

COMPUTER WORKSHOP I: ORE OPTIMIZATION AND RISK ASSESSMENT USING WHITTLE SOFTWARE

This workshop covers the steps needed to carry out geological risk analysis using the Whittle software. A data set obtained from a part of a gold mine containing fresh ore, FROR, oxide ore, OXOR, and waste material is used to perform the analysis. This computer exercise consists of three major parts.

The first part covers the topics: finding the optimal ultimate pit limits, determining nested pit shells, designing pushbacks, effect of extraction sequence of ore/waste blocks in production scheduling and long term planning, and some of the traditional risk analysis. Note that a parameter file called “parfile.par” and three input files named “kriging.mod,” “sim1.mod” and “sim2.mod” are used. The formats and contents of the files are discussed where appropriate.

An estimated orebody block model is imported to Whittle. After adding the slope set to the project, pit shells are generated and ultimate pit limits selected. Once the optimal final pit limits are decided, three pushbacks are defined to represent the mining sequence over three periods of production using Milawa NPV option. After generating the three periods of schedule, the results are viewed in the program and exported to a file in spreadsheet format. The scheduling performed on the first part based on the traditionally estimated orebody model is referred to, in this workshop, as “base case”.

In the second part of this workshop, sensitivity analysis under conditions of uncertainty on the ultimate pit and pushback is performed using simulated realisations of the orebody. A methodology to quantify the risk of the traditional pushback design is introduced.

In the third part of the workshop, the step by step optimization in mine design based on risk quantification is illustrated. In this optimization procedure, simulated realisations are used to generate different pushback designs. After generating two different designs, risk analysis is performed on each of the individual designs based on some selected criteria that a decision maker might be interested in knowing for selecting a mine design.

Computer Workshop I: Optimization and Risk Assessment

The results are summarised in the file Risk_Analysis.xls. There are two types of other files needed in this workshop: (A) the orebody block model file, and (B) the parameter file. The format and the contents of the files are as follows:

A) Orebody block model files (mod): This type of files are identified by their extension as “mod.” They contain the specification of the block model of the deposit such as block co-ordinates, metal grade, ore and waste tonnage etc.

Estimated (Kriging) model: kriging.mod: Used for building the “Base Case”

Simulation Models: sim1.mod and sim2.mod: Used to perform the risk analysis

Format: The formats of the parameter and model files are provided in the Whittle software’s manual and the summarised below.

Input Data Format:

The first line:

X Y Z Number of Parcels, Positional mining CAF, Processing CAF, tonnage

The second line:

X Y Z RockType tonnage MetalContent

If the number of the parcel for a block is zero, “the second line” doesn’t exist for that block. If the number of the parcels is 1 or more, “the second line” is written for each of the parcels for that block.

For example:

61	42	14	0	1.570	1.000	5664.00
45	43	14	1	1.570	1.000	5664.00
45	43	14	FRWS	5664.00	1055.20	

B) Parameter file: In this workshop, all the necessary parameters for the design and planning of the pit are provided.

The parameter file name: parfile.par

Format : The format of the parameter file is summarised as below.

1 dx dy dz x₀ y₀ z₀

Computer Workshop I: Optimization and Risk Assessment

- (block dimensions along x, y and z directions and the origin of model)
- 2** nx ny nz
(number of blocks along x, y and z directions)
- 3** ABI MCAF PCAF PRNT RSTINT RSTME
[active block indicator, positional mining CAF(1=use CAF, 0=do not use), processing CAF(1=use CAF, 0=do not use), printing index (1:quantity of unprocessed material printed, 0:quantity of unprocessed material not printed), restart interval and restart time]
- 4** 1 nx 1 ny 1 nz
(sub-region block limits)
- 5** 1 30 0.0
(number of slope regions, number of benches to generate structure arcs, default block tonnage)
- 6** 0.0 54.0
(slope bearing angle, pit slope)
- 12** 4 0 4 4 0 \$
(decimal places to write: block ton, total ton, revenue factor, currency total, currency-character)
- 13** 1.000 1.000 1 2 1.800 1
(general block tonnage, dilution factor, [recovery, the selling cost ratio; not used,] air flag A=consider air blocks in optimization(1) or do not (2), air flag B=air blocks not included in the result file (1) or air blocks within the ultimate pit are included (2)-Air flag A must be 1, or all air blocks in the model file are included (3), reference mining cost, ore selection by cutoff (1) or by cash flow (2))
- 14** 0.1657506
(revenue factor as single number or range start-step size-end)
- 18** GOLD 1 4 4 4

Computer Workshop I: Optimization and Risk Assessment

(element type, position in the file, decimal places for gold in the block: total unit of element, grades and cut-offs for this element.

20 GOLD 0 19.2900

(element, selling cost/unit, price/unit)

21 OXOR 1.000 0 1.000 (rock type, mining CAF, rehabilitation cost/ton,
processing throughput factor—speed of processor for a particular rock type)

25 MILL OXOR 8.195 (processing method, rock type, processing cost/ton)

26 GOLD C 0 0.900 0 0 100(element type, cutoff controlled (C) or
not controlled (N), processing cost/unit, process recovery fraction, recovery threshold,
minimum and maximum).

PART 1

The computer session of this first part focuses on the basics of using the Whittle software. This is only useful to those who have not used Whittle previously. This section covers importing data in to Whittle, generating pit shells and ultimate pit limits, designing pushbacks from pit shells and optimization with the Milawa-NPV option. Some of the traditional sensitivity analysis such as varying commodity price and processing capacity are also included in the notes, but is not be performed in this workshop. The data set that is generated from an estimation method (here kriging) is used as input and the schedules and pushbacks obtained in the first part are referred to as the “base case” during analysis performed in subsequent parts.

1 Import Deposit Data in to Whittle

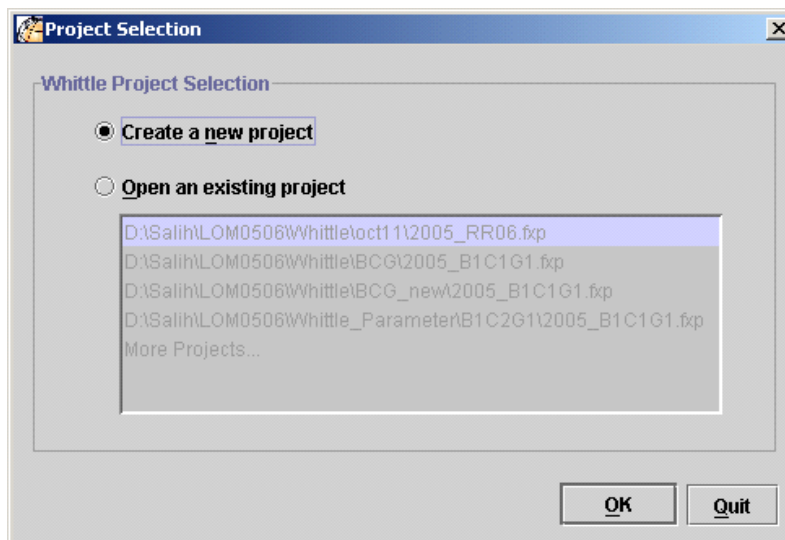
Make a new directory in C:\ drive called “workshop.” Then, inside the workshop directory, make a subdirectory called “working.”

Copy the files: ‘parfile.par’, ‘kriging.mod’ into the “workshop” directory.

Open Whittle and import parfile.par and kriging.mod files as follows:

Double click on icon FXPE.

Click on create a new project and hit OK.



Type project name: workshop, select project directory by clicking on the directory icon on the right side—C:\workshop. Then, select “project working” directory—

Computer Workshop I: Optimization and Risk Assessment

C:\workshop\working. Click on “next”, for import type, choose “block model,” browse in the directory workshop to find “kriging.mod” as the model file to import, and “parfile.par” as the parameter file to import. Then, click on finish and “yes” to confirm.

Project Name:
Workshop


Project Save File:
Workshop.fxp


Project Directory:
C:\workshop\


Project Working directory:
C:\workshop\working
(Directories will be created if they don't already exist)


Finish **< Previous** **Next >** **Cancel**


Import type


☒ **Block model** 


☐ **Datamine model** 

☐ **Flatfile model** 

☐ **Surpac model** 

☐ **Medsystem model** 

☐ **Pitshells** 

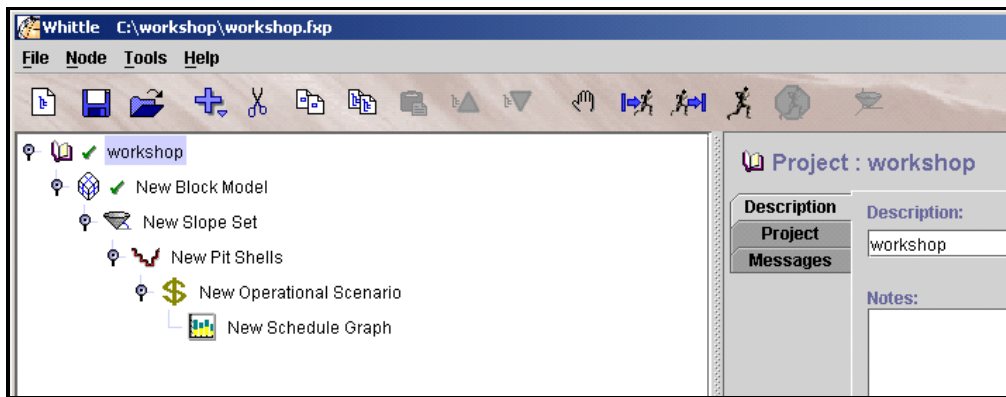
☐ **Project Only** 

Model File to import:
C:\workshop\kriging.mod

Parameters File to import (optional):
C:\workshop\parfile.par

Finish **< Previous** **Next >** **Cancel**

Computer Workshop I: Optimization and Risk Assessment



Check the parameters loaded and run the program by clicking on the third man icon.

