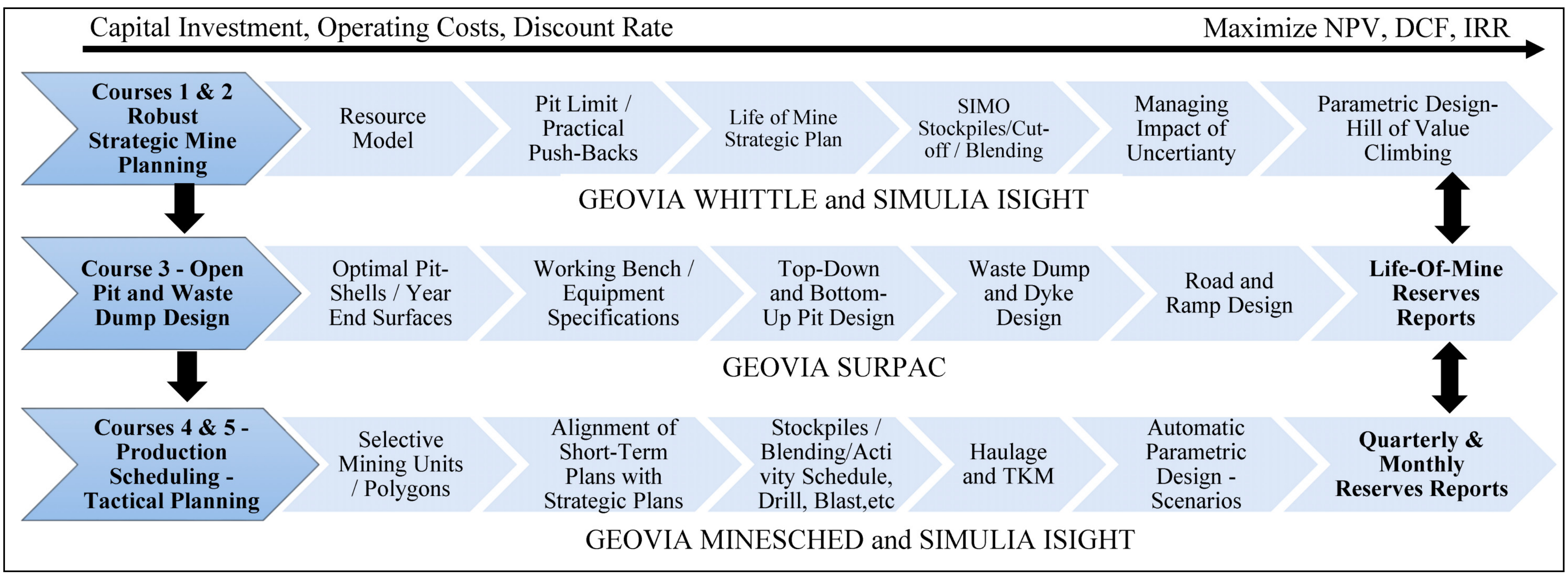
MINE PLANNING AND DESIGN - PROFESSIONAL SERIES
GEOVIA Whittle™, Surpac™, MineSched™, and SIMULIA Isight™





MINP 101-Whittle Core & Advanced – 5 Days
Strategic Mine Planning and Optimization

Hooman Askari, PhD, PEng.
OptiTek Mining Consulting Ltd.
Edmonton, Alberta, Canada - hooman@optitek.ca

	Time		Lecture/Lab Topic
Day 1	08:00- 10:00	Lec01	Introduction to Strategic Mine Planning & Optimization
	10:15-12:00	Lec02	Pit Limits I – Manual, Floating Cone, 2D Lerchs & Grossman
		Lec03	Pit Limits II – 3D Lerchs & Grossman
	13:00-14:45	Lec04	Block Value Calculations
		Lec05	What Costs to Include in Pit Optimization?
	15:00-17:00	Lab01	Open Pit Limit Optimization – Iron Ore
Day 2	08:30- 10:00	Lec06	Production Scheduling Concepts
		Lab02	Production Scheduling
	10:15-12:00	Lab02	Pit by Pit Graph and Compressed Revenue Factors
	13:00-14:45	Lab02	Production Scheduling - Minimum Mining Width – Iron Ore
	15:00-17:00	Lab03	Production Scheduling – Practical Push-Back NPV – Iron Ore
Day 3	08:30- 10:00	Lab04a	Production Scheduling - Mining Direction Control – Iron Ore
	10:15-12:00	Lab04b	Mining Direction Control – Auto – Iron Ore
	13:00-14:45	Lab04c	Mining Direction – Pre-Stripping – Iron Ore
	15:00-17:00	Exer02	Mining Direction – Pre-Stripping with Buffer Stockpiles
Day 4	08:30- 10:00a	Lab05	Buffer Stockpiles – Iron Ore
	10:15-12:00	Lab05b	Grade Ranges Binning for Buffer Stockpiles – Iron Ore
	13:00-14:45	Lab06a	Extractive Blending – Min Head-Grade Control
		Lab06b	Extractive Blending –Contaminant Head-Grade Control
	15:00-17:00	Lab06c	Extractive Blending – Blend Bins and Stockpile Grade Ranges
Day 5	08:30- 10:00	Lec09	Cutoff Optimization – Lane's Theory
	10:15-12:00	Lab07a	Cutoff Optimization – Improving NPV – Ac/Cu
	13:00-14:45	Lab07b	Simultaneous Optimization (SIMO)
		Exer03	Simultaneous Optimization (SIMO) – Au/Cu
	15:00-17:00	Exer04	Practical Considerations Au/Cu

MINP 101– Strategic Mine Planning and Optimization
GEOVIA Whittle™ Core

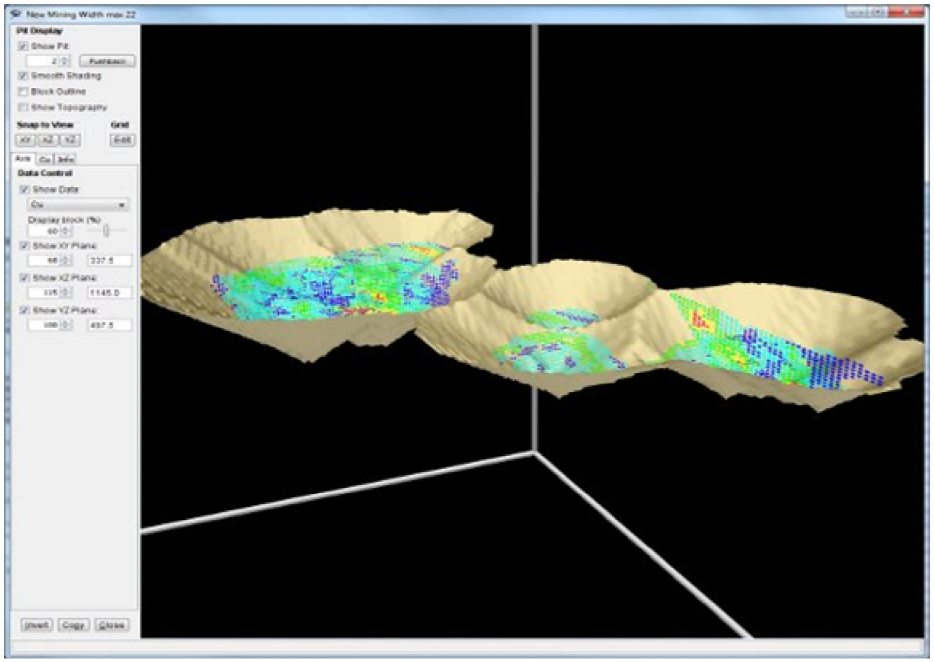
Capital Investment, Operating Costs, Discount Rate → Maximize NPV, DCF, IRR

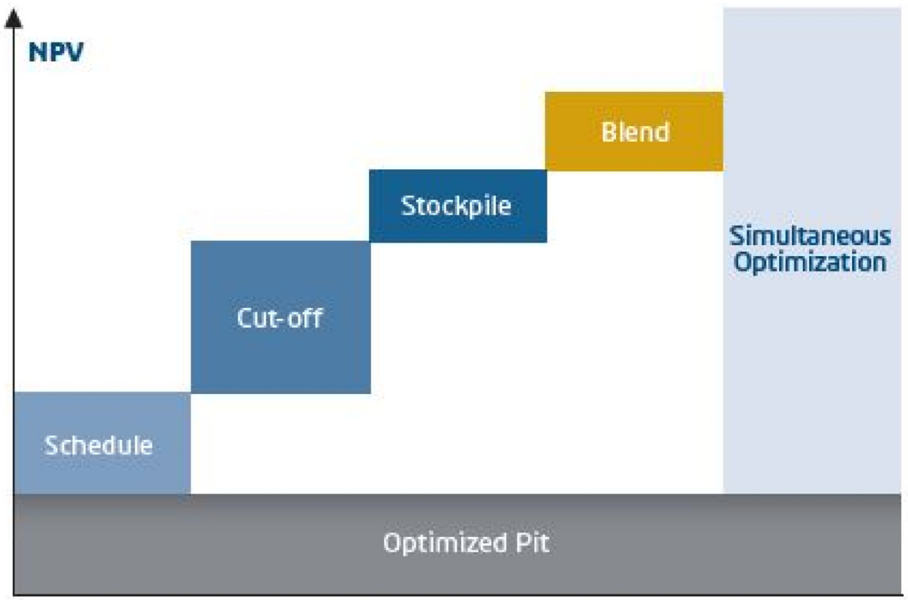
Courses 1 & 2 Robust Strategic Mine Planning → Resource Model → Pit Limit / Practical Push-Backs → Life of Mine Strategic Plan → SIMO Stockpiles/Cut-off / Blending → Managing Impact of Uncertianty → Parametric Design-Hill of Value Climbing

GEOVIA WHITTLE and SIMULIA ISIGHT

OptiTek Mining Consulting Ltd.

GEOVIA





MINP 101– Strategic Mine Planning and Optimization
GEOVIA Whittle™ Core

MINP 101 – Strategic Mine Planning and Optimization – GEOVIA Whittle™ Core

Strategic mine planning optimization process is the backbone of mining operations. In mining projects, deviations from optimal mine plans will result in significant financial losses, future financial liabilities, delayed reclamation, and resource sterilization. In this course, principles and fundamental concepts involved in strategic mine planning and optimization are presented.

Subjects covered are block value calculations; mining revenues and costs; open pit limit optimization using manual method, floating cone, and 2D & 3D Lerchs and Grossmann algorithms; Pseudo Flow algorithm, life-of-mine production planning; mine-life estimation.

Buffer stockpiles and its impact on mining and processing operations are presented. Blending problems are setup and solved. The course complements theory with comprehensive instructions, step-by-step documentation, and hands-on experience completing two projects including iron ore and gold-copper deposits using GEOVIA Whittle™ strategic mine planning software. Comparative analysis of different mine planning strategies, stockpiling, and their impacts on the bottom line of the mining business is illustrated.

Outcomes of the course include:

- Understand concepts of strategic mine planning
- How optimization improves economic performance
- Complete a strategic mine planning study in Whittle
- What costs should be included in pit optimization
- Resources and Reserves classification in Whittle
- Pit limits optimization with practical push-backs
- Generate optimal shells, reports and schedules
- Push-back design with a minimum mining width
- Advanced techniques with mining direction control
- Buffer stockpiles, blending and strategic stockpiles
- Extractive blending and bulk blending
- Iron Ore, Gold-Copper project work

Day 1

Pit Limits Optimization

- Introduction to Strategic Mine Planning & Optimization
- Pit Limits- Floating Cone, 2D Lerchs & Grossmann
- Optimal Pit Limit- 3D Lerchs & Grossmann
- Optimal Pit Limit - Pseudo Flow algorithm
- Concept of parcels and undefined waste
- Block Value Calculations
  - Revenue calculation assumptions
  - Dilution and mining recovery
  - Extra cost of mining material as ore
  - Mining and processing costs adjustments
- What Costs to Include in Pit Optimization?
  - Fixed costs
  - General and administrative costs
  - Time costs
  - Overhead costs
  - Mill limited or mining limited operations
- Geotechnical consideration and overall safe pit slopes
  - Rectangular slope regions
  - Slopes within rock-types
  - Slopes with zone numbers
  - Slope with profile numbers
- Block Model File Format (*.MOD, *.RES, *.MSQ)
- Concept of Revenue Factor (RF)
- Nested pit shells and RF parameterization
- Fixed and geometric RF
- Ore Selection by Cut-off and Cut-off Calculation
  - By marginal cut-off
  - By breakeven cut-off
  - By cash-flow
  - Formula for a cut-over
- Cut-offs with multiple elements
- Display of cut-offs and cut-overs and cut-off Scaling
- Ore selection by cash flow
- How cut-offs are affected by minima and maxima
- The effects of raised and lowered cut-offs
- Ore selection by Value Mode and Profit Mode
- Modeling nonlinear processing recoveries
- Resources and Reserves classification in Whittle

