320 Linking the FULL Value Chain – Chemical Crushing and Mechanical Crushing

Scott Giltner & Charles Hillmann

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321 Linking the FULL Value Chain – Chemical Crushing and Mechanical Crushing

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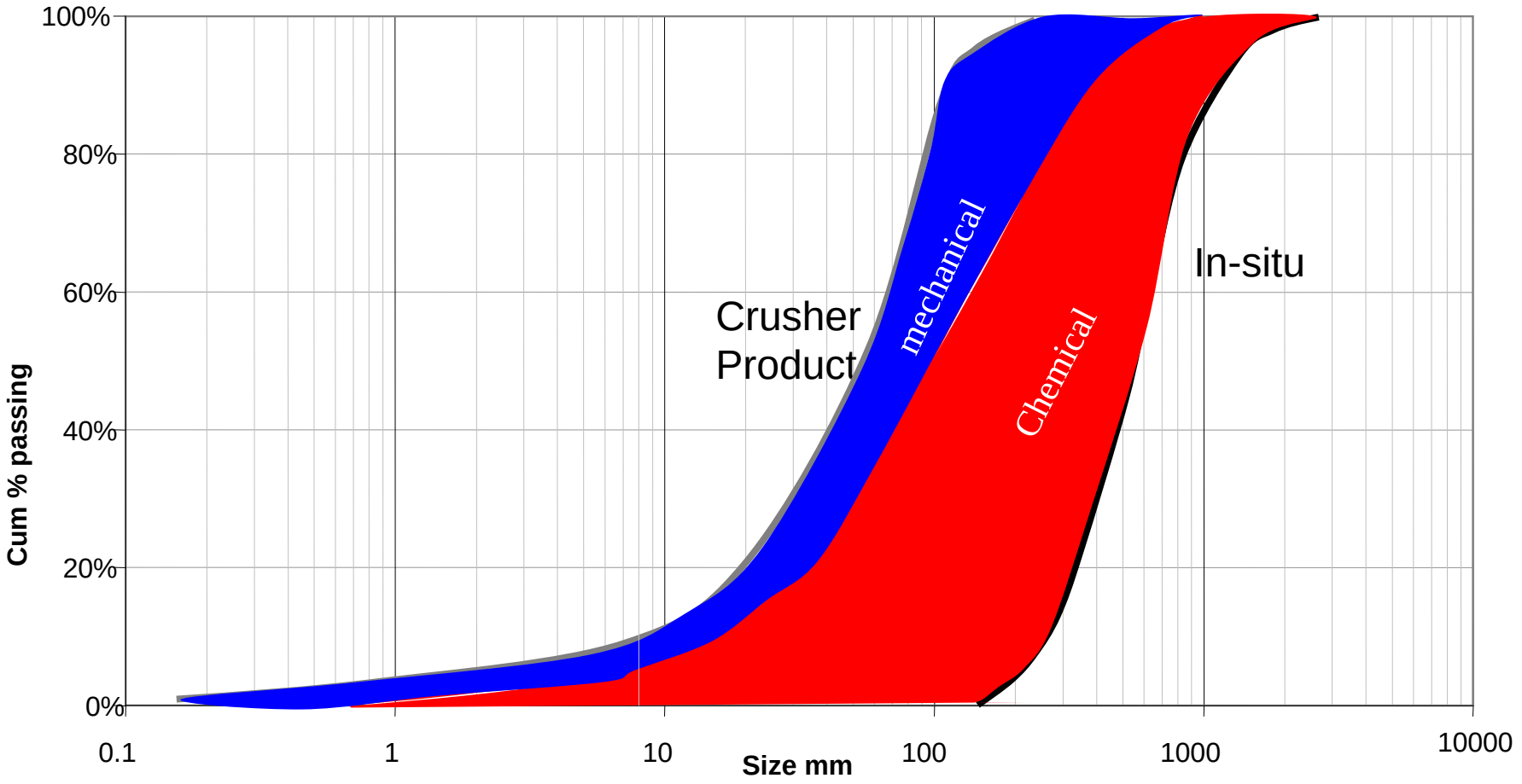
Comminution or Breakage



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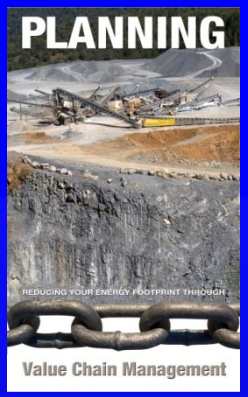
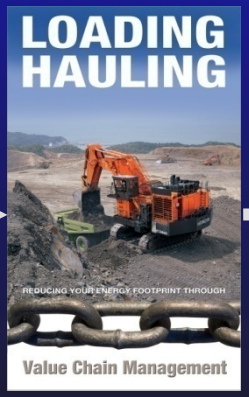
“Optimal Zone”