Now, click on each of the tabs and check what information is provided.

2 Generate Ultimate pit limits

Click on “**New Block Model**” on the left side and “description” tab appears on the right side. Type “Kriging Block Model.” By clicking on the tabs on the right side, you can check to ensure that correct parameters are entered in the parameter file. Click on “accept” on the right-bottom of the screen.

Click on “**New Slope Set**” on the left and description tab on the right. Type “Kriging Slope Set” for the description and click on accept keeping all the values as default. Click on “Profile” tab and check the parameters.

Click on “**New Pit Shells**” on the left and description tab on the right. Type “Kriging Pit Shells” for the description and click on accept keeping all the values as read from the parameter file. Right-click on “New Schedule Graph” on the left side and choose “cut-branch” from the menu.

Block Model : Kriging Model

Description

Rock-types present in entire model file:

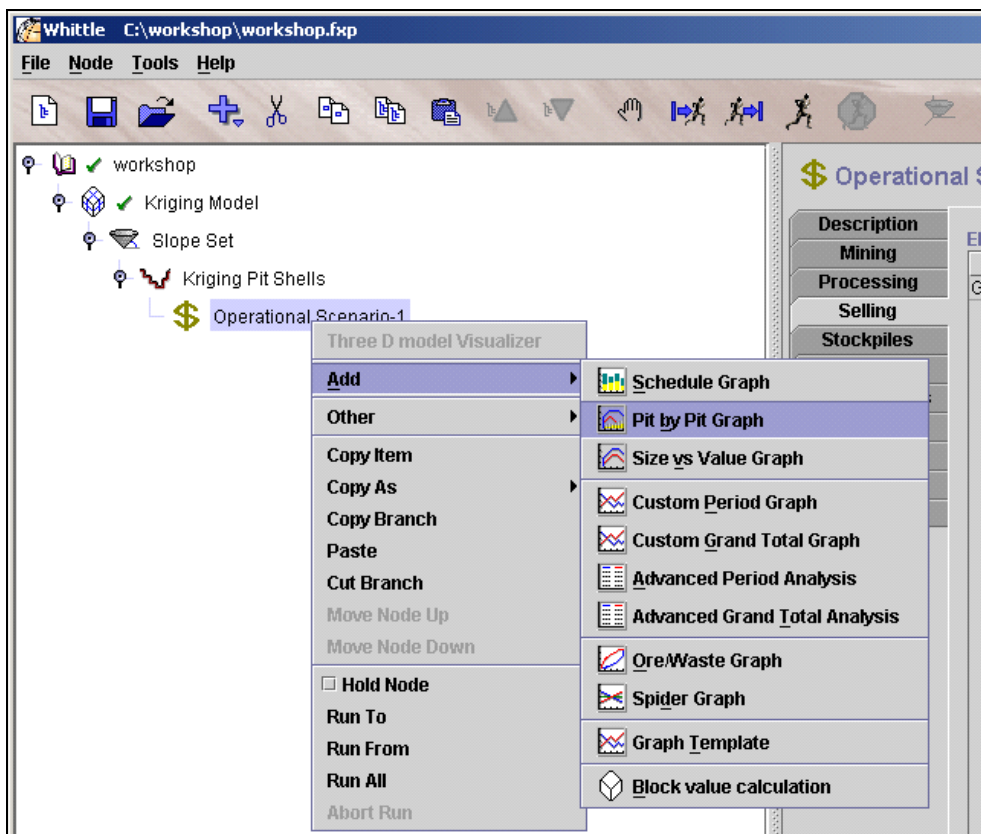
Num.	Rock-Type	tonne
1	OXOR	1,666,471
2	OXWS	0
3	FROR	29,865,482
4	FRWS	13,351,538

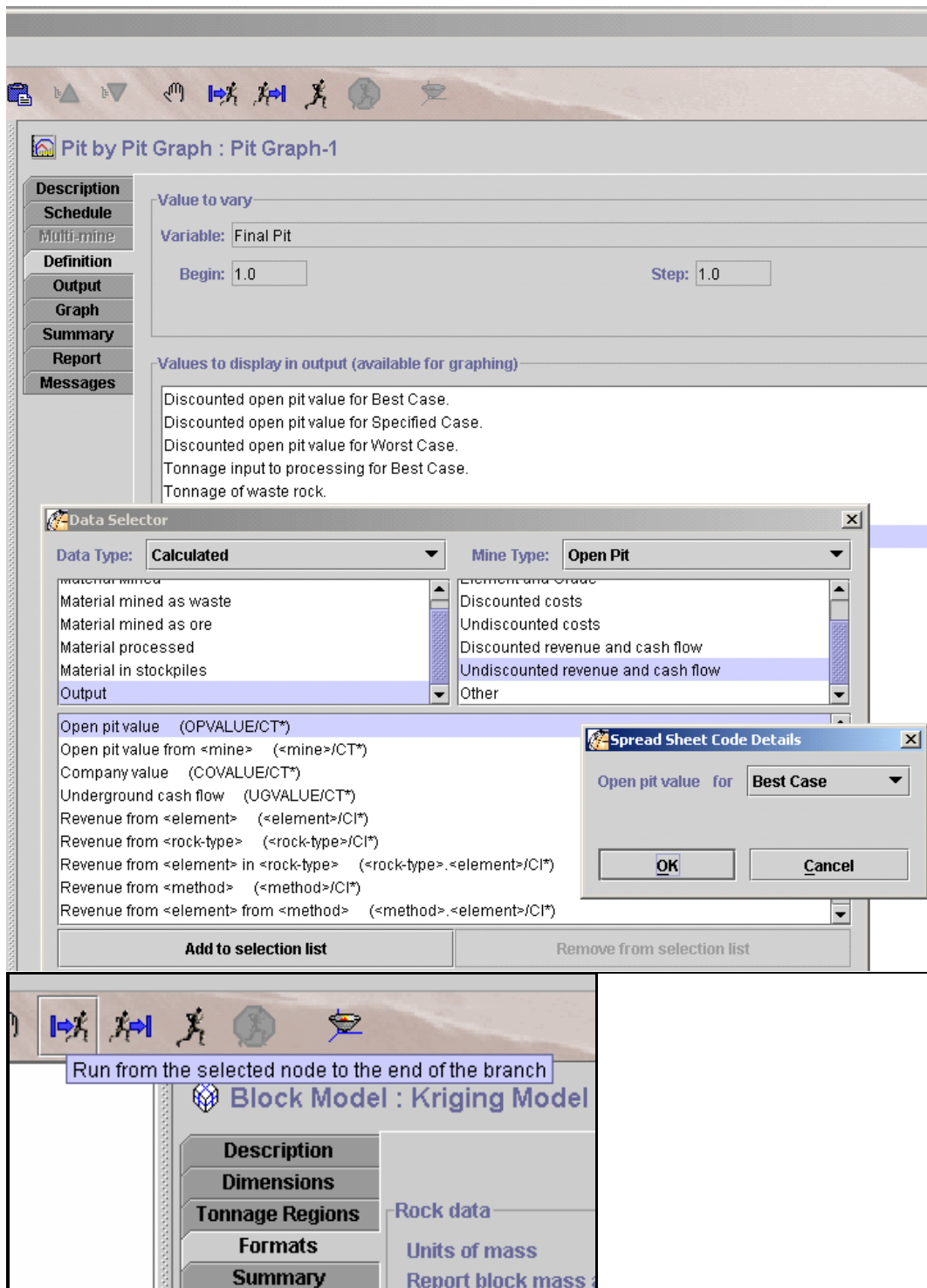
Elements present in entire model file:

Num.	Element	Total Units	Min.Grade	Max.Grade
1	GOLD	31,896,885	0.075	3.6809

Click on description tab and type “*Operational Scenario-1*.” Click on “time cost” tab and change the discount rate to 8%. Then, Click on the “limits” tab on the right side. Type 1,000,000 in processing method under “limit”. Then, click on “accept”.