Whittle Lab01 - Open Pit Limit Optimization Iron Ore

- Project data exploration history and field campaign
  - Rock-types and elements
- Project costs calculation
  - Waste and ore mining costs
  - Ore processing costs and recoveries
  - General and administrative costs
  - Mining or mill limited operation
- Open Pit Limit Optimization
  - Grade-tonnage curve
  - Re-Blocking node
  - Slope Set node and Pit Shells node
  - Choose 3D LG or Pseudo Flow algorithm
  - Operational scenario node and revenue factors
  - Ore selection discussion
  - Non-linear recoveries
  - Pit Shells node running an optimization
  - Compressed revenue factors
  - Schedule graph and bench schedules
  - Block size and selective mining unit (SMU)
  - Pit by Pit Graph – Nested Pit Shells
  - Choosing push-back manual, auto, semi-auto
  - Practical push-back selection criteria
  - Skin analysis

Day 2

Life-of-Mine Production Scheduling

- Production Scheduling Concepts

MINP 101– Strategic Mine Planning and Optimization

GEOVIA Whittle™ Core

- Benchmark schedules
- Choose the ultimate pit
- Choose push-backs
- Sensitivity analysis
- Taylor's rule

- Benchmark Production Schedules
  - Worst case scenario
  - Best case scenario
  - Concepts of lags and leads
  - Fixed lead schedules
  - Milawa NPV algorithm
  - Milawa balanced algorithm
  - How Milawa algorithm works
- Effect of Scheduling
  - Discounting and time value of money
  - Sensitivity analysis
  - Cost positioning
  - NPV vs Reserves
  - Payback period
  - Internal rate of return
  - Costs of not using the full mining capacity

Whittle Exercise 1 – Gold-Copper – Pit Optimization

Whittle Lab02 – Open Pit Production Scheduling

- Schedule graph and bench schedules
- Mine-life estimation and sharing time related costs
- Push back chooser
- Milawa NPV and Milawa Balanced algorithms
- Push-backs with minimum mining width
  - Mining width node with/without the outer pit expansion
  - How the minimum mining width works
- Benchmark schedules and optimized schedules
- Sensitivity analysis using spider graph
- Hiring Contractors
  - Decide on contractors hiring strategy and costs
  - Transfer the schedule to excel
- Bench-mark schedule meeting tonnes and grade constraints
- Improve schedules using NPV as a metric
  - Impact of operational constraints on NPV
  - Trade-off between operational mine plans and NPV
  - Trade-off between mine plan flexibility vs. NPV
- Document comparative analysis of new scenarios

Whittle Lab03 - NPV Practical Pushbacks

- How NPV Practical Pushbacks works
  - Integrating mining with and scheduling
- Fixed and variable lead and lag
- Hiring contractors improving the schedule
- Compare NPV Practical Pushbacks vs Min Mining Width
- Interim push-back design
- The impact of geo-metallurgy/ore hardness
- Truck-hours constraint

Whittle Exercise 2 – Gold-Copper – Production Scheduling

Day 3

Whittle Lab04 – Control Mining Direction & Pre-stripping

- Constrain the direction and growth of pit shells
- Producing directional shells using expressions
- Defining Mining Distance Factor (MDF) as expression
- Specify directional shells on the Optimization tab
- Implementing and evaluating mining direction
- Mining Direction Control
- Oils Sands deposit exercise
- Pre-stripping without stockpiles
- Pre-stripping with stockpiles
- Controlling waste reject
- Impact of directional constraints on NPV
- How to compound mining directions

Day 4

Whittle Lab05 - Buffer Stockpiles

- Store economic ore in stockpiles
- Supply ore to the mill in periods that the mill is not fully fed
- Supply ore to the defined processes once mining has stopped
- Allow pre-stripping and stockpiling of economic ore
- Use buffer stockpile to balance mining and processing limits
- Grade-tonnage curve analysis for stockpile grades
- Legacy stockpiles - tonnage and grade
- Cost associated with stockpiles
- Treatment and re-handling costs
- Stockpile cut-off calculation
- Stockpile input-output grade and tonnes analysis
- Multi-element stockpiles, low, medium, and high grade
- Use data selector to plot customized charts and graphs

Whittle Lab06 – Blending Stockpiles – Extractive Blend

- Bulk blend vs Extractive blend
- Blending stockpiles
- Blend targets and definitions
- Blend bins concept
- Fixed blend bin size
- Automatically adjust bin size
- Control the head-grade by blending constraints
- Improve process throughput
- Variable penalties on contaminant thresholds
- Blending desired ratio of rock types into processes
- Rehabilitation cost for stockpiles

Whittle Exercise 3 – Gold- Copper – Blending

MINP 102-Whittle-Isight-Advanced – 3 Days
Robust Strategic Mine Planning Optimization

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	Time		Lecture/Lab Topic
Day 1	08:30- 10:00	Lab08a	Multi-Mine Pit Optimization – Pit by Pit
	10:15-12:00	Lab08b	Multi-Mine Production Scheduling
	13:00-14:45	Lab08c	Multi-Mine Production Scheduling with Stockpiles
	15:00-17:00	Lab08d	Multi-Mine – Multi-Process with Stockpiles – Improve NPV
Day 2	08:30- 10:00	Lec10	A Guided Tour through Isight
	10:15-12:00	Lab09a	Isight-Design of Experiments - Excel Example
	13:00-14:45	Lab09b	Isight- Monte Carlo Simulation - Excel Example
	15:00-17:00	Lab09c	Isight-Whittle Design of Experiments – Pit Shells Node
Day 3	08:30- 10:00a	Lab10a	Isight – File Handling, Approximations, Optimization
	10:15-12:00	Lab10b	Isight-Whittle DOE – Production Schedule
	13:00-14:45	Lab10c	Isight-Whittle DOE – Production Schedule and Slopes
	15:00-17:00	Lec11	Production Scheduling in the Presence of Grade Uncertainty

MINP 102 – Robust Strategic Mine Planning and Optimization
Advanced GEOVIA Whittle™ and SIMULIA Isight™

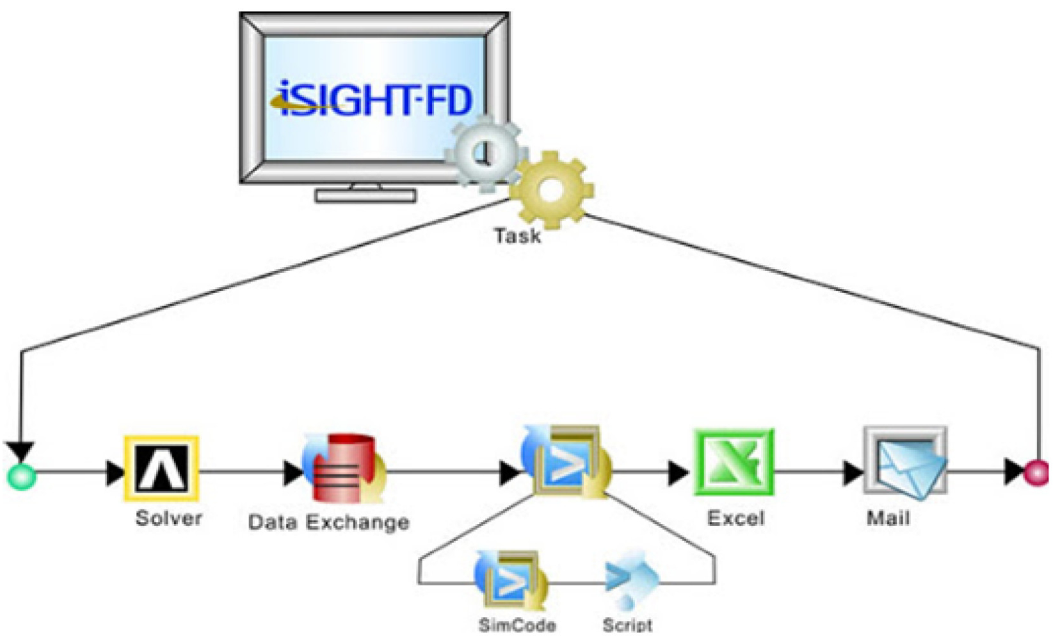
Capital Investment, Operating Costs, Discount Rate → Maximize NPV, DCF, IRR

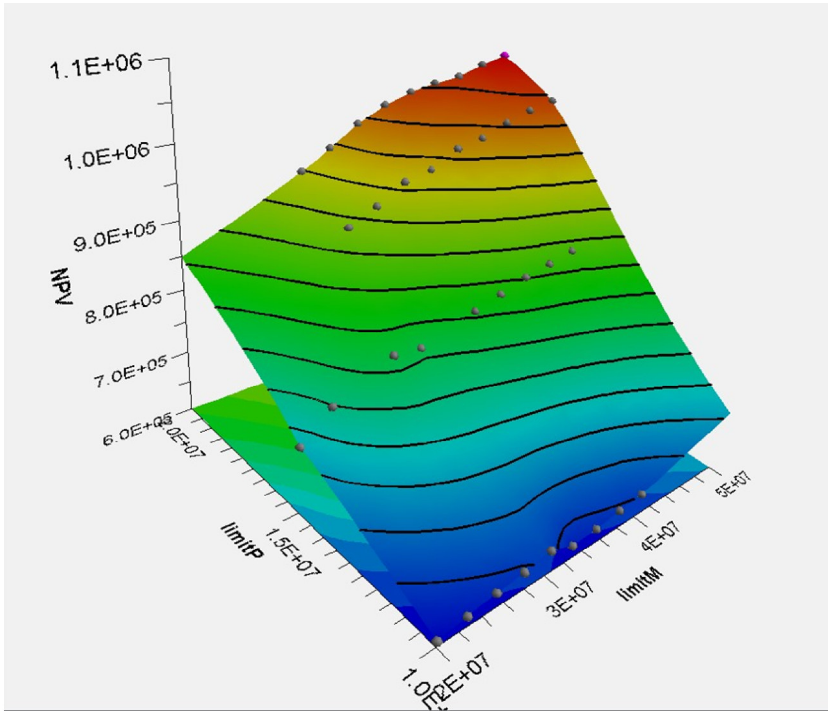
Courses 1 & 2 Robust Strategic Mine Planning → Resource Model → Pit Limit / Practical Push-Backs → Life of Mine Strategic Plan → SIMO Stockpiles/Cut-off / Blending → Managing Impact of Uncertainty → Parametric Design-Hill of Value Climbing

GEOVIA WHITTLE and SIMULIA ISIGHT

SIMULIA Isight

GEOVIA





MINP 102 – Robust Strategic Mine Planning and Optimization
Advanced GEOVIA Whittle™ and SIMULIA Isight™

MINP 102 – Robust Strategic Mine Planning - Advanced GEOVIA Whittle™ and SIMULIA Isight™

The life-of-mine plan determines the order of extraction of materials and their destinations over the mine-life. The course covers advanced strategic mine planning techniques using GEOVIA Whittle and SIMULIA Isight.

The following topics are presented in this course: cut-off grade optimization and Lane's theory; simultaneous optimization (SIMO); multi-mine multi-process production scheduling, automation and parametric design using SIMULIA Isight.

Integration of SIMULIA Isight with GEOVIA Whittle allow mine planners to run hundreds of scenarios within one project in a short period of time. Isight is a Process Integration and Design Optimization (PIDO) software framework, which enables various applications to be easily integrated. With Isight you can create flexible simulation process flows to automate the exploration of design alternatives and identification of optimal performance parameters. This course comprehensively covers the Design and Runtime Gateways along with several fundamental components, exposing users to the ways in which a workflow can be built in Isight and the ways in which the design space can be explored.

We present an approach on how to quantify and manage geological and grade uncertainty using Whittle and Isight. The course complements theory with comprehensive instructions and hands-on experience completing two projects using GEOVIA Whittle strategic mine planning software and SIMULIA Isight process automation tool. Comparative analysis of different production scenarios, stockpiling, cutoff optimization, SIMO, multi-mine and their impacts on the bottom line of the mining business is illustrated. Participants carry out strategic planning of iron ore, gold-copper, and polymetallic (zinc, lead, silver, copper) case studies.