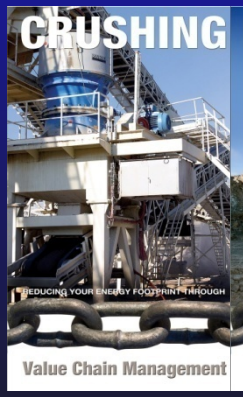


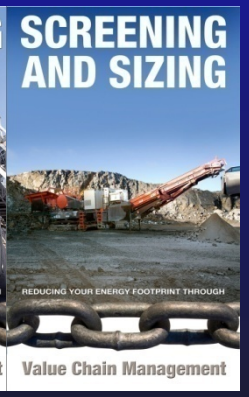
+ optimum

Total Cost

$ $





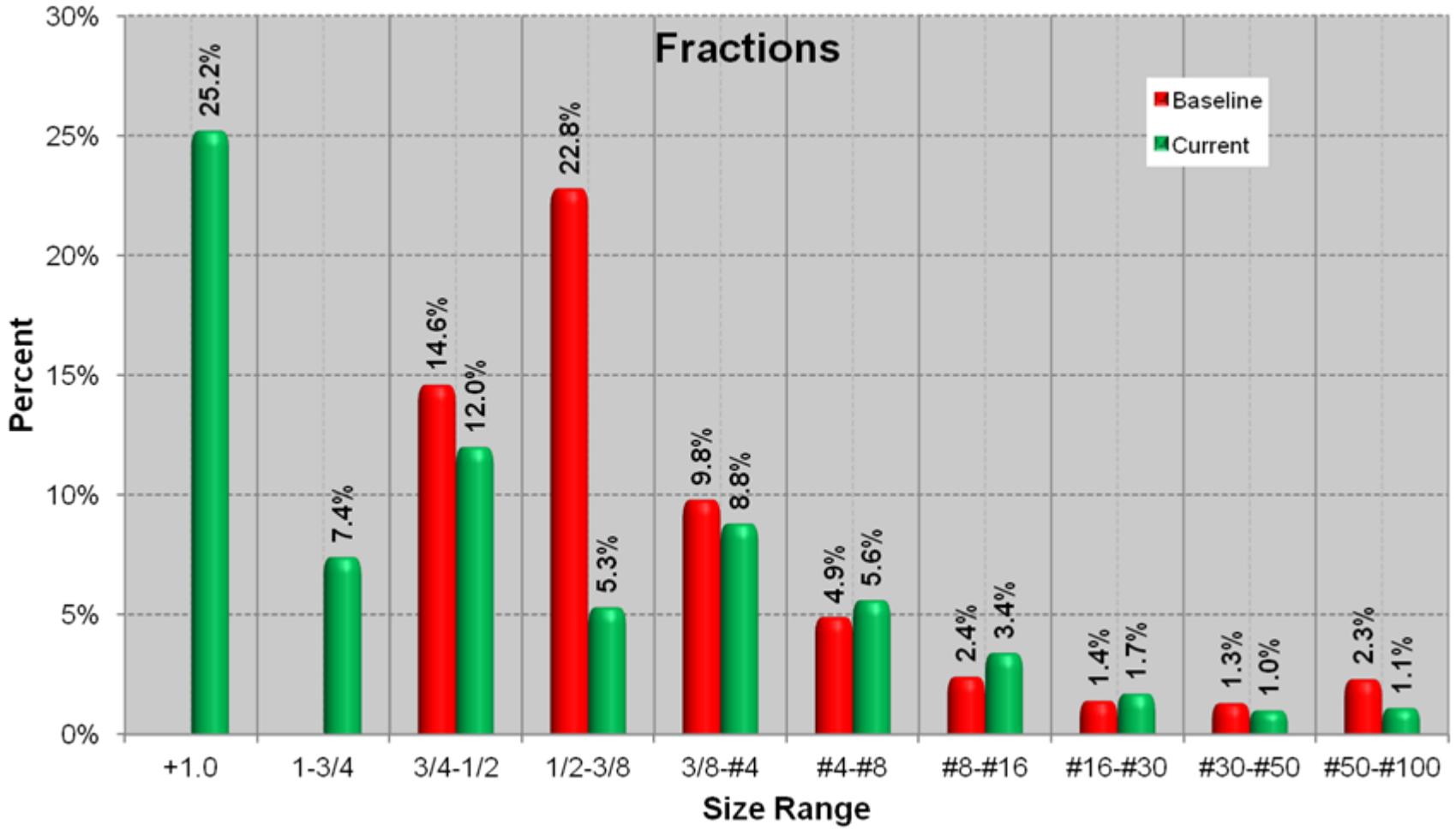


Chemical Crushing

Transport

Mechanical Crushing

Fines Reduction Project 2010



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Blast Models

- **HSBM (Hybrid Stress Blast Model)**
  - ✓ 3-D Blast model
  - ✓ ‘High end’ engineering tool
  - ✓ Suitable for surface, underground, & block modeling

- **FAS-Blast**
  - ✓ Blast design & modeling tool
  - ✓ ‘Every day’ tool for blasters & engineers
  - ✓ Primarily applicable for surface applications