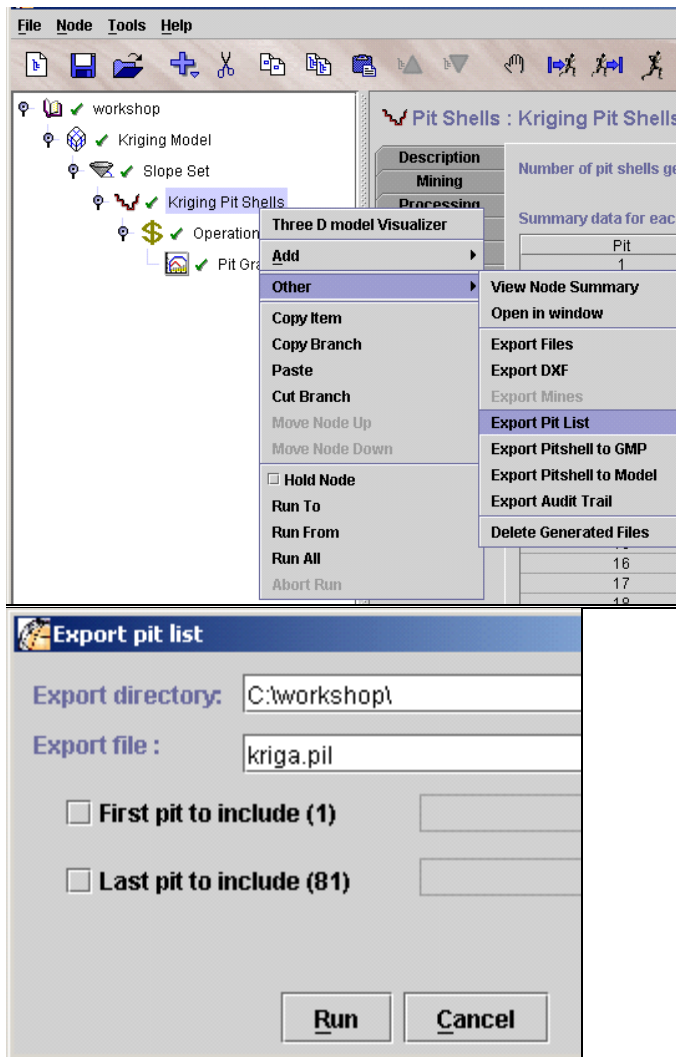
Add Pit by Pit Graph: Right click on “Operational Scenario-1” and add “Pit by Pit Graph”. Click on “description” tab and type “Pit by Pit Graph-1”. On schedule tab, ensure that “fixed lead” is selected with “0” value. On definition tab, delete all the lines below “tonnage of waste rock”. Then add a new value to be displayed by clicking in ‘add’ select output on the left and select undiscounted revenue and cash flow’ on the right, and choose “Open Pit Value”. Click on add to selection list and best case, click on OK. Then, click on OK and accept it by clicking “accept” in the general window. Then, run the program by clicking the running man icon.





Generating the pit list: Right click on the Kriging Pit Shells and select Tools-Export-Pit-List- select the workshop directory and change the name to kriga.pil, click on run. Click on “OK” for the message. The pit list exported contains 81 pit shells and will be used later.

Computer Workshop I: Optimization and Risk Assessment



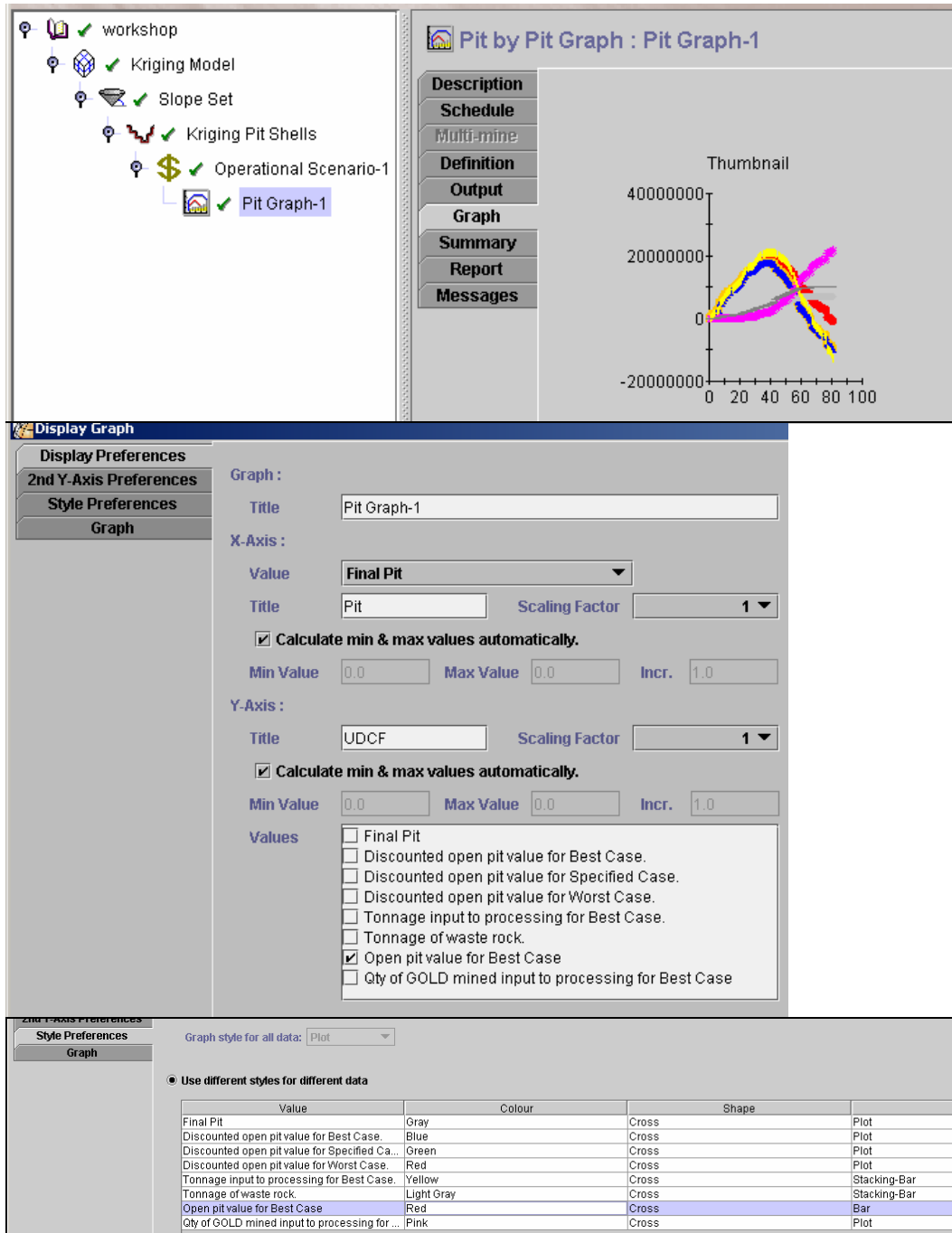
Computer Workshop I: Optimization and Risk Assessment

Finding the optimal pit: Click on “Pit by Pit Graph-1.” Click on “output” tab on the right side. It shows the best, specified and worst case scenarios. The optimum pit can be found from there: checking in the undiscounted cash flow it is seen that pit shell 41 has the highest value and is chosen as the ultimate pit.