Outcomes of the course include:

- How to carry out strategic mine plan within designed final pit limits, push-backs, and year-end designed pits.
- Understand cut-off optimization
- Understand Lane's Theory
- Carry out cut-off optimization using strategic stockpiles and cut-of Type II in Whittle
- Advanced simultaneous optimization (SIMO)
- CAPEX optimization
- Calculate sensitivities to develop risk reduction strategies
- Understand and execute Sim-flow in Isight
- Visualize Sim-flow results
- Evaluate design alternatives
- Create Sim-flow to capture a process, by integrating various software (Whittle and Isight)
- Perform design optimization
- Gain Design Space understanding
- Use various techniques such as DOE, Optimization, Monte Carlo etc. in Isight
- Robust strategic mine planning - Simulia Isight
- Integrate Simulia Isight and Geovia Whittle
- Hill of value climbing concepts
- How to control highly variable input parameters
- Multi-mine production scheduling
- Feeding multi-process plants
- Managing the risk associated with grade uncertainty
- Quantify the Impact of geological and grade uncertainty on pit limits and production scheduling
- Allowing for underground mining
- Surface and underground transition
- Iron Ore, Gold-Copper, poly-metallic projects work

Day 1

Whittle Lab07 - Cut-off Grade Optimization

- Cut-off Optimization - Lane's Theory
- Cut-off Optimization – Maximizing Profit
  - Mining, mill, and market limited cut-offs
  - Cut-off optimization to balance mining and processing
  - Cut-off optimization to balance mining and market
  - Cut-off optimization to balance processing and market
- Cut-off Optimization – Maximizing NPV
  - Maximize the difference between present values of the remaining reserves
  - Concept of increments in cut-off optimization
  - Compaction of grades, tonnage, and increments
  - Defining grade ranges for strategic stockpiles
  - Multi-element stockpiles
  - Use of Profit mode in cut-off optimization
- Revisit: how to decide on ore selection methods
- Section A: Cut-offs
  - Ore Selection by Cut-off and Cut-off Calculation
  - The Formula for a Cut-over
  - Multiple Processing Methods
  - Cut-offs with Multiple Elements
  - Ranked Cut-offs
  - Cut-offs, Cut-overs, and Cut-off Scaling
- Other methods: Cash-Flows, Value Mode, Profit Mode

Whittle Lab08 - Simultaneous Optimization (SIMO)

- Introduction to simultaneous optimization
- How SIMO works
- Integrating scheduling, blending, stockpiling, and cutoff
- Advanced optimization control
  - Optimization tab
  - Blend bins tab
  - Manual versus automatic bins

MINP 102 – Robust Strategic Mine Planning and Optimization
Advanced GEOVIA Whittle™ and SIMULIA Isight™

  - Stockpiles tab
  - Comparative analysis of value generated by SIMO
- Simultaneous Optimization
  - CAPEX Optimization process
  - Use additional capacity at a set cost per unit
  - Purchase additional mining and processing capacity
  - Use period validation to control additional limits
  - Simultaneous Reporting
  - Report CAPEX limits and costs
  - SIMO spreadsheet reports
  - SIMO with Mining Recovery and Dilution
  - Specific errors and warnings

Day 2

ISIGHT Lab09 – Introduction to Isight

- What is Isight?
- The Design gateway
- The Runtime gateway
- Using post-processing tools
- Accessing the design gateway
- Adding an Excel component to the sim process flow
- Adding a loop component to the model
- Configuring the executable
- Publishing a component
- Automate a series of functions to create a sim-flow
- Add components to a sim-flow
- Set up the core component
- Configure components to pass data to/from each other
- Execute a Sim-flow
- Visualize Sim-flow results
- Evaluate design alternatives
- Handling files in Isight
  - Configuring file parameters
  - Isight results database
- Create a Sim-flow to capture a process
- How to control highly variable input parameters into projects
- Integrate GEOVIA's Whittle SIMO with SIMULIA's optimization toolbox
- Assure stability of results using controllable variables against uncertain environmental variables
- Controllable variables
  - Push-back selection
  - Mining direction
  - Mill capacity
  - Mining capacity
- Environmental variables
  - Commodity price
  - Mining costs
  - Recoveries
  - Processing costs
  - Slope stability
  - Resources
- Determine robust & optimal values for numerous schedules
- Whittle SIMO – Final optimization of schedule using output of Isight Analysis
- Production scale that reacts well to changing parameters

Heavy blocks and pit optimization

- Exclusion polygons and pit optimization

Day 3

Whittle Exercise 4 – Gold- Copper – Cut-off Optimization

Whittle Exercise 5 – Gold- Copper – SIMO

Whittle Lab10 - Managing Risk and Grade Uncertainty

- Grade and Geological uncertainty
- Use Isight and windows command line for process automation and simulation
- Reduce design cycle time through integrating workflow
- Establishing a final pit-shell under grade uncertainty
- Equi-probable realizations of grade within the orebody
- Optimal pit for Krig, E-type models
- Optimal pit for P90 & P10 realizations
- Impact of grade uncertainty on the final pit limit
- Quantifying the Impact of grade uncertainty on scheduling
- Final pit limit in the presence of grade uncertainty

Day 4

Whittle Lab11 - Multi-Mine Multi-Process Optimization

- Introduction multi-mine multi-process optimization
- Creating a Multi-Mine Model
- Merging multiple block models in one project
- Mining limits applied to multiple mines
- Advanced mine scheduling
- Mining limits on individual mines
- Prioritize sequence of mines
- Prioritize sequence of mines
- Multi-mine multi-process optimization
- Dry and wet separation streams processes
- Complex processing methods
  - Separation
  - Element extraction different stages
  - Different selling costs
- Redirect ore to processes that are not full
- Multiple/alternative processing streams
- Multiple/alternative products
- A complex mine logistics example
- Manipulate the multi-pit sequences
- Maximize NPV by multi-process profit mode
- Lessons learnt from optimizing multi-mine
- Wrap up and conclusion for the course

MINP 201- Open Pit Mine and Waste Dump Design using Surpac

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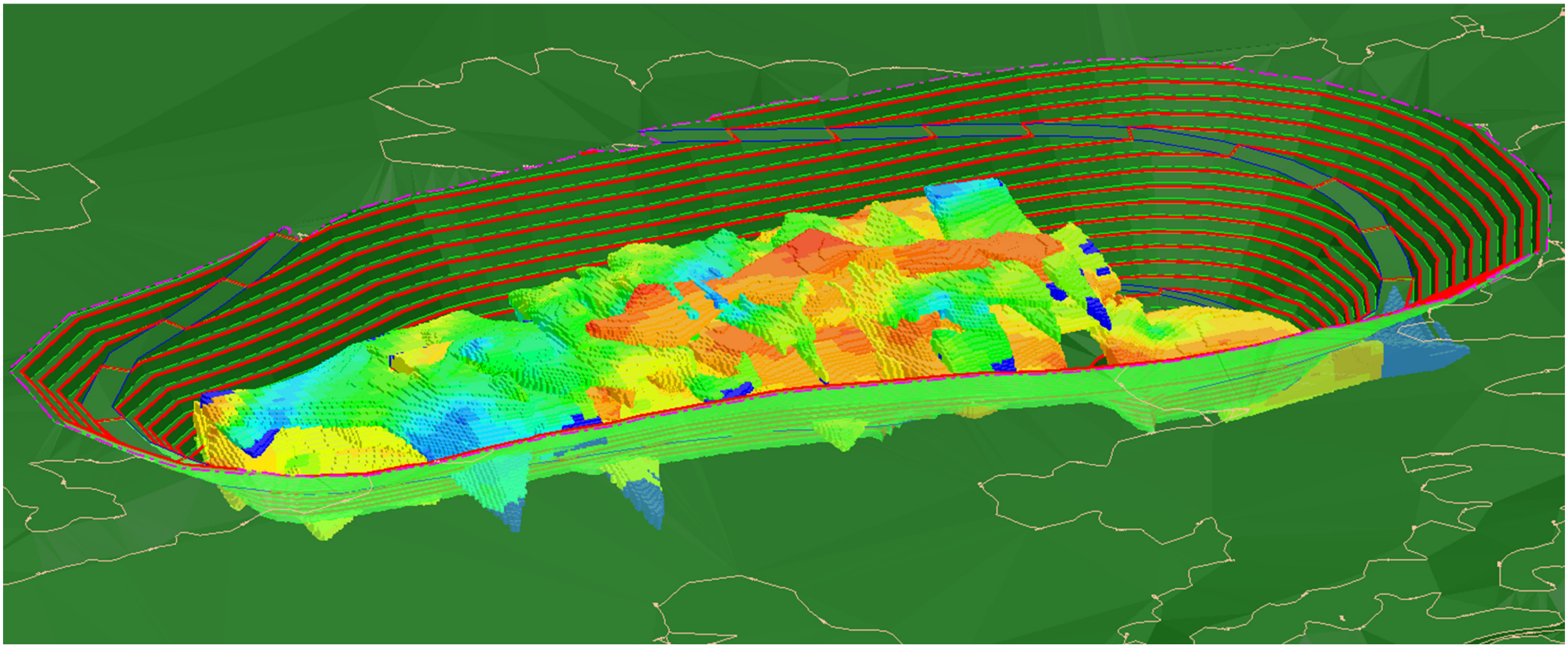
	Time		Lecture/Lab Topic
Day 1	08:30- 10:00	Lab01	Introduction to Surpac / Strings and Planes
	10:15-12:00	Lab01	Managing Layers
	13:00-14:45	Lab02	Selection and Move tools
		Lab02	Triangulated Surfaces
	15:00-17:00	Lab02	Clipping Boundaries – Polygon Intersections
Day 2	08:30- 10:00	Lec01	Pit Design – Lectures
		Lab03	Pit Design – Create Sections for Block Model
	10:15-12:00	Lab03	Pit Design – use Whittle Outlines as Guide / Slope Setup
	13:00-14:45	Lab03	Pit Design – Top Down and Bottom Up Design
	15:00-17:00	Lab03	Creating Surfaces/Clipping Topography
Day 3	08:30- 10:00	Lec02	Pit Design and Road Design
	10:15-12:00	Lab03	Complete Pit Design Lab
	13:00-14:45	Exer	Pit Design Iron Ore Mine – Whittle Push-Backs and Periods
	15:00-17:00	Exer	Pit Design - Iron Ore Mine
Day 4	08:30- 10:00	Exer	Complete – Pit Design – Iron Ore
	10:15-12:00	Lec03	Waste Dump Design
	13:00-14:45	Lab04	Waste Dump Design Tutorial
	15:00-17:00	Exer	Waste Dump Design – Iron Ore
Day 5	08:30- 10:00	Exer	Waste Dump Design – Iron Ore Complete
	10:15-12:00	Tut03	Road Design – using String Editing Tools
	13:00-14:45	Tut03	Road Design – using the Road Design Module
	15:00-17:00	Tut03	Road Design Volume Calculations

MINP 201 – Open Pit Mine and Waste Dump Design
GEOVIA Surpac™

Capital Investment, Operating Costs, Discount Rate — Maximize NPV, DCF, IRR

Course 3 - Open Pit and Waste Dump Design → Optimal Pit-Shells / Year End Surfaces → Working Bench / Equipment Specifications → Top-Down and Bottom-Up Pit Design → Waste Dump and Dyke Design → Road and Ramp Design → **Life-Of-Mine Reserves Reports**

GEOVIA SURPAC



MINP 201 – Open Pit Mine and Waste Dump Design

GEOVIA Surpac™

MINP 201 – Open Pit Mine and Waste Dump Design – GEOVIA Surpac™

Open Pit Mine and Waste Dump Design is a four-day course designed for mine planners, mining engineers, and geologist who are responsible for activities that require them to design and manage pits, ramps, switchbacks, slots, and waste dumps. It is ideally suited to those from industry who wish to gain a more in depth knowledge of modern mine planning and design theory and software tools.

The participants will complete a pit-design project during the course. The course covers open pit design terminology, impact of loading and hauling equipment on pit and waste dump design, working bench and safety berm geometry, haul road parameters and geometric pit design.

Prior to engaging in pit design, the course reviews principles and fundamental concepts in creating points, strings, and triangulations; generations of plans and sections and tools required in pit design. In addition, surface and solid modeling for the purpose of open pit design is reviewed and practiced.

The course includes a project for top-down and bottom-up pit design guided by year-end surfaces generated in a life-of-mine Whittle project. The project starts from the final optimal pit shell, intermediate pits shells, and the long-term schedule generated in Whittle. It covers topics on how to choose the required parameters such as berm width, variable pit slope angle, and batter angle to achieve a desired pit and dump design. The project continues with creating surface triangulations from the pit design, obtaining volumes, tonnages and grades reported by bench, rock type and grade range from the designed pit.