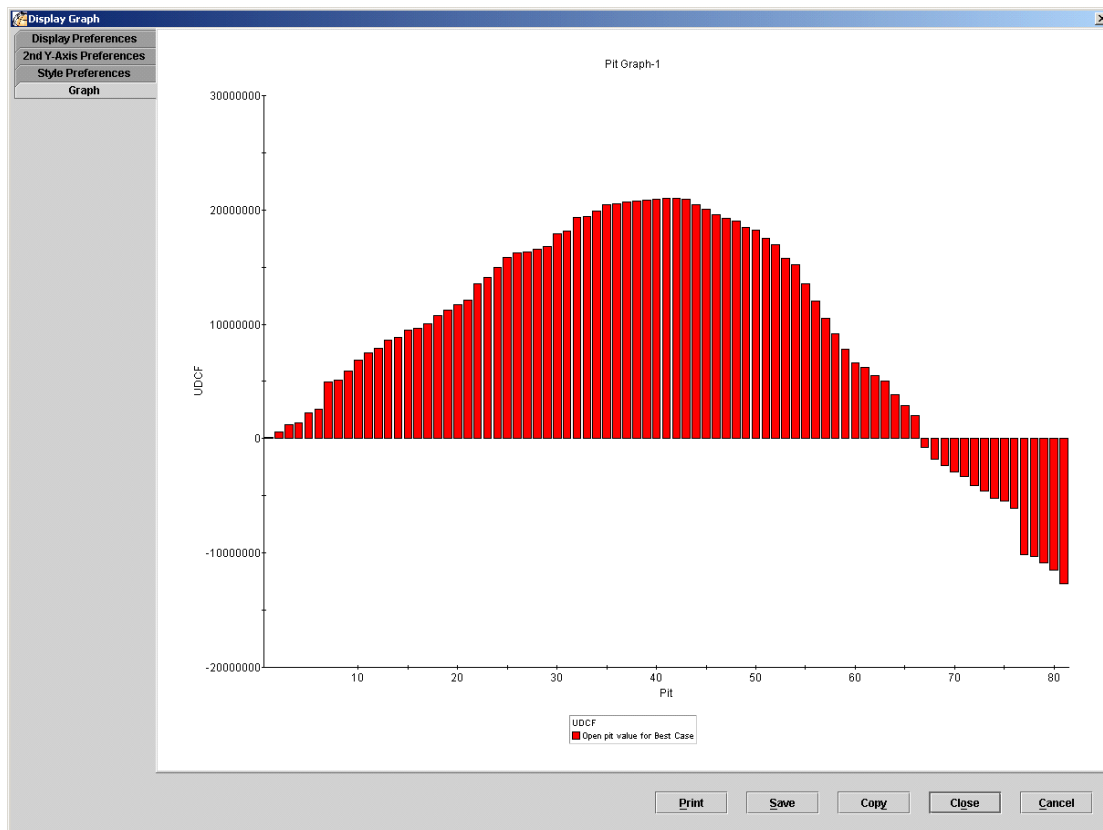
<div> <div>workshop</div> <div> <div>Kriging Model</div> <div>Slope Set</div> <div>Kriging Pit Shells</div> <div>Operational Scenario-1</div> <div>Pit Graph-1</div> </div> </div>		Pit by Pit Graph : Pit Graph-1							
Description									
Schedule									
Multi-mine									
Definition									
Output									
Graph									
Summary									
Report									
Messages									
	Final pit	Open pit cashflow best \$ disc	Open pit cashflow specified \$ disc	Open pit cashflow worst \$ disc	tonne input best	Waste best tonne	Open pit cashflow best \$	Units input GOLD best	
16		9,318,051	9,318,051	9,318,051	471,681	108,710	9,662,521	1,128,967	
17		9,702,453	9,702,453	9,702,453	503,154	146,905	10,085,533	1,194,150	
18		10,321,432	10,321,432	10,321,432	566,412	152,569	10,781,311	1,304,726	
19		10,726,485	10,726,485	10,726,485	622,802	152,569	11,253,143	1,379,423	
20		11,107,545	11,107,545	11,107,545	664,393	152,569	11,690,271	1,454,549	
21		11,430,565	11,430,565	11,430,565	713,346	152,569	12,075,647	1,522,379	
22		12,630,369	12,630,369	12,630,369	879,858	306,803	13,515,253	1,809,487	
23		13,133,674	13,133,674	13,133,674	953,010	369,273	14,133,165	1,936,646	
24		13,840,801	13,839,139	13,839,139	1,059,647	369,273	14,950,242	2,110,481	
25		14,645,565	14,623,183	14,623,183	1,191,005	421,503	15,837,085	2,320,462	
26		15,000,943	14,959,463	14,959,463	1,255,109	472,512	16,235,239	2,413,443	
27		15,113,507	15,061,027	15,061,027	1,282,469	472,512	16,363,191	2,446,883	
28		15,280,996	15,214,217	15,214,217	1,318,219	472,512	16,553,765	2,499,015	
29		15,532,670	15,437,687	15,437,687	1,376,007	472,512	16,842,820	2,583,710	
30		16,428,088	16,199,937	16,199,937	1,591,514	840,106	17,894,510	2,914,072	
31		16,618,947	16,351,339	16,351,339	1,653,301	868,426	18,127,565	2,994,889	
32		17,573,104	17,074,575	17,074,575	1,959,239	1,381,953	19,324,028	3,462,263	
33		17,680,891	17,141,370	17,141,370	2,006,253	1,384,379	19,464,996	3,521,471	
34		18,035,499	17,436,380	17,436,380	2,146,893	1,553,682	19,883,527	3,723,986	
35		18,525,230	17,774,835	17,774,835	2,372,647	1,931,759	20,479,047	4,058,970	
36		18,593,066	17,800,915	17,800,915	2,415,690	1,943,087	20,564,173	4,113,441	
37		18,701,115	17,834,049	17,834,049	2,504,605	1,943,087	20,702,875	4,222,080	
38		18,763,020	17,844,839	17,844,839	2,566,163	1,971,407	20,784,268	4,301,855	
39		18,844,326	17,833,407	17,833,407	2,682,438	2,182,262	20,896,252	4,468,411	
40		18,890,163	17,764,484	17,764,484	2,792,357	2,306,046	20,965,404	4,609,862	
41		18,906,882	17,566,107	17,566,107	2,992,369	2,627,008	21,009,780	4,868,825	
42		18,904,775	17,453,851	17,453,851	3,129,587	2,699,940	21,008,836	5,031,811	
43		18,836,803	17,219,989	17,219,989	3,356,147	2,944,642	20,921,786	5,318,343	
44		18,497,937	16,188,168	16,188,168	4,025,843	3,555,467	20,459,318	6,111,077	
45		18,211,636	15,527,108	15,527,108	4,384,978	4,187,395	20,061,190	6,556,859	
46		17,885,695	14,878,446	14,878,446	4,669,634	4,827,328	19,587,926	6,933,642	
47		17,687,099	14,456,765	14,456,765	4,827,746	5,121,985	19,290,650	7,130,413	
48		17,516,520	14,116,434	14,116,434	4,952,354	5,311,131	19,030,733	7,281,159	
49		17,156,973	13,605,643	13,605,643	5,149,154	5,577,416	18,497,053	7,500,074	
50		16,987,299	13,357,157	13,357,157	5,211,458	5,726,087	18,243,427	7,574,681	
51		16,537,792	12,664,607	12,664,607	5,392,706	6,275,294	17,558,454	7,808,790	
52		16,170,761	12,105,289	12,105,289	5,522,498	6,559,995	16,987,136	7,954,683	

Computer Workshop I: Optimization and Risk Assessment

Click on the “Graph” tab and press zoom button. Click on the preferences. Type UDCF on the Title of Y-Axis. Select only “Open Pit Value” and unselect the other options. Click on the 2nd Y-Axis preference tab and unselect “Use multiple Y-Axis” because you have choosen only one display, so no need for the second axis. Click on “Style preferences” and select “Open pit value for the best case.” Change the Style to Bar, and Colour to red. Click on Graph tab to see the modified plot.

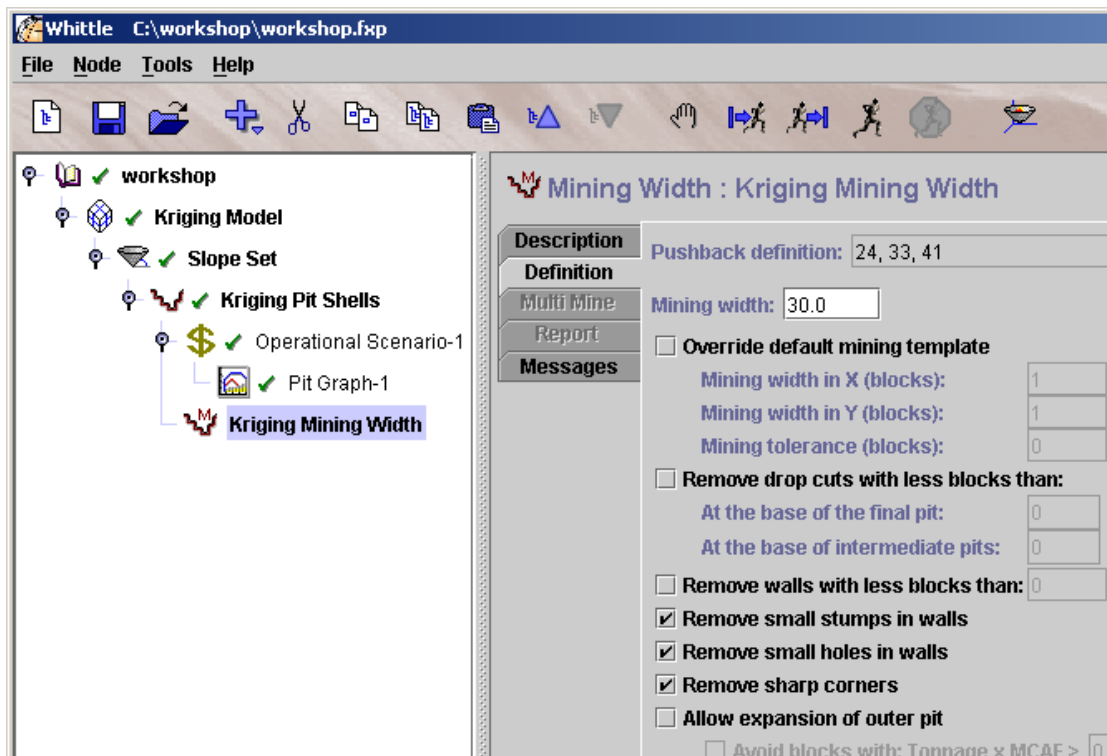
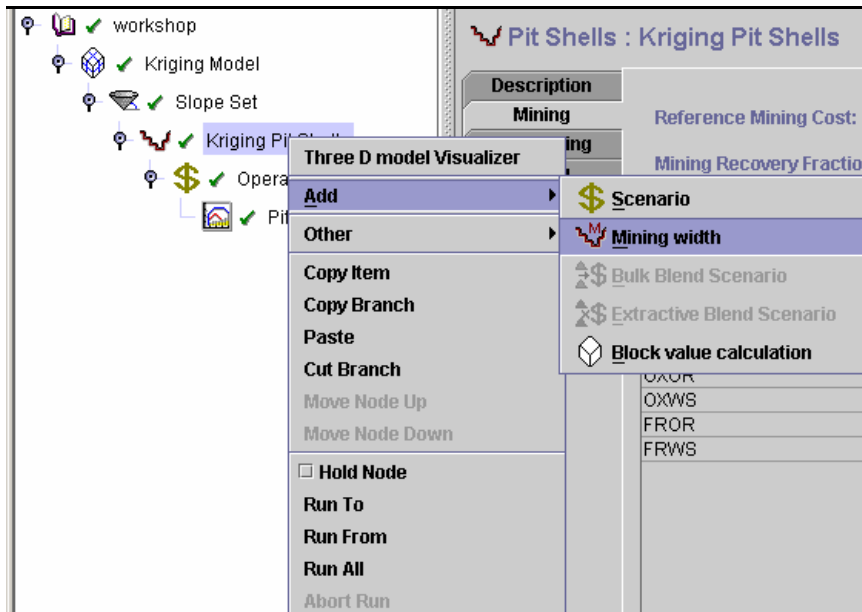


Computer Workshop I: Optimization and Risk Assessment



3 Generating Pushbacks From Pit Shells

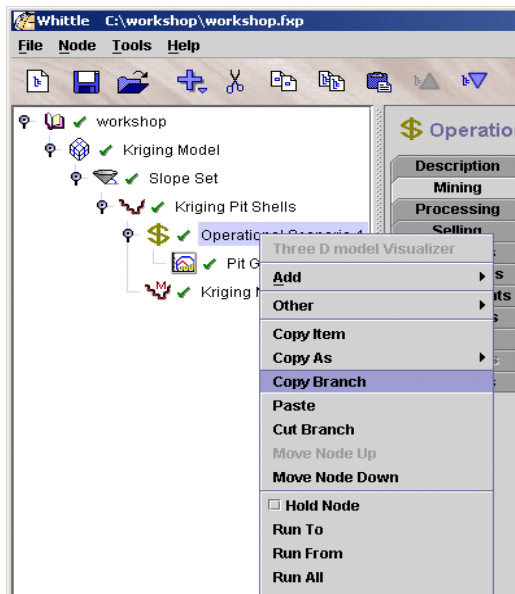
Adding **Mining Width** (combine pit shells to pushbacks): Right-click on “Kriging Pit Shells” select “add” and “mining width”. Then, click on description tab and type “Kriging Mining Width.” Click on “definition” tab. Type 30 as mining width. Then, in “pushback definition”, click on edit pushbacks and type 24, 33, 41. Run the program to combine pit shells to pushbacks.



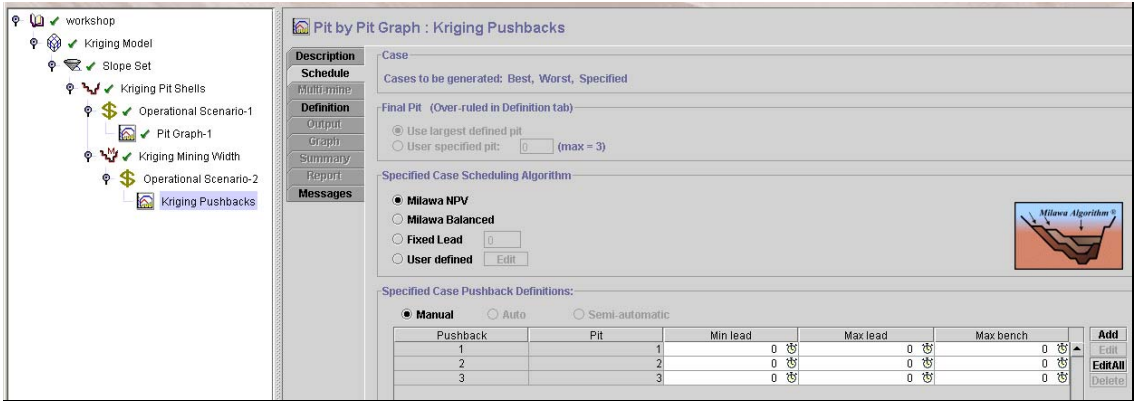
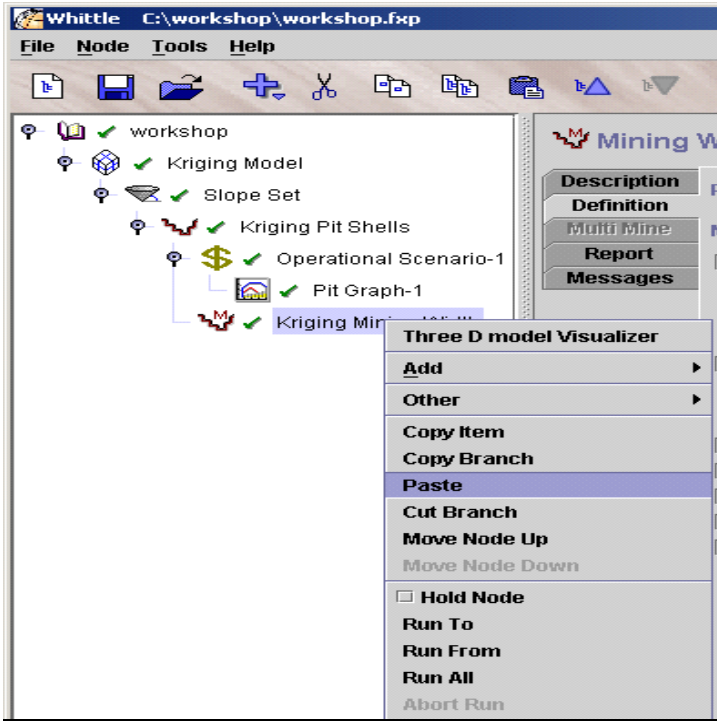
Generating Pit list Krigb.pil: Right click on “Kriging Mining Width”, tools-exporting pit-list- select the working directory and change the name to krigb.pil, export it. Here, this pit list contains block coordinates and the number representing three pushbacks.

4 Optimization by Milawa-NPV

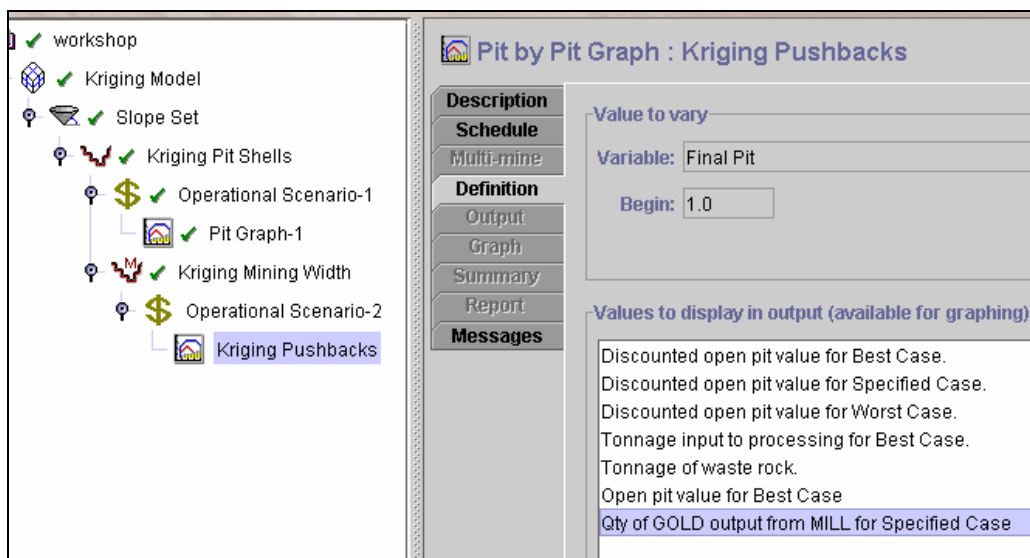
Add Scenario: You can copy and paste from the previous scenario and pit by pit graph and modify the pit by pit graph, or right click on “mining width” icon and add scenario. Click on description tab and type “Operational Scenario-2” and Click on time cost tab to change discount rate to 8%. Click on limits and type 1,000,000 on mill limits and click “accept. Right click on “operational scenario-2”