Outcomes of the course include:

- Understand pit design parameters & components
- Understand pit design theory
- Create detailed pit and dump designs
- Use optimal pit shells in pit design
- Understand haul road design
- Use year-end surfaces in pit design
- Create road designs incorporating super-elevation
- Create road designs using vehicle velocities
- Create simple dam and dyke designs
- Gridding and contouring of surface data
- Generating bench plan views and reports
- Block model tonnage and grade calculations
- Cut and fill volume calculations
- Design based on loading and hauling equipment
- Define Bench geometry as a function of equipment specs
- Design of toes, crests, ramps, switchbacks and slots
- Define berm width, pit slope angle and batter angle
- Create final pit designs and surfaces from the designs
- Obtain volumes, tonnages and grades reported by bench
- Design variable pit slopes
- Handle multi-benching
- Manage single-pit splitting to multi-pits
- Design variable pit slopes based on rock-types
- Design waste dumps

Day 1

Introduction to SURPAC for pit design

- SURPAC data types
- Function-centric and data-centric operations
- Strings
  - String data hierarchy
  - Description fields
  - Data numbering and ranges
  - String directions
  - String file structure
- Planes
  - Active plane
  - Planes projection distance
  - Moving between planes
  - Moving between planes in reverse view
  - Changing the viewing corridor
- Determine bearing and distance between two points
- Select mode to break, join, and renumber segments
- Use String/Object/Cloud mode to delete and clean strings
- Use String/Object/Cloud to renumber a string
- String tools
  - Create toe/crest line types/ user profiles
  - Create boundary polygons
  - Creating strings for pit design
- The Move tool
  - Move data along an axis
  - Move data in a plane
  - Move data in three dimensions
- Create a simple pit design
  - Managing data in layers
  - Creating a boundary string between two DTM
  - Calculating cut and fill volume using DTM surfaces
  - Calculate a volume for a solid model
  - Clip data by a boundary
- Produce a plot of a pit using Auto-plot

Day 2

Pit Geometry

- Basic bench geometry
- The pit expansion process
- Pit slope geometry
- Final pit slope angles
- Plan representation of bench geometry
- Geometric sequencing
  - Frontal cuts
  - Drive-by cuts
  - Parallel cuts
  - Minimum required operating room for parallel cuts
  - Cut sequencing
- Open Pit Terminology & Calculations
  - Bench Face, Crest, Toe
  - Bench Height and Width
  - Berm, Batter Angel, Bank Width

MINP 201 – Open Pit Mine and Waste Dump Design

GEOVIA Surpac™

SURPAC Tools for Pit Design

- Open Pit Design
  - How many benches?
  - Deepest bench?
  - Single pit splitting into multiple pits
- Pit design parameters
  - General design parameters
  - Define bench parameters
  - Define ramp slot parameters
- Display the mine design toolbar and menu bar
- Creating a simple pit
- Pit design data preparation
  - Create ore outlines
  - Import LG practical optimal push-backs
  - Import Whittle long-term mine plan
  - View Whittle outlines in the block model
  - Add slope values
- Pit design project set up
  - Modify toe/crest string profiles
  - Create new toe/crest strings
  - Define the starting string
  - Define the slope method
  - Define a new ramp entrance
  - Ramp generation and automated pit design
  - Expand by bench height and berm width
  - Expand single bench
  - Expand multiple benches
  - Edit a pit design
- Pit design methods
  - Bottom to top design
  - Top to bottom design
- Additional Pit Design Tools
  - Restart a pit design
  - Design a switchback
  - Create slot entrance & switchbacks
  - Create line for opposite ramping
- Creating a DTM of a pit design
  - Clean pit design strings
  - Create a DTM of a pit design
  - Surface creation errors
- Intersect pit design with surface topography
- Create a block model constraint of material in a pit
- Calculating and categorizing volumes
  - Volumetric reports (tonnes/grades)
  - Volume between two surfaces
  - Volume by bench
  - Grades and tonnages
- Typical pit design issues and errors

Day 3

Life-of-mine pit design exercise

Waste Dump Design

- General dump design parameters
- Define bench parameters
- Set current bench/toe
- Create new toe/crest lines
- Create ramp entrance
- Expand single bench
- Expand multiple benches
  - Design a waste dump
  - Calculate dump volume

Day 4

Haul Road Design Concepts

- Haul road geometric design parameters
  - Design of a spiral road-inside the wall
  - Design of a spiral ramp - outside the wall
  - Design of a switchback
- The volume represented by a road
- Road section design
- Straight segment design
- Curve design
- Conventional parallel berm design
- Median berm design
- Key road planning and alignment factors
- Haul truck stopping distance
- Sight distance and vertical curves
- Road Width for curves
- Turning circle of large haul trucks
- Super-Elevation
- Super-Elevation Runout
- Inflection point
- Spiral or transition curve
- Vertical curve
- Optimal and maximum sustained grades
- Road Geometrical Design Process
  - Integrating design methodology with mining plan
  - Including haul roads in the ultimate pit design
  - Integrating roads through the mine schedule
  - Safety berms, ditches and drainage
  - Intersection design
- Road Surface
  - Traction
  - Rolling resistance
  - Typical rolling resistance values

Haul Road Design

- Designing roads using string editing tools
  - Design a road using CURVE END
  - Design a road using CURVE TANGENT
  - Design a road at a Constant Gradient Along Contours
  - Create a variable width road outline
- Using the road design module
  - Create horizontal curves
  - Drape centreline over DTM
  - Create longitudinal profile
  - Create vertical inflection points
  - Create vertical curves
- Apply longitudinal profile
- Create road outline
- Calculating road design volumes
- Calculate road cut volume
- Calculate road fill volume

MINP 301 – Surface Mine Production Scheduling – Tactical Planning MineSched and Surpac

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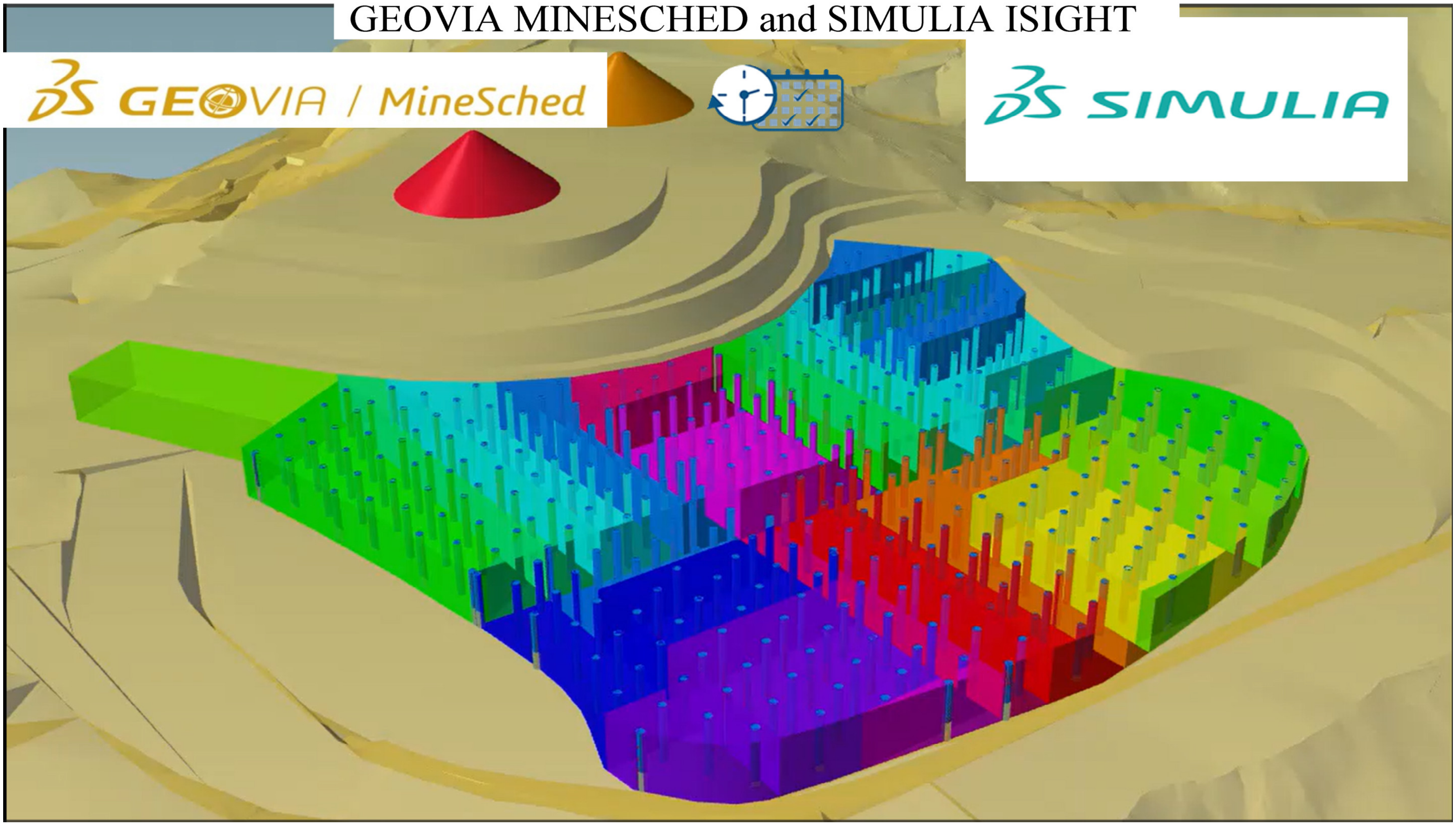
Data: Copper			
	Time		Lecture/Lab Topic
Day 1	08:30- 10:00		Tutorial 01 – MineSched Production Scheduling Intitialization
	10:15-12:00		Tutorial 02 - MineSched Production Scheduling Material Movement
	13:00-14:45		Tutorial 3 – MineSched Production Scheduling Target Blending
	15:00-17:30		Tutorial 4 – MineSched Production Improving the Schedule
Data: Polymetallic Multi-Mine (Zinc, Copper, Lead, Silver)			
Day 2	08:30- 10:00		Truck-Shovel Production Estimation in Excel
			Setting Up Mining Locations and Mining Resources (Shovels)
	10:15-12:00		Material Movement to All Destinations
	13:00-14:45		Plotting Production Charts and KPI
	15:00-17:00		Custom Reports Cash Flow and NPV Reports
Day 3	08:30- 10:00		Setting up Parameters – Bench Reports by Pivot Tables
	10:15-12:00		Mining by Benches controlling practical mining constraints
	13:00-14:45		Mining Bench Polygons using Blast Locations
	15:00-17:00		Setting up Precedence between Polygons and Mine Phases
Day 4	08:30- 10:00		Setting up Waste Dump Location Block Models and Lift Precedences
	10:15-12:00		Setting up Haul Road Network and Trucking Requirements
	13:00-14:45		Reporting Tonne-Kilometer, Truck Hours, and Number of Trucks
			Grade Blending and Head-Grade Targeting
	15:00-17:00		Backfilling the Pit with In-Pit Waste Dump Location
Day 5	08:30- 10:00		Update NPV by TKM and Stockpile Animation
	10:15-12:00		Calendars – Preventive Maintenance – Fleet Up-Time and Down-Time Modeling
	13:00-14:45		Short-Term Planning – Drill, Blast, Mining Activities
	15:00-17:00		Pit Activity Example – Drill, Blast, Mining sequencing Gannt Chart

MINP 301 - Surface Mine Production Scheduling
GEOVIA MineSched™ Core

Capital Investment, Operating Costs, Discount Rate → Maximize NPV, DCF, IRR

- Courses 4 & 5 - Production Scheduling - Tactical Planning
- Selective Mining Units / Polygons
- Alignment of Short-Term Plans with Strategic Plans
- Stockpiles / Blending/Activity Schedule, Drill, Blast,etc
- Haulage and TKM
- Automatic Parametric Design -Scenarios
- Quarterly & Monthly Reserves Reports



MINP 301 - Surface Mine Production Scheduling
GEOVIA MineSched™ Core

MINP 301 - Surface Mine Production Scheduling – GEOVIA MineSched™ Core

Surface Mine Scheduling is a four-day course designed for mine planners, mining engineers, geologists, and technical managers who are responsible for activities that require them to generate or oversee monthly and weekly mine production schedules. The course is designed to provide theory through lectures, complemented by a hands-on production-scheduling project using GEOVIA MineSched. The project covers all the required steps from a long-term yearly schedule generated within a designed pit to a monthly production schedule taking into account mining and processing capacities, truck-shovel hours, drilling and blasting, blending, and stockpiles management constraints. Learn how to model and manage stockpiles and processes, block modeled waste dumps followed by automated filling strategies and waste scheduling. Also, reporting and 3D visualization of a spatial database of the materials within the waste-dump, which is critical for both long-term waste dump management and reclamation. The course covers the following topics:

- Medium/ short-term planning concepts
- Alignment of short-term plans with strategic plans
- Parameters: rates, delays, priorities
- Quantity and quality targets
- Defining mining locations
- Defining process streams
- Period polygons: tonnage/grades
- Reporting: Excel, Access, MS Project
- Animations & presentation tools

Outcomes of the course include:

- Schedule from block, polygonal and grid models with any number of elements, material types, and qualities
- Calculate polymetallic Net Smelter Return (NSR)
- Graphically sequence mining blocks
- Control all aspects of the schedule or use target-based scheduling algorithms.
- Incorporate mining directions, bench lags/leads, face geometry, location limits, and other mining constraints to ensure practical schedules.
- Schedule ancillary activities such as drilling, blasting, and back filling.
- Include material movement to stockpiles, processes, and spatially modeled waste dumps.
- Blend material from mines, stockpiles, processing plants, and waste dumps.
- Visualize Mine Schedules with 2D and 3D Graphics.
- Display tonnage and grade attributes.
- View colored period and production data.
- Generate intermediate mining surfaces.
- Animate mining sequence as a movie or frame-by-frame.
- Validate and communicate the sequence of activities.
- Generate reports with production tonnage and grade data.
- Produce polygon and bench reports.
- Obtain a detailed understanding of the schedule.
- Communicate the results to management.
- Create reverse vertical lag or constant face distance.
- Design cut polygons on specific layers
- Apply geometry rules to create new polygons.
- Attach attributes to the mine cut polygons.
- Sequence the mine polygons.