Computer Workshop I: Optimization and Risk Assessment

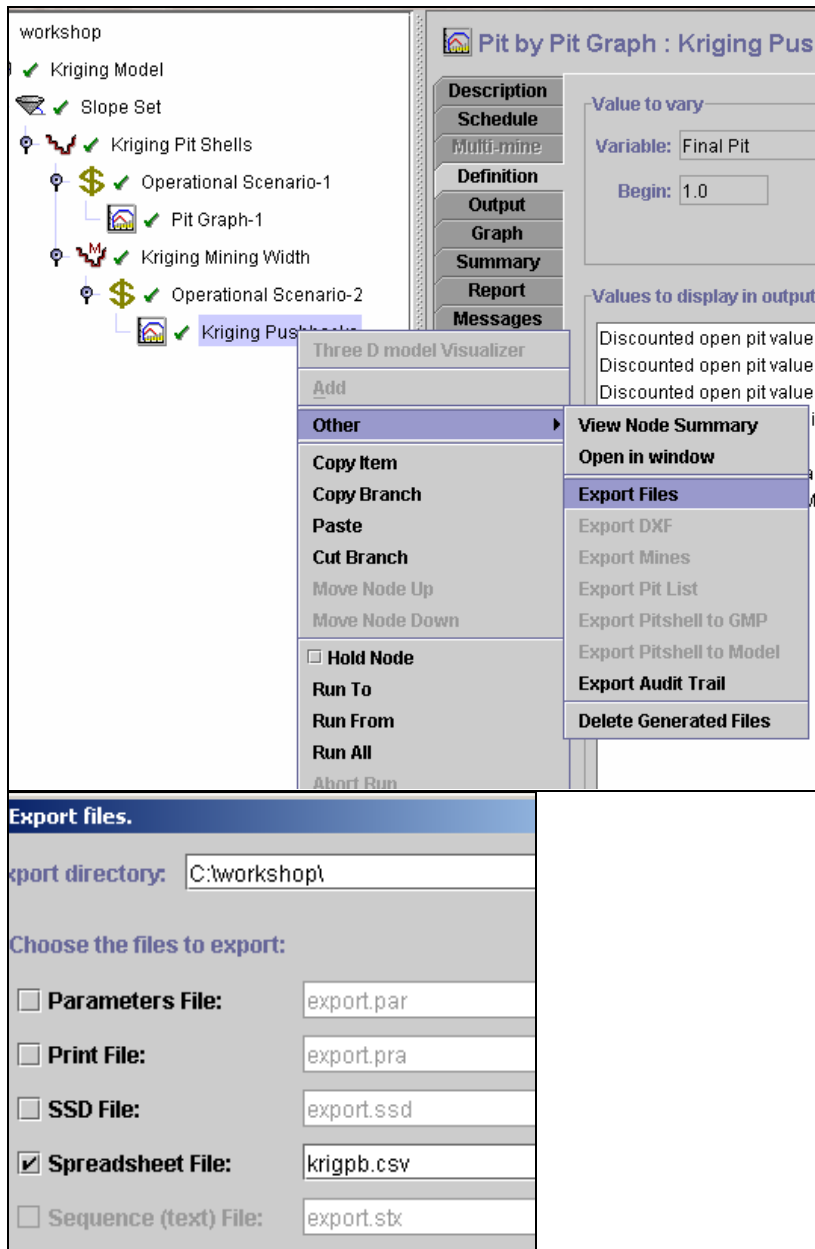


Pit by Pit Graph: Select pit by pit graph and on description tab, type “kriging pushback”. On “schedule” tab, click on “Milawa NPV” and click on “add” on the right side, pit 1, then pit 2 and pit 3 by clicking “add” on the right side. On definition tab, delete all the lines below “tonnage of waste rock” and click on add. Then, click on “output” on the left, and on the right choose “element and grade” and at down choose “Qty of <element> output from <method> (<method><element> /UO*) to have metal in the output file. Click on “add to selection”, choose “Gold”, from “mill” for “specified case”, and OK. Click “accept”. Then, run the program by clicking on 2nd running man.



5 Exporting the Results to Excel Worksheet

Click on the menu-button on “Kriging Pushbacks” on the left side. Choose Tools-Export Files options. See the directory that file will be created (directory can be changed by clicking at the end of directory name box). Click on the square beside “Spreadsheet File” to put a check-sign and type the name as “krigpb.csv” and Ok .- Ok.

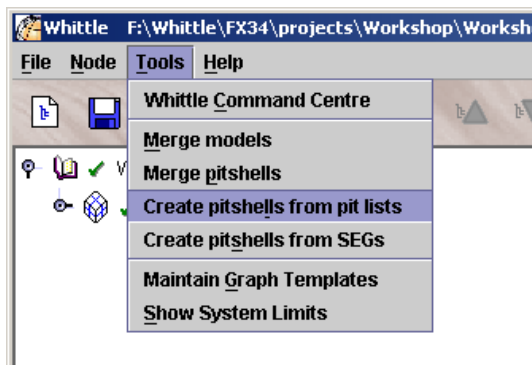


PART 2

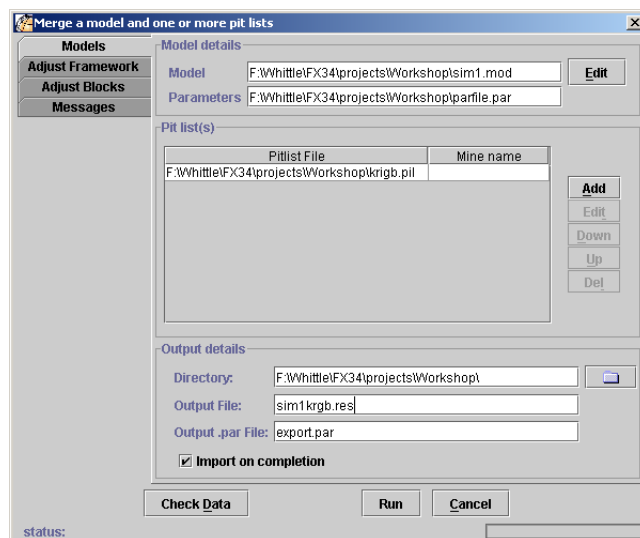
The computer session of this second part covers the detailed sensitivity analysis of a mine design under the condition of grade uncertainty. Two simulated orebody model files, sim1.mod and sim2.mod, are used to perform the analysis based on the project indicators: discounted cash flow (DCF), ore tonnage and metal content within each pushback and the final pit limits generated in Part 1.

6 Overlapping krigb.pil Frame on the Simulation Models and Generate Result Files

6.1 In the Tools menu select “Create pitshells from pit lists”



6.2 Click in Edit and browse for the Sim1.mod and parfile.par files. Select krigb.pil as the pit list file and change the name of the result file to sim1krbg.res.



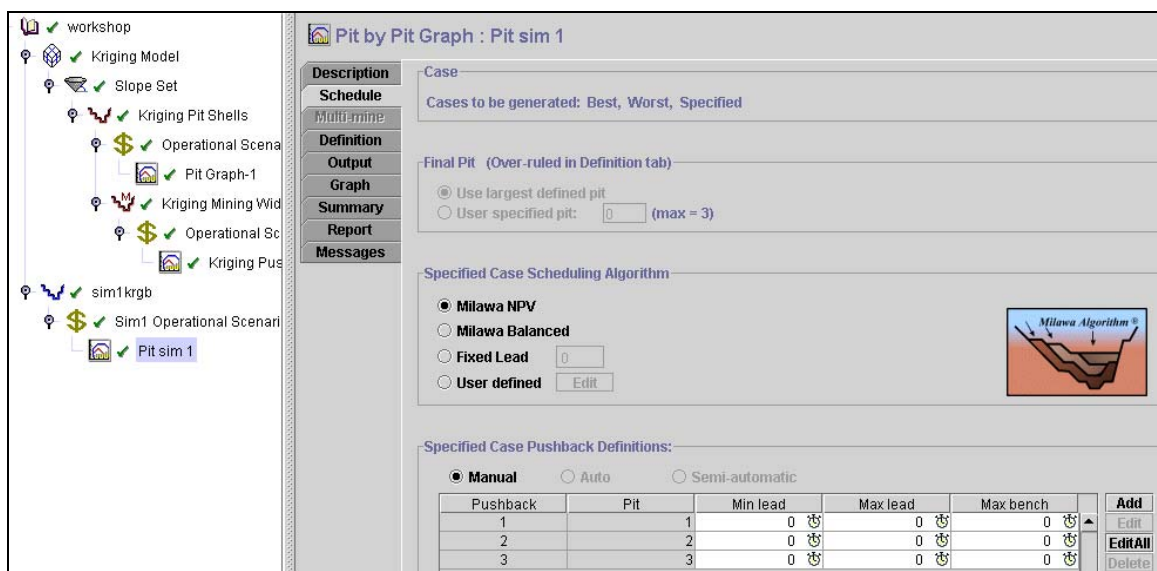
The Result File contains a code (-1 1 -97 0, first pit, last pit, 0, and revenue factor) in the first row. The other part is the same format as the model file except that the last column contained in Result File contains the pit number that is not in the mod file.

Risk analysis in this example can be summarised as follows: we have a pit design and a schedule generated from the estimated orebody model; and then we assess what happens if the true deposit one of the simulated orebody models mined with the previous design.

7 Generating the Values for the Result File

Rename “new imported pit shells” as “sim1krigb” on description tab and click “Accept.”

Copy the Operation Scenario 2 and paste under sim1krigb. Rename the scenario to “Sim1 Operational Scenario” and the pit-by-pit graph to “PitSim1”.



Milawa Schedule: Click on “schedule” tab. Choose “Milawa NPV” and click on add to include pits 1, 2 and 3. Then, run the program. Note that choosing “Milawa-

Computer Workshop I: Optimization and Risk Assessment

NPV” option here doesn’t have any importance, because each pushback contains only 1 year of ore material. So, the result is just the values obtained when the simulated model is overlapped with the base case schedule.

Checking Results: Click on output tab and see total DCF in specified case (\$19.718M) is higher than kriging case (\$18.877M). The first period’s ore production is very close to the original design, but in the second period, the mill could not be fed with full capacity, and appears almost 150k tons (15%) short in ore.

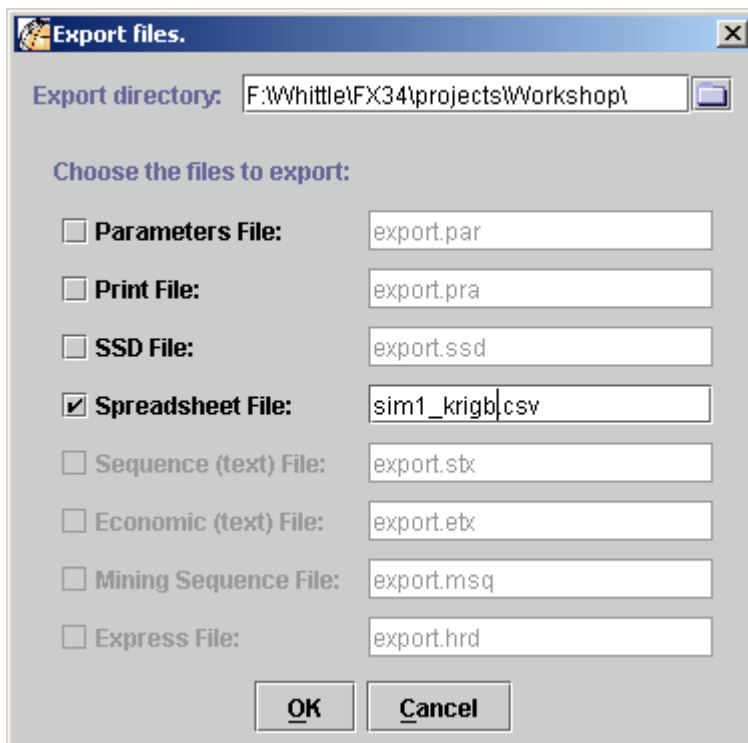
Pit by Pit Graph : Kriging Pushbacks								
Description								
Schedule								
Multi-mine								
Definition								
Output	Final pit	Open pit cashflow best \$ disc	Open pit cashflow specified \$ disc	Open pit cashflow worst \$ disc	tonne input best	Waste best tonne	Open pit cashflow best \$	Units output MILL GOLD specified
Graph	1	13,839,139	13,839,139	13,839,139	1,059,647	369,273	14,950,242	1,780,006
Summary	2	17,653,990	17,653,990	17,141,370	2,006,253	1,384,379	19,464,996	2,971,169
Report	3	18,877,372	18,877,372	17,566,107	2,992,369	2,627,008	21,009,780	4,105,429

Pit by Pit Graph : Pit sim 1								
Description								
Schedule								
Multi-mine								
Definition								
Output	Final pit	Open pit cashflow best \$ disc	Open pit cashflow specified \$ disc	Open pit cashflow worst \$ disc	tonne input best	Waste best tonne	Open pit cashflow best \$	Units output MILL GOLD specified
Graph	1	15,567,531	15,567,531	15,567,531	996,509	468,864	16,808,416	1,831,021
Summary	2	19,229,779	19,229,779	18,823,709	1,846,403	1,610,520	21,066,018	2,924,567
Report	3	19,718,016	19,747,821	18,818,852	2,501,867	3,208,971	21,758,126	3,740,430

Repeat all the steps starting from 6.1 up to the end of 7.4 for sim2.mod file. i.e., replace the word “sim1” by “sim2” in everywhere necessary.

8 Analysis Using Spreadsheet

Export the Results to spreadsheet file: Click on the menu-button on “Pit Sim1” on the left side. Choose tools-export file options. Click on the square beside “Spreadsheet File” to put a check-sign and type the name as “sim1_krigb.csv” and Ok .- Ok.



Click on the menu-button on “Pit Sim2” on the left side. Choose tools-export file options. Click on the square beside “Spreadsheet File” to put a check-sign and type the name as “sim2_krigb.csv” and Ok .- Ok.

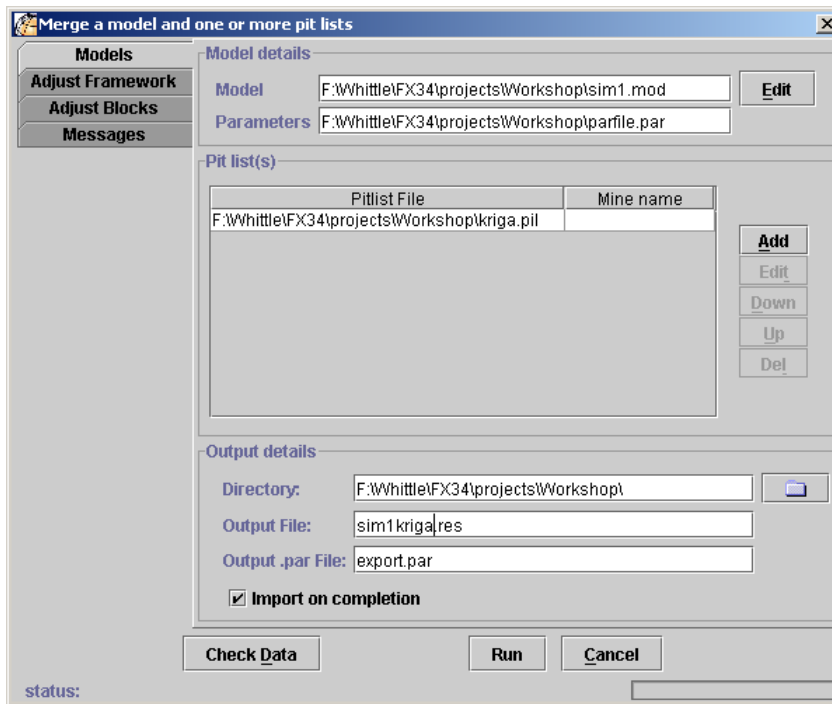
Open “Risk_Analysis.xls”, located in your working directory. Enable the auto-refreshment and if required browser for the files (all located in your working directory).

PART 3

The computer session in Part 3 of this workshop covers designing pushbacks for each of the simulations within the ultimate pit determined from the estimated orebody and quantifying the risk in each design. Then, based on certain selection criteria, the best design is chosen. Since the “frame” of ultimate pit is kept the same, the first process is to overlap pit shells (81) within the final pit with the simulated models sim1.mod and sim2.mod.

9 Overlapping the kriga.pil Frame on Simulated Models to Generate Result Files

As in step 6, reblock simulations sim1 and sim2 but now using the pit list kriga.pil. Generate sim1kriga.res and then sim2kriga.res in a similar way as generating sim1kriga.res.



10 Designing Pushbacks for Simulated Orebody Models

Click on the “New Imported Pit Shells” on the left and rename as “Sim1kriga” and Accept.

Copy the “Operational Scenario-1” branch under “Kriging Pit Shells” Node.

Copy the “Slope Set” item under “Kriging Model” node and paste it on “sim1kriga” node and accept. Then add “New Mining Width” on the “Slope Set” under sim1kriga.

Copy the “Operational Scenario” branch under “Kriging Mining Width.” Re-name the nodes to be able to recognise them in the future.

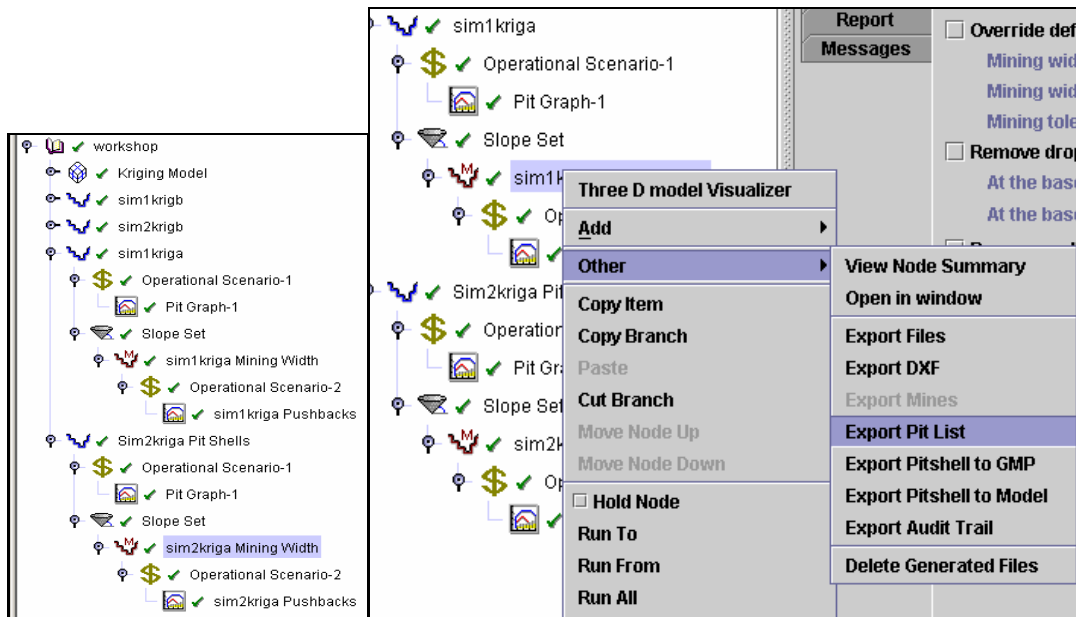
Click on the Definition tab on mining width and Edit on the right side of “Pushback definition” line by typing 25, 35, 41. Type 30 as mining width. Click on Accept. Run the program.