Day 1

- Data storage and familiarization
  - a) Setup data management hierarchy
  - b) Data review
- Data editing and management
  - Block model reporting
  - Determine the tonnes and grades in rock types
  - Polygons for graphical results
- Block model material classes
  - Assign material classes for the schedule
  - Quality of elements report average or aggregate
  - Define user parameters
  - Define user calculations for mining cost, NPV, NSR
- Validate material type quantities
- Scenario management
  - Creating and opening scenarios
- Navigating the scenarios
  - Data grids & Charts
  - Dashboard & Spreadsheet views
- Scenario parameters – geological model data
  - Defining geological models
  - Add the model for scheduling
  - Assign material classes for the schedule
  - Validate model & check the model for errors
- Define mining locations for scheduling constrained by
  - Surpac constraints file
  - Surfaces/ Solids
  - Block/ Polygon
  - X, Y,Z planes
- Define mining method
  - Benches / Polygons
  - Whole / Bench-polygons
- Define mining directions by
  - Direction / Azimuth
  - Radial / Roaming
- Consolidate blocks into larger units

Polymetallic Net Smelter Return (NSR)

- NSR Calculations
  - Recovery factor of the metal at the mill
  - Concentrate grade / Transport cost
  - Payable metals
  - Treatment charges / Penalties
  - Price participation / Refining charges
  - Calculate the NSR factors ($/ unit of product)
- Estimate the value of a mining sector
- Calculate the revenues of mine plans
- Calculate the value of broken mineralization in the plan

MINP 301 - Surface Mine Production Scheduling
GEOVIA MineSched™ Core

Day 2

- Production - mining constraints
  - Define mining resources / diggers
  - Allocation of resources to locations
  - Production rates
  - Resources capacities
  - Resources availabilities
  - Physical location constraints
  - Precedence of mining based on date/event
  - Delays between mining locations
- Create schedule
  - Define a timeline for the schedule
  - Define units of time for periods
  - Create the schedule
  - Add reports and charts to the dashboard
- Publishing results
  - Create graphical results & animations
  - Standard and custom reports
  - Gantt charts
  - Block model schedule
  - Analyzing the schedule
  - Production charts by material type
  - Stockpile balances
  - Detailed production reports
  - Production animation
- Adding calendars to resources
  - Preventive maintenance for shovels
  - Preventive maintenance for mill
  - Working days and holidays
  - Duration and frequency
  - Start and end date
- Sequencing the stages
  - Sequencing the stages using precedences
  - Sequencing the stages using production priorities
  - Production priority changes after date/event
  - Graphically sequencing polygons
- Perform quick metal price sensitivity studies

Day 3

- Targets
  - Quality and Quantity targets
  - Add a quality target to the schedule
  - Add flexibility to the schedule
  - Explore the options for meeting the targets
  - Minimize the rehandling
  - Material ratio and strip ratio targets
  - Effects of material classes on capacities
  - Create a schedule that has a constant ore production
  - Create a schedule that pre-strips waste
  - Variable throughputs
- Fill locations
  - Add the block-model that will be used for filling
  - Dump location modeling
  - Change the waste stockpile to two waste dumps

Make the schedule more practical

- Production parameters
  - Mining direction
  - Investigate the different mining directions
  - Investigate vertical and horizontal-lag
  - Investigate maximum-lag
  - Maximum active benches
  - Maximum active groups
  - Maximum bench drop per period
  - Maximum benches per period
  - Maximum and minimum capacity
  - Recalculate active location at period start
  - Swell factor
  - Number of active benches per period
  - Production rate modifiers
- Precedence parameters
  - Blocks in sequence
  - Block precedences constrained by group
  - Groups in defined sequence
  - Horizontal lag all directions
  - Maximum lag distance
  - Vertical lag all directions/specific direction

Day 4

- Selection of Loading & Hauling Equipment
  - Shovel size selection
  - Bucket capacity selection
  - Theoretical cycle time
  - Fill factor, efficiency, and availability
  - Determination of shovel geometry
  - Dumping radius and height
  - Shovel Selection from OEM literature
  - Haulage truck selection
- Bench Geometry and Equipment Specifications
  - Shovel working range specifications
  - Haul truck OEM specifications
  - Working bench width calculations
  - Safety bench width calculations
- Haulage and Tonne Km calculations
  - Adding Haulage to the schedule
  - Create haulage route strings
  - Reporting TKM
- Short-term polygons
  - Creating short-term polygons within the long-term schedule
  - Bench plans
  - End of period surfaces
  - Polygon mining vs. Bench Polygon mining
  - Polygon constraints
  - Polygon mining to a seam boundary
  - Polygon mining a single bench
  - Different polygons on separate benches
  - Polygon mining a single bench by flitches
- Polygon sequencing
  - Adding a polygon sequence
  - Apply the correct sequence for this schedule
- Ancillary activities
  - Drilling and blasting activity
  - Graphically animating the activities
  - Production activities (optional)

MINP 302 - Robust Mine Production Scheduling - MineSched, Surpac & Isight

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Data: Polymetallic Multi-Mine (Zinc, Copper, Lead, Silver)			
	Time		Lecture/Lab Topic
Day 1	08:30- 10:00		Review of Long-Term Plan (Whittle Project) to be exported into MineSched
	10:15-12:00		Setting Destinations from Long-Term Plan as Material Type for MineSched
			Compliance of Long-Term Material Destinations in Short-Term Plans
	13:00-14:45		Truck-Shovel Production Estimation in Excel
			Mining by Benches Controlling Practical Mining Constraints
	15:00-17:30		Mining Bench Polygons using Blast Locations
Day 2	08:30- 10:00		Setting up Precedence between Polygons and Mine Phases
			Introduction to Design of Experiments (DOE) with Isight and Excel
	10:15-12:00		Introduction to Monte Carlo Simulation with Isight and Excel
	13:00-14:45		Running MineSched from Command Line
	15:00-17:00		Review of Available Commands for MineSched (Switches and Arguments)
Day 3	08:30- 10:00		DOE MineSched-Isight – Setup and Preparation
	10:15-12:00		DOE around – Varying Mining Rate and Milling Rate
	13:00-14:45		DOE around – Varying Mining Direction in Four Push-Backs
	15:00-17:00		Assessing DOE Responses on NPV and Mine-Life

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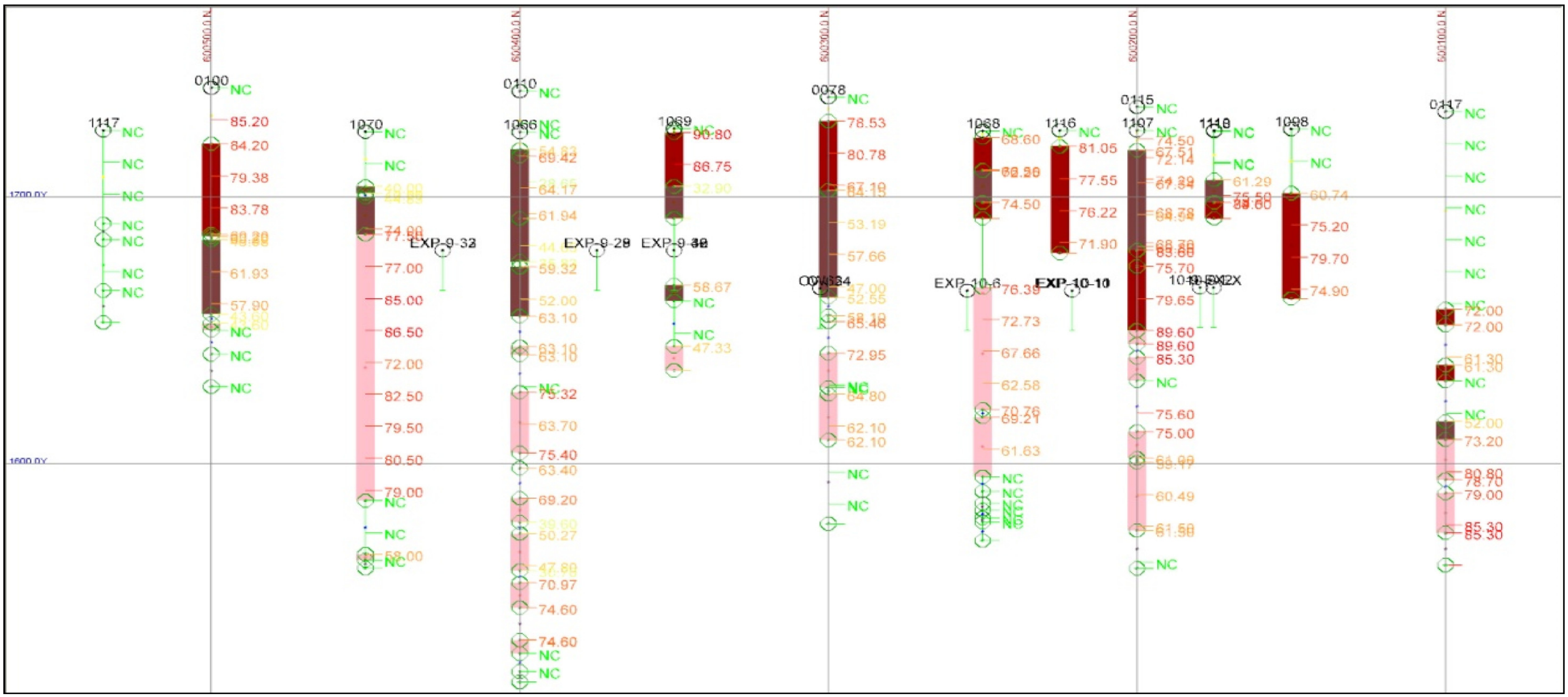

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MINP 401 – Drillholes to Block Model using GEOVIA Surpac™

COURSE DESCRIPTION

Software: GEOVIA SURPAC

Drillholes to Block Model is a five-day course designed for geologists, geo-modelers, geoscientists, mine planners, mining engineers, and technical managers who are responsible for activities that require them to generate or oversee drillhole database management to estimating block models. The course is designed to provide theory through lectures, complemented by a hands-on real-world resource modeling project using GEOVIA SURPAC. The course covers principles and fundamental concepts involved in drillhole database management; data manipulation, filtering, and validation techniques; drillhole compositing techniques; plot generations; surface and solid modeling for geological domain characterization; basic geostatistical analysis, variography and search ellipsoids setup, block model setup and estimation, inverse distance and kriging estimation, and NI-43-101 resource classification into measured, indicated, and inferred categories.

The course includes comprehensive instructions and hands-on experience using GEOVIA SURPAC software. Participants will complete a resource modeling project with an iron ore drillhole dataset. The project covers all the required steps from drillhole database setup to statistical analyses, experimental variogram calculation, variogram modeling, search ellipsoid setup, grade estimation using inverse distance and kriging, and finally resource classification.