Generating Pit list: Right click on “Sim1a Mining Width”, tools-exporting pit-list- and change the name to sim1c.pil, export it. Here this pit list contains three pushbacks including pit shells up to 25, 35 & 41.

Obtaining Values within Pushbacks: Click on “schedule” tab. Choose “Milawa NPV” and click on add to include pits 1, 2 and 3. Then, run the program.

Export Results to Spreadsheet: Right click on “Sim1A Pushbacks” to select Tools-Export Files. Select Spreadsheet file and name it as “design1.csv”

Computer Workshop I: Optimization and Risk Assessment



Repeat the steps 2.1-2.8 by applying three changes carefully everywhere necessary:

Instead of typing sim1A, type sim2A

Instead of typing 25, 35 41, type 24, 37,41

Instead of design1, type design2.

Design according to sim1.mod, values are from sim1.mod.

Pit by Pit Graph : sim1kriga Pushbacks								
Description								
Schedule								
Multi-mine								
Definition								
Output	Final pit	Open pit cashflow best \$ disc	Open pit cashflow specified \$ disc	Open pit cashflow worst \$ disc	tonne input best	Waste best tonne	Open pit cashflow best \$	Units output MILL GOLD specified
Graph	1	16,651,185	16,651,185	16,651,185	1,119,900	532,737	18,004,744	2,017,043
Summary	2	19,765,352	19,766,191	19,214,268	2,122,913	2,257,092	21,815,025	3,291,319
Report	3	19,681,725	19,685,098	18,818,852	2,501,867	3,208,971	21,758,126	3,740,430

Design according to sim2.mod, values are from sim2.mod.

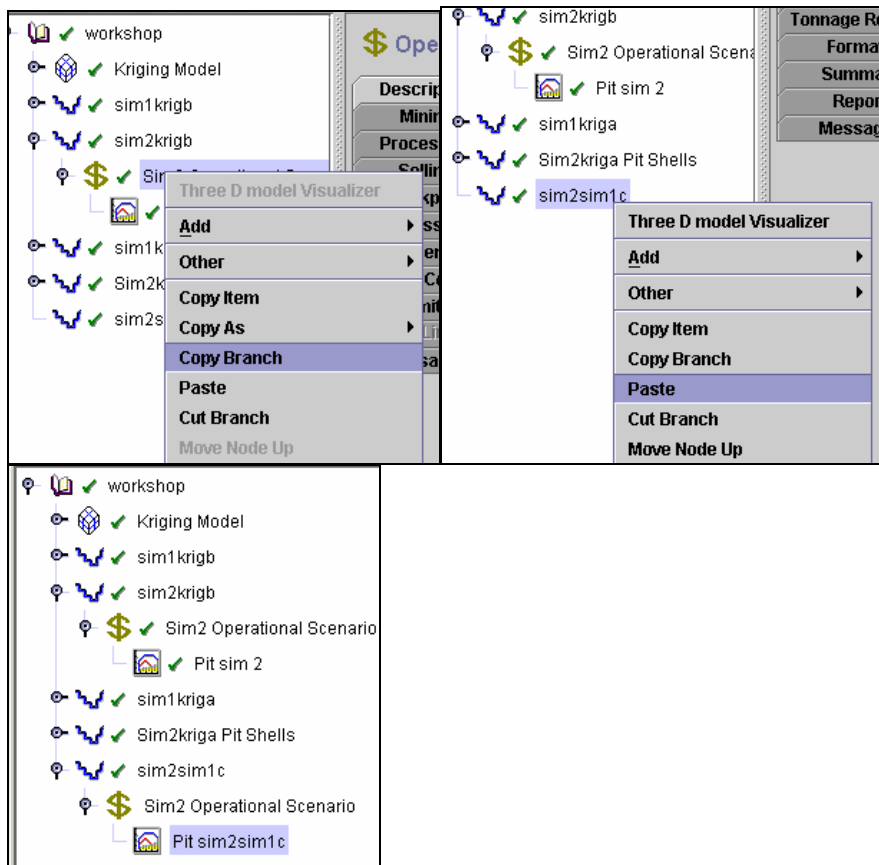
Pit by Pit Graph : sim2kriga Pushbacks								
Description								
Schedule								
Multi-mine								
Definition								
Output	Final pit	Open pit cashflow best \$ disc	Open pit cashflow specified \$ disc	Open pit cashflow worst \$ disc	tonne input best	Waste best tonne	Open pit cashflow best \$	Units output MILL GOLD specified
Graph	1	12,406,078	12,406,078	12,406,078	1,009,912	455,460	13,398,692	1,657,302
Summary	2	14,176,505	14,176,505	13,501,382	2,002,415	2,521,765	15,476,962	2,858,820
Report	3	13,270,060	13,270,060	12,416,039	2,252,613	3,458,225	14,398,779	3,129,283

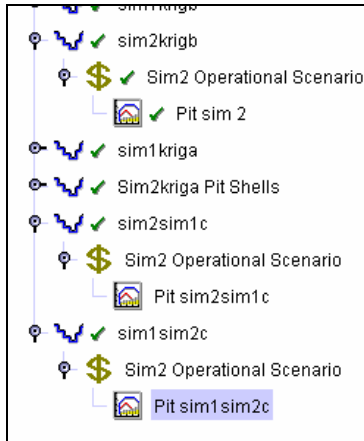
11 Overlapping sim1c.pil Frame on sim2.mod; sim2c.pil on sim1.mod and Generate Result Files

Use sim1c.pil to reblock sim2.mod and generate sim2sim1c.res; similarly use sim2c.pil to reblock sim1.mod and generate sim1sim2c.res.

12 Generating the Values for the Result files (sim2sim1c.res and sim1sim2c.res)

Rename “new imported pit shells” as “sim2sim1c Pushbacks” on description tab and click “Accept.”





New Operational Scenario appears on the left-hand side of the window. Rename it as “Sim2sim1c Scenario” on the description tab. Click on the “limits” tab and type 1000000 on the mill limits. Click on “time cost” to change discount rate to 8% and accept.

Right click on the “New Schedule Graph” and “Cut Branch”.

Add Pit By Pit Graph: Right-click on “sim2sim1c Scenario,” choose “add---pit by pit graph”. Rename “Pit by Pit Graph” as “Pit by Pit Sim2sim1c” by clicking on description tab. Click on “Pit Sim2sim1C” icon and definition tab. Delete “mine life’s and internal rate of return” for all cases. Add quantity of metal in definition tab as before. Then, click on edit and change the end pit from 0 to 3.

Milawa Schedule: Click on “schedule” tab. Choose “Milawa NPV” and click on add to include pits 1, 2 and 3. Then, run the program.

Exporting Results: Right click on the Pit by Pit Sim1C to choose tools—export files. Choose the spreadsheet and name the file as sim1c.csv

Repeat Steps 4.1 – 4.6 carefully replacing sim1 by sim2 everywhere.

Design according to sim1.mod, values are from sim2.mod.

Pit by Pit Graph : Pit sim2sim1c								
Description								
Schedule								
Multi-mine								
Definition								
Output								
Graph								
Summary								
Report								
Measure								
	Final pit	Open pit cashflow best \$ disc	Open pit cashflow specified \$ disc	Open pit cashflow worst \$ disc	tonne input best	Waste best tonne	Open pit cashflow best \$	Units output MILL GOLD specified
	1	12,482,286	12,482,286	12,482,286	1,096,839	555,798	13,494,109	1,754,377
	2	14,035,787	14,035,787	13,541,443	1,925,245	2,454,760	15,413,100	2,777,861
	3	13,150,116	13,150,311	12,416,039	2,252,613	3,458,225	14,398,779	3,129,283

Design according to sim2.mod, values are from sim1.mod.

Computer Workshop I: Optimization and Risk Assessment

Pit by Pit Graph : Pit sim1sim2c								
Description								
Schedule								
Multimine								
Definition								
Output	Final pit	Open pit cashflow best \$ disc	Open pit cashflow specified \$ disc	Open pit cashflow worst \$ disc	tonne input best	Waste best tonne	Open pit cashflow best \$	Units output MILL GOLD specified
Graph	1	15,567,531	15,567,531	15,567,531	996,509	468,864	16,808,416	1,831,021
Summary	2	20,141,033	20,141,033	19,480,622	2,228,402	2,295,777	22,233,689	3,415,426
Report	3	19,696,655	19,721,776	18,818,852	2,501,867	3,208,971	21,758,126	3,740,430

Then open the Excel spreadsheet “Designs_Comparison” to see the results.