The modules for the course are as follows:

- Module 1: Introduction to Surpac
- Module 2: Drillholes Databases and Workspaces
- Module 3: Sections, Plan Views, and Plotting
- Module 4: Drillhole Compositing
- Module 5: Geology – Surface Modeling
- Module 6: Geology – Solid Modeling
- Module 7: Basic Statistics and Data Manipulation
- Module 8: Variograms
- Module 9: Block Modeling
- Module10: Resource Classification

Outcomes of the course include:

By the end of this course, you will be able to complete the following in GEOVIA SURPAC:

- Add and modify sections and plans views
- Load and display drillholes
- Manipulate data in the drillhole database
- Perform basic statistics on drillhole data
- Composite drillhole data
- Create points and polylines
- Plotting
- Use drillhole data to create basic surfaces
- Digitize 3D rings from interpreted drillhole data
- Create and manage triangulation solids ad surfaces
- Perform statistical analysis
- Understand variogram concepts
- Calculate experimental variograms
- Model variograms
- Interpret variogram maps
- Establish search ellipsoids
- Create block model projects
- Update block attributes for rock type and density
- Understand kriging theory
- Estimate grades using inverse distance and kriging
- Cross validate the estimated block model values
- Import and export block models
- Classify resources based on NI 43-101 guidelines
- Report volumes and tonnages using the block model

Day 1

Introduction to SURPAC

- Starting Surpac
- Set the work directory
- Modifying the Surpac desktop icon
- The Surpac interface
  - Menus and Toolbars
  - Navigator
  - Preview pane and Legend pane
  - Properties pane and Layers pane
  - Status bar
  - Message window
- Surpac concepts
  - Surpac data types
  - Function-centric operations
  - Data-centric operations
- Strings
  - String data hierarchy
  - Types of strings
  - Description fields
  - Data numbering
  - Data ranges
  - String file names
  - String directions
  - Viewing string data
  - String file structure
  - Planes and Active plane
  - Planes panel
  - Planes viewing modes and groups
  - Planes projection distance
- Viewing and saving data
  - Multiple viewports
  - Orbit mode
  - Saving data
- Managing data in layers
  - Layers and the Surpac work area
  - Creating layers
  - Appending data to a layer
  - Replacing data in a layer
  - Saving workspace settings

String Tools-Surfaces

- Selection modes
  - Change selection modes
  - Use Point/Triangle/Block mode
  - Use Segment/Trisolation mode
  - Use Select mode to break, join segments
  - Use String/Object/Cloud mode
  - Use String/Object/Cloud to renumber a string
- The Move tool
  - Move data along an axis
  - Move data in a plane

MINP 401 – Drillholes to Block Model using GEOVIA Surpac™

- Move data in three dimensions
- Creating data
    - Create a simple pit design
    - Create a simple pit design
- Triangulated surfaces
    - Naming conventions
    - Breaklines and spot heights
    - DTM conventions
    - Viewing a DTM surface
    - View a DTM in Graphics
- Creating a DTM surface
    - Create a DTM — graphics-based method
    - Create a DTM — file-based method
- Creating a boundary string between two DTM surfaces
    - Create a boundary string – file-based method
    - Create a boundary string – graphics-based method
- Calculating cut and fill volume using DTM surfaces
- Calculate cut and fill volumes between two DTMs
- Clip data by a boundary
- Apply a boundary string to a soil sampling file
- Classify strings
- Polygon intersection
    - Calculate the area of an ore zone within a pit
    - Clip ore blocks inside a pit

Day 2

Drillhole Databases

- Drillholes/Geological Database
    - Geological Database
- Importing and viewing data
- Display Drillholes
- Applying Styles to Drillholes
- Setting Up a Default Styles File
- Basic Statistics and Histograms
- Displaying drillholes with color filled bar graphs
- Drillhole investigation and interrogation
    - Identify drillhole
    - Graphically edit drillhole
- Sections
    - Creating sections graphically
    - Creating quick planes
    - Cross-sectional viewing
    - Ore digitization
- Compositing
    - Compositing Downhole
    - Statistics – downhole compositing
    - Bench Compositing
    - Fixed length within geological domains

Basic Plotting

- Updating plotting ssi files.
- Two-dimensional plotting
- Plan view plotting
- Section plotting
- Adding an image of a legend
- Three-dimensional plotting
- Create a section plot with a plan strip
- Create multiple section plots

Day 3

Surface Modeling

- Surface Modeling Concepts
    - Setting up for the surface (DTM) creation
    - Strings and DTMs
    - Naming conventions
    - Breaklines and spot heights
    - Graphical vs file-based options
- Creating a DTM
    - Create a DTM – graphics-based method
    - Create a DTM – file-based method
    - Create a DTM from spot height data
    - Create a DTM using breaklines and spot heights
    - Create a DTM on the plane of best-fit
- Viewing DTMs
    - Colour a DTM by elevation
    - Perform graphical animation
    - Save images of a graphical animation
- Transform a DTM to a different coordinate system
- DTM volume calculations
    - Create a boundary string using the file-based method
    - Create a boundary string using the graphics-based method
    - Calculate the volume between two DTMs
    - Calculate cut and fill volumes
    - Net volume between DTMs
- Clipping a DTM
    - Clip a DTM – file-based method
    - Clip a DTM – graphics-based method
    - Clip a DTM with another DTM – file-based method
    - Clip a DTM with another DTM – graphics-based method
- Sectioning a DTM
    - Create a DTM section axis line
    - Create DTM sections
- Creating contours
    - Create DTM contours – file-based
    - Create DTM contours – graphics-based
    - Create index contour file with annotations
- Draping a string over a DTM
    - Drape a spot height string over a DTM
    - Drape a non-spot height string over a DTM
    - Drape an image over a DTM
- DTM/DTM intersections
    - Create an upper triangles surface of two DTMs
    - Create a lower triangles surface of two DTMs
    - Create solid by intersecting two DTMs
- Point cloud for surface
    - Create a surface mesh
    - Create a surface mesh with classification
    - Restrict surface mesh generation within a polygon
    - Restrict mesh generation within closed segment
    - Restrict mesh generation within closed string
    - Calculate the deviation of a point cloud
    - Recalculate the deviation of a point cloud
    - Create a point cloud from a trisolation
    - Remove outlier points from the point cloud file

Solid Modeling

- Solids concepts
    - What is a solid model
    - Terminology
    - Solids files

MINP 401 – Drillholes to Block Model using GEOVIA Surpac™

- Preparing data
  - Combine string files into one file
  - Check string file directions using string file summary
  - Transform data from section view to plan view
  - Check and remove foldbacks
  - Highlight and remove duplicate points

Creating solids

- Triangulating using between segments
- Triangulating using control strings
- Triangulating Using Many Segments
- Create a Solid by Specifying a Range of Strings
- Triangulating using bifurcation techniques
  - Perform bifurcation - one segment to many segments
  - Perform one segment to two segments (bifurcation union)
  - Perform bifurcation union – split parent
  - Use one segment to two segments to model a bifurcation
  - Perform bifurcation using the triangulate shape tool
- Triangulating using segment to a point
- Editing solids
  - Renumber an object and trisolation
- Validating solids
- Repairing a solid
- Removing small triangles
- Intersecting solids and DTM surfaces
- Intersecting solids
  - Perform solids union
  - Perform intersection of solids
  - Perform outersection of solids
  - Clip a solid above a DTM
  - Clip a DTM outside a solid
- Intersecting DTM surfaces
  - Perform upper triangles intersection of two DTMs
  - Perform lower triangles intersection of two DTMs
  - Create a solid by intersecting two DTMs

Day 4

Basic Statistics

- Understanding the Geological Domains
- The Impact of Domains on Estimated Values
  - Basic Statistics
  - Descriptive statistics
  - Histograms
  - Cumulative probability plots
  - Probability plots
  - Bimodal distributions
- Outliers
  - Outliers and top cuts
  - Methods for determining a top cut value
  - Confidence interval
  - Percentile
  - Applying a top cut
  - Anisotropy
- Viewing a Search Ellipse Sphere
  - Examples of Search Ellipse Parameters

Variograms

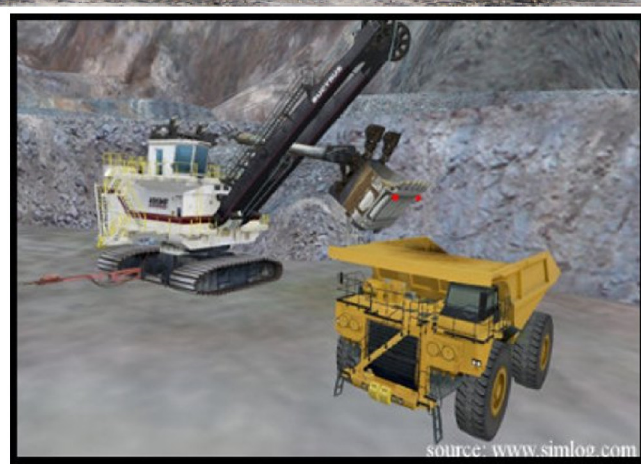
- Anisotropy
- Variogram concepts
- What is a variogram?
- Variogram parameters
  - Linear (downhole) variography
  - Omnidirectional and directional variography
  - Effect of nugget, and range
  - Creating and viewing experimental variograms
- Changing the variogram type
- Summary: steps to create an experimental variogram
- Modeling a Variogram
  - Modeling an experimental variogram
  - Viewing different types of variogram models
  - Summary: steps to model an experimental variogram
  - Variogram modelling tips
- Variogram Maps
  - Calculating and modeling the variogram maps
  - Establishing major direction of continuity
  - Saving variography parameters to profiles

Day 5

Block Modeling

- Block modelling concepts
  - Model space
  - Blocks and attributes
  - Constraints
  - Estimation
- Creating a block model
- Creating model attributes
- Constraints within a block model
- Applying constraints to a block model
- Estimation attributes in the block model
  - Assign Value
  - Fill the block model using Assign Value
  - Nearest neighbour
  - Estimation using nearest neighbour
  - Inverse distance Methods
  - Ordinary kriging
- Block model reporting
- Creating calculated attributes
- Report on grade, grouped by rock type
- Model reblocking
- Column processing
- Classify blocks into ore and waste
- Calculate dilution and reduction
- Recoverable product
- Import a block model from a .csv file
- Import a block model for Whittle from a .csv file
- Import a block model from a .csv
- Resource classification

Arena Simulation



MINP 501 - Simulation of Mining and Haulage Systems using Arena

MINP 501 - Simulation of Mining Systems

Simulation Software: Arena

Fundamentals of Discrete Event Simulation (DES) modeling and its industrial applications to mining and processing systems are presented. Theoretical and statistical aspects of simulation, including input and output analysis, experimental design, and variance reduction techniques are presented. Arena Simulation Environment (by Rockwell Automation) is used as the primary modeling simulation tool for explaining simulation concepts.

The course focuses on modeling detail truck-shovel simulation models that uses the historical dispatch data, road profiles, and short-term mine plans as input into the simulation model. The simulation models need to be calibrated, and verified to link the short-term mining schedules to the operational plans in presence of uncertainties of cycle times, scheduled and unscheduled down times, shift changes, etc.

The rest of the course will focus on combined continuous and discrete-event simulation of processing systems. Size classifications including sieves and hydrocyclones; comminution operations including crushing machines, grinding, and semi-autogenous mills; solid-liquid separation including thickeners and filtration; and also gravity and magnetic separation modeling will be covered by examples.

The course is intended for mining and processing engineering disciplines and participants who would like to use simulation to design and optimize real-world mining systems. On completion of this course, successful attendees will have an in depth understanding of principles and methodologies, of discrete event simulation.

Also, they will be able to use Arena Simulation Software (Rockwell Automation) as the simulation modeling tool for simulating and optimizing real world systems. A series of labs using Arena Simulation Software (Rockwell Automation) are undertaken to model and optimize real world systems. Students undertake a complete simulation modeling/analysis project. The completed models and labs will be shared by the participants.

Review of past Haulage Simulation Projects

We will present mine haulage simulation tools developed and implemented for our clients' large-scale mining operations. The developed simulation models have been used as operational planning tools in our clients' businesses. The simulation tool takes the mine production schedule as an input and imitates the truck-shovel haulage-systems and its interaction with the extraction plant including crushers and downstream assets. The simulation tool reports the major system's KPIs at 95% level of statistical confidence within 3% accuracy of the historical dispatch data. Major KPIs reported by the automated output reporting system are: ore and waste production, queue time, spot time, load time, dipper tonnage, haul time, dump time, truck speeds, backup time, loading cycle time, head grade, time and number of trucks in queue, and truck-and-shovel operational KPIs. The simulation tool gives the planner capability to assess the impact of changing operational scenarios such as stockpiling, different sizes of mixed-fleet trucks, and introduction of new haul-roads into to the mine plan. Normalized results of real projects will be presented.

Outcomes of the course include:

- Review of main truck-shovel time charts such as definition of work, ops delay, ops standby, short down, down service, down technical, down waiting, and out of system.
- A review on probability and statistics and fundamental simulation concepts.
- Review of main truck-shovel KPIs such as definition of physical availability, use of availability, operating efficiency, effective utilization, tonne per net operating hours, etc.
- Truck-shovel simulation modeling using resources, queues, and basic animation to calculate fleet productivity.
- Assess the uncertainty associated with the fleet productivity, haulage costs, and cash flow analysis to support decision making.
- Mixed fleet truck-shovel simulation modeling using resources sets and maintenance schedules.
- Introduction of resource failures with defining probability distribution functions for mean time between failures and mean time to repairs of trucks, shovels, and crushers.
- Truck dispatching using station-route and assessing the reliability of the system.
- Combined continuous and discrete event simulation of processing systems.
- Comminution operations including crushing machines, grinding, and semi-autogenous mills,
- Bulk material terminal modeling including arrival of trains, stockyard cells, stockpile blending, stackers and reclaimers, and the ships loading section.

Day 1

Lec01 – Introduction to Simulation Modeling

- Fundamental simulation concepts
- Systems and models
- Types of simulation models
- Discrete and continuous models
- Static vs. dynamic
- Deterministic vs stochastic
- Advantage and disadvantages
- Steps in simulation study
- Functional specification / assumption document

Lec02 – Review of Basic Probability and Statistics

- Probability and statistics review
- Variance and covariance
- Correlation
- Generating random variates
- Statistical inference
- Confidence interval estimation
- Half-width

MINP 501 - Simulation of Mining and Haulage Systems using Arena

- Number of replications

Lec03 – Pieces of a Simulation Model

Lec04 – A Guided Tour through Arena

- A guided tour through Arena,
- Variables, entities, entity flow and attributes,
- Resources, capacity constraining, queues,
- Using basic process module in Arena to model:
  - Entity flow and attributes
  - Capacity constraining (Resources)
  - Attributes, Variables, and Queues
- Flow control, input/output (I/O)
- Animation of variables (scoreboard),
- Variable spreadsheet module

Lab01 – Resources and Queues

- Truck-Shovel Basic Modeling
  - Resources and Queues – Seize, Delay, Release
  - Decisions and Statistics, Replications
  - Truck Shovel Queue and Resource Animation

Lab02 – Basic Truck Shovel Simulation II – Decisions and Statistics, Replications

Lab03 – Basic Truck Shovel Animation - Queue and Resource Animation

Day 2

Lec05 – Truck Shovel Time Charts & KPIs

- Time Chart Categories
  - Ops Delay
  - Ops Standby
  - Short Down
  - Down Service
  - Down Technical
  - Down Waiting
  - Out of System
- Truck-Shovel KPIs
  - Physical Availability
  - Use of availability
  - Operating efficiency
  - Effective utilization
  - Tonne/NOH
  - Tonne/GOH

Lec06 – Resource Sets and Schedules

- Schedule rules
  - Wait; Ignore; Preempt
- Resource Failures
- Instantaneous utilization
- Scheduled utilization

Lab04 – Truck-Shovel - Resource Sets & Schedules

- Resource Sets
  - Use resource sets for cross utilization of resources (Sets)
  - Limiting resource availability (Schedules)
  - Limit the number of created entities
  - Use expressions for defining process times etc.
  - Use statistics data module for reporting.
- Read/Write into and from external files
- Use resource sets, schedules, and states

Lab05 – Truck Shovel Simulation – Failures

- Modeling Trucks as entities
- Modeling Trucks as resources
- Modeling trucks as resources and duplicate load entities
- Considering failure for trucks

Day 3

Lab05e – Truck Shovel Simulation - Writing to Files

- Truck-Shovel Advanced Modeling
- Resource Sets & Mixed Fleet Modeling
- Maintenance Schedules
- Truck and Shovel Major and Minor Failures
- Station and Route

Lec07 – Iterative Looping

- Modeling Detailed Operations
- Using logical or probabilistic conditions
  - DECIDE
  - IF-ELSE-ENDIF
  - BRANCH
  - Using loops
  - DECIDE loop (go to programming)
  - WHILE-ENDWHILE
- Submodels & Iterative Looping

Lab06 – Entity Transfer Constructs

- Understand the modeling concepts
  - Stations and Routes,
  - Transporters and Entity Sequences.
- Learn how to choose the best entity transfer construct to model a system in Arena.
- Arena Constructs:
  - Station flowchart module
  - Route flowchart module
  - Request flowchart module
  - Transport flowchart module
  - Sequence data module
  - Transporter data module

Lab06a – Batch and Separate

- Combining entities and creating a new entity, and
- Assigning animations for entities in different stages.
- Match and batch

Lab07 – Truck Dispatching - Station-Route, Logical Entities

- Use modules from advanced process panel
  - Use 2-Way/N-Way by condition/chance decide modules
  - Check system variables, queue lengths, utilizations
  - Define terminating conditions
  - Understand and use fake (logical) entities
  - Add detailed animation to your model
  - Read variables/expressions directly from Excel
- Decide module
  - 2-way by Chance
  - 2-way by Condition
  - N-way by Chance
  - N-way by Condition

Day 4

Lec08_ Input Data Analysis – Probability Distributions

- Input Data Analysis and Modeling

MINP 501 - Simulation of Mining and Haulage Systems using Arena

- Testing Goodness of Fit
  - Chi – Square
  - Kolmogorov – Smirnov (K-S) Test
  - Square – Error
  - The P-P (probability – probability) plot
  - The (Q-Q) (quantile – quantile) plot

Lec09_Output Data Analysis

- Output Data Analysis and Modeling
  - Within replication statistics
  - Across replication statistics
  - Observational and Time-Persistent Data
- Simulation time horizon
- Finite horizon
  - Infinite horizon
  - Runtime confidence interval
- Process Analyzer

Lec10_Discrete Continuous Models

- What is a continuous system?
- Simple linear continuous systems
- Combined discrete/continuous systems
- Non-linear and complex systems
- Continuous systems Elements
  - Levels and Rates
  - Continuous
  - Crossing tolerance
  - Detect Block

Lab09 – Flow Process

- Tanks
  - Bulk material holding or storage
  - Liquid storage where a regulator represents a valve
  - Fluid-like material storage regulator is a gate valve
- Combining tanks

Lab10 – Modeling Coal Storage Bin Design

- Model storage bins/stockpiles
- Model crusher and run of mine stockpile
- Use continuous simulation - signal and regulators
- Combine discrete and continuous models
- Illustrate variable values in a plot
- Modify inter-arrival times during the simulation
- Hold entities until a specific condition is met
- Model surge bin and crusher dump pocket

Lec11_Advanced Statistics

- In shift time persistent statistics
- In shift frequency statistics

Lab11 – Stockpile Modeling

- Read the records from a sequential file
- Write the results to a sequential file
- Model truck arrivals based on dispatching data
- Coal/Iron Ore Terminal Stockpiling and Ships
- Modeling Discrete/Continuous Models
  - Flow Process Template – To Model Flow
  - Tanks, Regulators and Regulator Sets
  - Seize Regulator and Release Regulator modules
  - Trigger actions using a Sensors
  - Animate Flow of material
  - Continuous to discrete conversion

Day 5

Lec12_Transporters Free Path

- Model constrained entity transfer with resources
- Model constrained entity transfer with transporters
- Model automatic guided vehicles systems
- Basic animation for entity transfer situations
- Flowchart modules
  - Allocate, Move, Transport
  - Free, Halt, Activate

Lec13_Transporters Guided Path

- AGV is autonomous powered vehicle
- Transporters compete with each other for the space
- Vehicle's network
  - Network links
  - Zones and Bidirectional path
  - Unidirectional path
  - Spur and Stations
  - Intersections
- Start and end zone control rules
- Deadlocks

Lab12 – Advanced Transporters – Free and Guided Path

- Mine haulage simulation
- Arena Constructs:
  - Intersections element
  - Intersection object
  - Network data module
  - Network Link module

Lec14_Conveyors

- Gravity based and powered conveyors
- Accumulating conveyors
- Non-Accumulating conveyors
- Fixed spacing conveyors
- Random spacing conveyors
- Cell size and efficiency
- Modules
  - Conveyor - Segment
  - Access, Convey, Exit
  - Start, Stop
  - Enter and Leave
- Transferring between conveyors
- Merging conveyors
- Diverging conveyors
- Processing on conveyors

Lec15_Transporters & Conveyors Failures

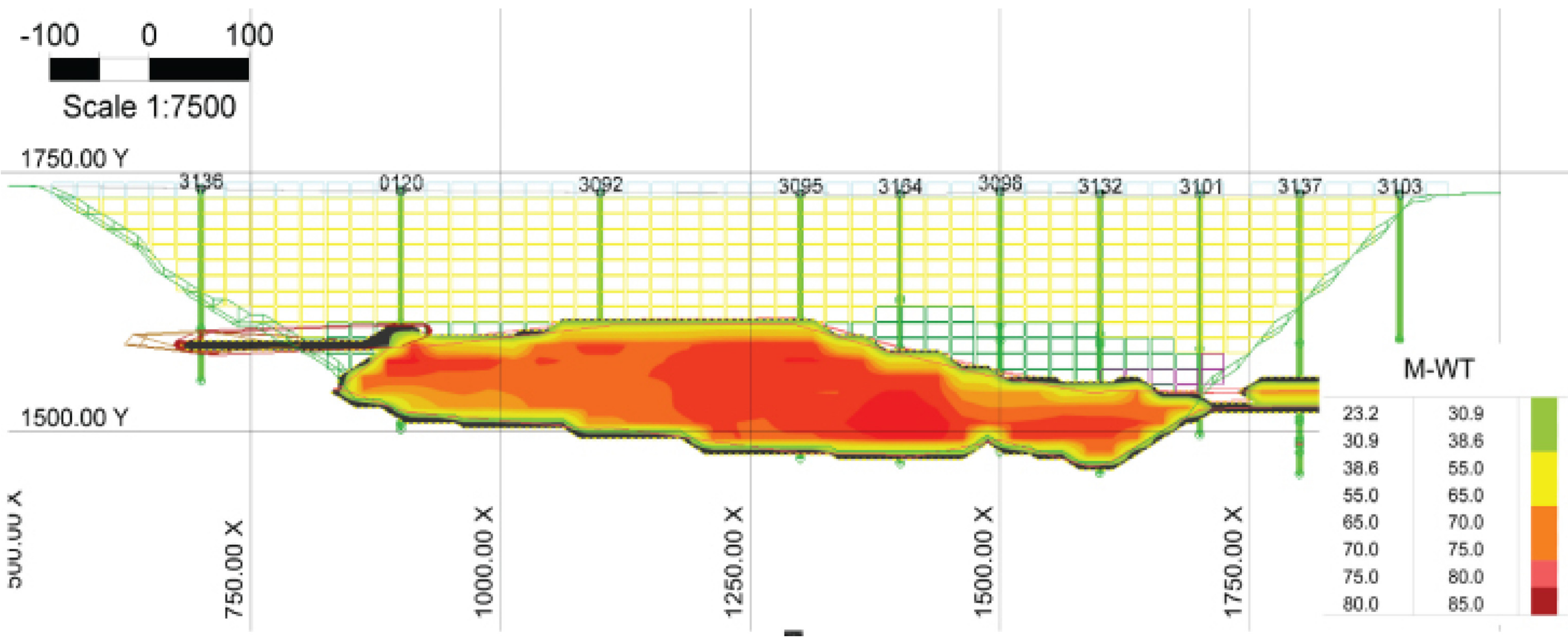
Lab13 – Crushing and Size Reduction Plant

- Model size reduction machines
- Model classifiers and branching streams
- Crusher and Conveyors
- Storage bins and stockpiles

Lab14 – Magnetic Separation

- Comminution machines
- Gyratory Crusher
- Semi-Autogenous Mills

GEOVIA GEMS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MINP 402 – Drillholes to Block Model using GEOVIA GEMS™

COURSE DESCRIPTION

Software: GEOVIA GEMS

Drillholes to Block Model is a five-day course that covers principles and fundamental concepts involved in drillhole database management; data manipulation, filtering, and validation techniques; drillhole compositing techniques; plot generations; surface and solid modeling for geological domain characterization; basic geostatistical analysis, variography and search ellipsoids setup, block model setup and estimation, single and multiple folder block models, inverse distance and kriging estimation, and NI-43-101 resource classification into measured, indicated, and inferred categories. This course will also explore different methods of categorizing and reporting volumes and tonnages for resources.

The course complements theory with comprehensive instructions and hands-on experience using GEOVIA GEMS software. Participants will complete a resource modeling project with an iron ore drillhole dataset. The project covers all the required steps from drillhole database setup to statistical analyses, experimental variogram calculation, variogram modeling, search ellipsoid setup, grade estimation using inverse distance and kriging, cross validation of results, and finally resource classification.

The modules for the course are as follows:

- Module 1: Drillholes Databases and Workspaces
- Module 2: Sections, Plan Views, and Plotting
- Module 3: Basic Statistics and Data Manipulation
- Module 4: Drillhole Compositing
- Module 5: Geology – Surface and Solid Modeling
- Module 6: Basic Statistics
- Module 7: Variograms
- Module 8: Single Folder Block Model
- Module 9: Partial Block Models
- Module10: Resource Classification

Outcomes of the course include:

By the end of this course, you will be able to complete the following in GEOVIA GEMS:

- Create new projects and databases
- Add and modify sections and plans views
- Load and display drillholes
- Manipulate data in the database
- Perform basic statistics on drillhole data
- Composite drillhole data
- Create points and polylines
- Use Plot Maker
- Use drillhole data to create basic surfaces
- Digitize 3D rings from interpreted drillhole data
- Create and manage triangulation solids ad surfaces
- Perform statistical analysis
- Understand variogram concepts
- Calculate experimental variograms
- Model variograms
- Interpret variogram maps
- Establish search ellipsoids
- Create block model projects
- Update block attributes for rock type and density
- Understand kriging theory
- Estimate grades using inverse distance and kriging
- Indicator kriging for numerical rock type modeling
- Create partial block models
- Cross validate the estimated block model values
- Import and export block models
- Classify resources based on NI 43-101 guidelines
- Report volumes and tonnages using the block model

Day 1

Module 1: Project Databases and Workspaces

- Drillhole databases
- Workspace and database concepts
- Header, survey, assay, lithology,
- From–to, distance, and point databases
- Workspace concepts
- Data types
- Creating workspaces for drillholes
- Editing data
- Validating the drillhole data
- Defining colour profiles and drillhole display profiles
- Opening drillhole data into the graphical area
- Profiles and profile groups

Module 2: Sections, Plan Views, and Plotting

- Sections and plan views
- Profiles and profile groups
- Cross and longitudinal sections, plan views
- Creating sections and plan views
- Viewing data on sections and plan views
- Creating inclined and diagonal sections
- Plotting data
- Creating drillhole plots from displayed data
- Creating symbol plots from displayed data
- Creating a grid and contour plot
- Create a structure plot
- Batch plotting

MINP 402 – Drillholes to Block Model using GEOVIA GEMS™

- Defining plot styles
- Creating extra viewports
- Creating title blocks and graphical images
- Saving images into catalogues
- Defining grid transformations

Day 2

Module 3: Basic Statistics and Data Manipulation

- Point data and filtering data
- Validating data
- Creating a workspace structure report
- Generating a quick report
- Preparing a user defined report
- Data extraction from the workspace
- Univariate statistics
- Multivariate statistics
- Creating a point area workspace
- Importing points into a point area workspace
- Defining the point display profile
- Opening points in the graphical area
- Basic statistics on raw data
- Working with data filters
- Working with SQL filters
- Manipulating data
- Defining manipulations
- Simple manipulation and conditional manipulation
- Cross table transfer and de-surveying

Module 4: Drillhole Compositing

- Compositing methods
  - By plan view
  - By equal length
  - By length within intervals from another table
  - By merging intervals from two tables
  - By a single cut-off value.
  - By multiple cut-off values
  - By grouped similar values
  - By Optimal values
- Workspace for composite results
- Calculating the composite
- Performing a thickness calculation
- Displaying drillholes with the calculated composites
  - Composite by rock code for geology polylines
  - Composite by cut-off grade
  - Basic Statistics on Composites
  - Determine optimum sample length for compositing
  - Composite equal length intervals within domains
  - Extract composites into a point area workspace
  - Carry out and compare basic statistics

Day 3

Module 5: Geology - Surface and Solid Modeling

- **Surface Modeling**
  - Working with polyline data
  - Creating a polyline workspace
  - Importing polylines from DXF or ASCII files
  - Defining the polyline display profile
  - Opening polylines into the graphical area
  - Selecting the drillhole intersects for the surface creation
  - Creating surfaces from active data
  - Preparing the surface using Laplace gridding
  - Gridding and Contouring Surfaces
  - Create and validate surfaces
  - Create topography, weathering, pits, faults, etc.
  - Creating surfaces with two sets of lines
  - Optimizing surfaces
  - Creating Surfaces using Spherical Gridding
  - Defining a spherical grid profile
- **Solid Modeling**
  - What are the basic polyline types and uses
  - Digitizing new polylines
  - Making polyline modifications
  - Drawing close polylines on sections
  - Defining 3D rings on section or plan
  - Using tie lines to connect 3D rings
  - Basics rules for the creations of rings and tie lines
  - Grooming the 3D rings
  - Creating the solid from rings and tie lines
  - Plotting the solid on section
  - Handling split rings
  - Handling dog ears
  - Drawing tie lines
  - Create geological domains using solids
  - Quick tonnes/grade calculations for geological domains
  - Solid boolean operations
  - Solid intersection with clipping boundaries
  - Contouring solids

Day 4

Module 6: Basic Statistics

- Understanding the Geological Domains
  - The Impact of Domains on Estimated Values
- Basic Statistics
  - Descriptive statistics
  - Histograms
  - Cumulative probability plots

MINP 402 – Drillholes to Block Model using GEOVIA GEMS™

- Probability plots
- Bimodal distributions
- Outliers
  - Outliers and top cuts
  - Methods for determining a top cut value
  - Confidence interval
  - Percentile
  - Applying a top cut in GEMS
- Anisotropy
  - Viewing a Search Ellipse Sphere
  - Examples of Search Ellipse Parameters

Module 7: Variograms

- Anisotropy
- Variogram concepts
  - What is a variogram?
  - Variogram parameters
  - Linear (downhole) variography
  - Omnidirectional and directional variography
  - Effect of nugget, and range
  - Creating and viewing experimental variograms
  - Changing the variogram type
  - Summary: steps to create an experimental variogram
- Modeling a Variogram
  - Modeling an experimental variogram
  - Viewing different types of variogram models
  - Summary: steps to model an experimental variogram
  - Variogram modelling tips
- Variogram Maps
  - Calculating and modeling the variogram maps
  - Establishing major direction of continuity
  - Saving variography parameters to profiles
  - Other geostatistical considerations

Day 5

Module 8 – Block Modeling

- **Single folder block model**
  - Block model geometry and workspace
  - Create additional attributes
- Create cell display profiles for block model
- Define block model geometry and set up workspace
- Create additional attributes and model mappings
- Initialize/check background values
- Steps required of block model initiation
  - Colour profiles
  - Rock Codes
  - Grade names
- Block model interpolation
  - Assignment of rock codes
  - Update rock types from solids
  - Updating density
- Grade estimation using Inverse Distance Squared (IDS)
  - Inverse Distance (True)
  - Inverse Distance (Anisotropic)
- Ordinary Kriging
  - Trace blocks
  - Search ellipse,
- Variogram and kriging profiles
- Block model manipulations
- Visual validation
- Other validation methods
- Block display
  - Selecting blocks for display
  - Display modes
  - Text height
  - Decimal places for value string
  - Scaling

- **Partial Block Models**
- Multiple folder block model setup
  - Grade interpolation using ID2 and OK
  - Volume, tonnes and grade reports
  - Compare and validate results
- **Resource Classification**
  - Measured, Indicated, and Inferred
- **Volumetric Resources/Reserves Reports**
  - Reporting groups
  - Rock codes and rock groups
  - Setting up rock codes
- Setting up rock groups
- Grade names and grade groups
- Resource/Reserve reporting groups
- Volumetrics profile export

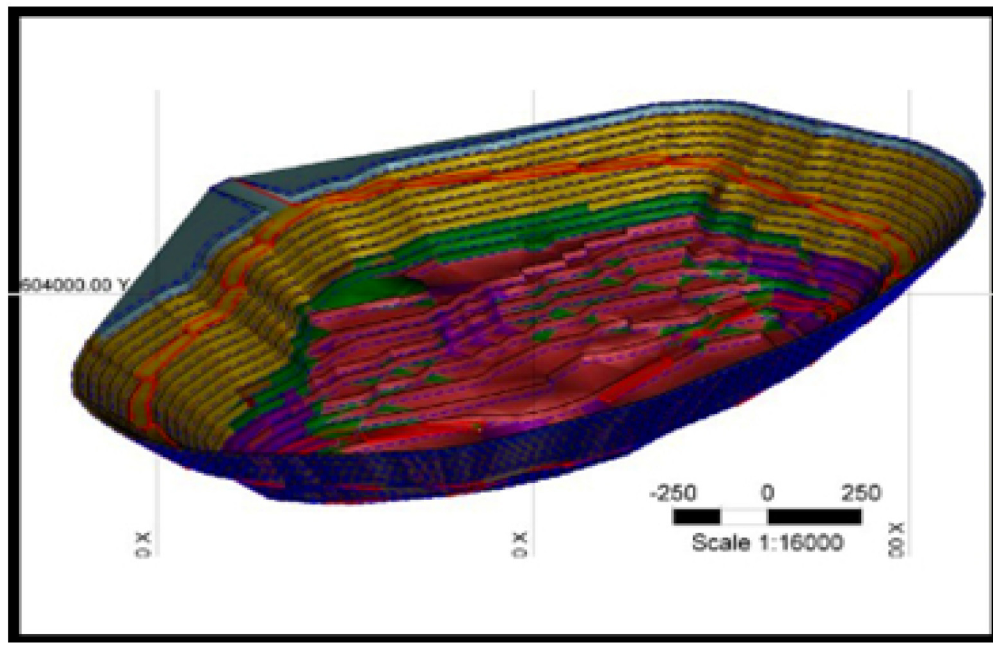
MINP 202 – Open Pit Mine and Waste Dump Design
GEOVIA GEMS™

Capital Investment, Operating Costs, Discount Rate → Maximize NPV, DCF, IRR

Course 3 - Open Pit and Waste Dump Design → Optimal Pit-Shells / Year End Surfaces → Working Bench / Equipment Specifications → Top-Down and Bottom-Up Pit Design → Waste Dump and Dyke Design → Road and Ramp Design → **Life-Of-Mine Reserves Reports**

GEOVIA

GEOVIA GEMS



MINP 202 – Open Pit Mine and Waste Dump Design
GEOVIA GEMS™

COURSE DESCRIPTION

Software: GEOVIA GEMS

Open Pit Mine Design is a two-day course designed for mine planners, mining engineers, geologist, and people who are responsible for activities that require them to design and manage pits, ramps, switchbacks, slots, and waste dumps. The participants will complete a pit-design project during the course. The course covers open pit design terminology, selection of loading and hauling equipment based on targeted annual production, working and safety bench geometry calculations, haul road parameters and geometric design. Prior to engaging in pit design, the course reviews principles and fundamental concepts in creating points, polylines, and triangulations; generations of plans and sections; also surface and solid modeling for the purpose of open pit design. The course includes a step-by-step project for top-down and bottom-up pit design. The project starts from the final optimal pit shell, intermediate pits shells, and the long-term schedule generated in Whittle. It covers topics on how to choose the required parameters such as berm width, variable pit slope angle, and batter angle to achieve a desired pit and dump design. The project continues with creating surface triangulations from the pit design, obtaining volumes, tonnages and grades reported by bench, rock type and grade range from the designed pit.

Outcomes of the course include:

- Understand pit design parameters & components
- Understand pit design theory
- Use optimal pit shells in pit design
- Select loading and hauling equipment
- Define Bench geometry as a function of equipment specs
- Understand haul road design
- Design of toes, crests, ramps, switchbacks and slots
- Define berm width, pit slope angle and batter angle
- Create final pit designs and surfaces from the designs
- Obtain volumes, tonnages and grades reported by bench
- Design variable pit slopes
- Handle multi-benching
- Manage single-pit splitting to multi-pits
- Design variable pit slopes based on rock-types
- Carryout multi-benching
- Design waste dumps

Day 1

- Open Pit Terminology & Calculations
  - Bench Face, Crest, Toe
  - Bench Height and Width
  - Berm, Batter Angel, Bank Width
- Selection of Loading & Hauling Equipment
  - Shovel size selection
  - Bucket capacity selection
  - Theoretical cycle time
  - Fill factor, efficiency, and availability
  - Determination of shovel geometry
  - Dumping radius and height
  - Shovel Selection from OEM literature
  - Haulage truck selection
- Bench Geometry and Equipment Specifications
  - Shovel working range specifications
  - Haul truck OEM specifications
  - Working bench width calculations
  - Safety bench width calculations
- Haul Road Design
  - Haul road design parameters
  - Haul road geometric design
  - Optimal and maximum sustained grades
  - Horizontal (longitudinal) alignment
  - Road width calculations
  - Curvature and switchbacks
  - Safety berms
  - Ditches and drainage
  - Estimating haul road rolling resistance
- Polyline Tools
  - Advance GEMS polyline tools
  - Create status line types/ user profiles
  - Create polyline workspaces
  - Digitize/edit and select polylines
  - Create boundary polygons
  - Multiline
  - Creating polylines for pit design

Day 2

- Pit Design Project Set Up
  - Create pit design project workspaces
  - Create/modify status line types
  - Create/modify bench profiles
- Pit Design Parameters
  - General design parameters
  - Define bench parameters
  - Define ramp slot parameters
  - Define rock code parameters
- Import LG Optimal Pit Shells & Schedule
- Open Pit Design
  - How many benches?
  - Deepest bench?
  - Top bench
  - Pit design steps
  - Bottom to top design tools
  - Top to bottom design tools
  - Create new toe/crest lines
  - Automatic fix features
  - Activate feature
  - Create ramp entrance
  - Ramp generation and automated pit design
  - Expand single bench
  - Expand multiple benches
  - Create slot entrance & switchbacks
  - Create line for opposite ramping
  - Single pit splitting into multiple pits
  - Typical pit design issues and errors

Day 3

- Variable Pit Slopes
  - Defining geotechnical domains
  - Blending?
  - Defining slope domains for the pit
- Multi-Benching
- Creating a Surface from Pit Designs
  - Create TIN Surface
  - Create a pit surface
  - Combine the pit surface with topography
  - Surface Creation Errors
- Calculating and Categorizing Volumes
  - Volumetric reports (tonnes/grades)
  - Volumetric settings
  - Volume between two surfaces
  - Volume by bench
  - Grades and tonnages
- Dump Design
  - General dump design parameters
  - Define bench parameters
  - Set current bench/toe
  - Create new toe/crest lines
  - Create ramp entrance
  - Expand single bench
  - Expand multiple benches