Blast Models

- **HSBM (Hybrid Stress Blast Model): 3-D blast model**

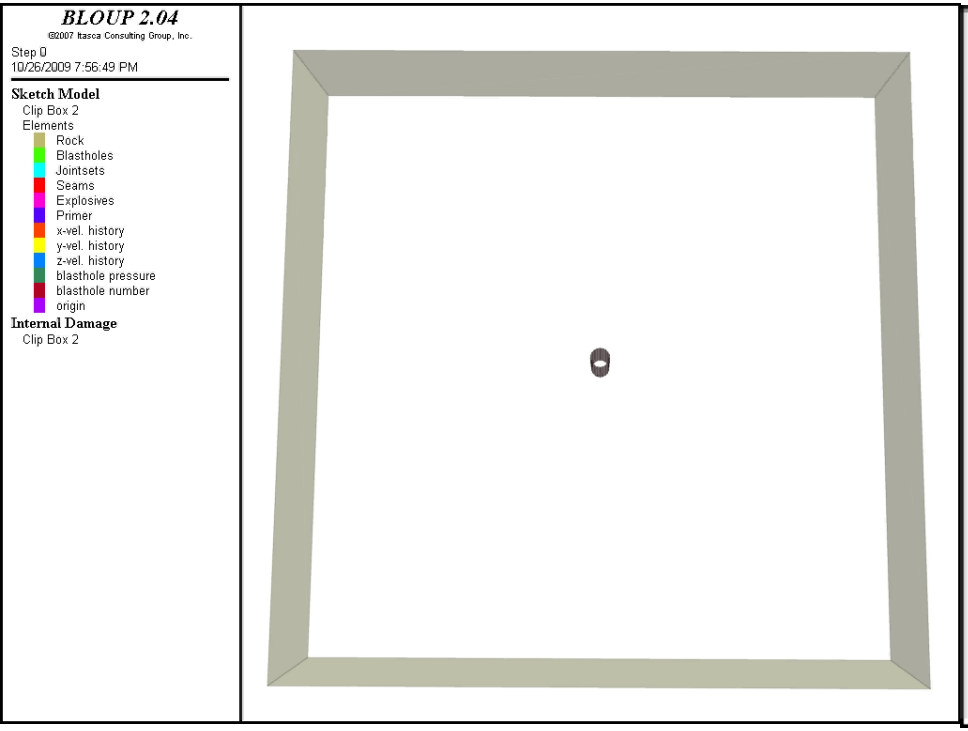
  <u>Models:</u>

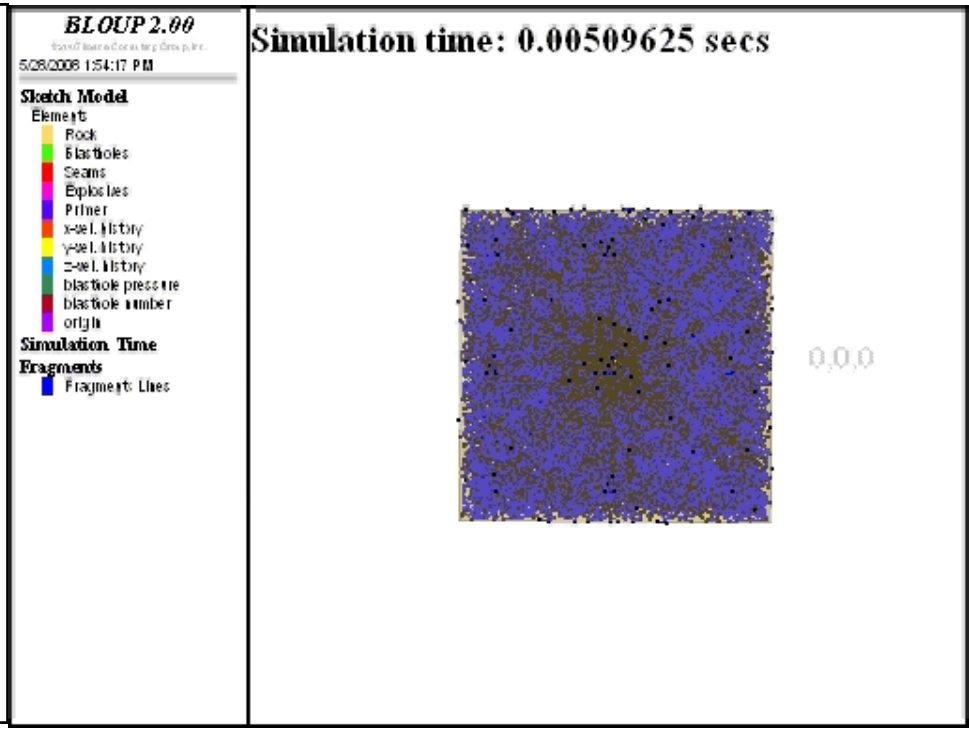
  - ✓ **Dynamic forces**
  - ✓ **Fracture mechanisms**
  - ✓ **Face velocity**
  - ✓ **Fragmentation**
  - ✓ **Muckpile distribution**

Blast Models

- **FAS-Blast**
  - ✓ **Designs blast**
  - ✓ **Models fragmentation**
  - ✓ **Models vibration**
  - ✓ **Determines costs**

HSBM (Fracturing around blasthole)





Fracturing around blasthole

Fragment displacement

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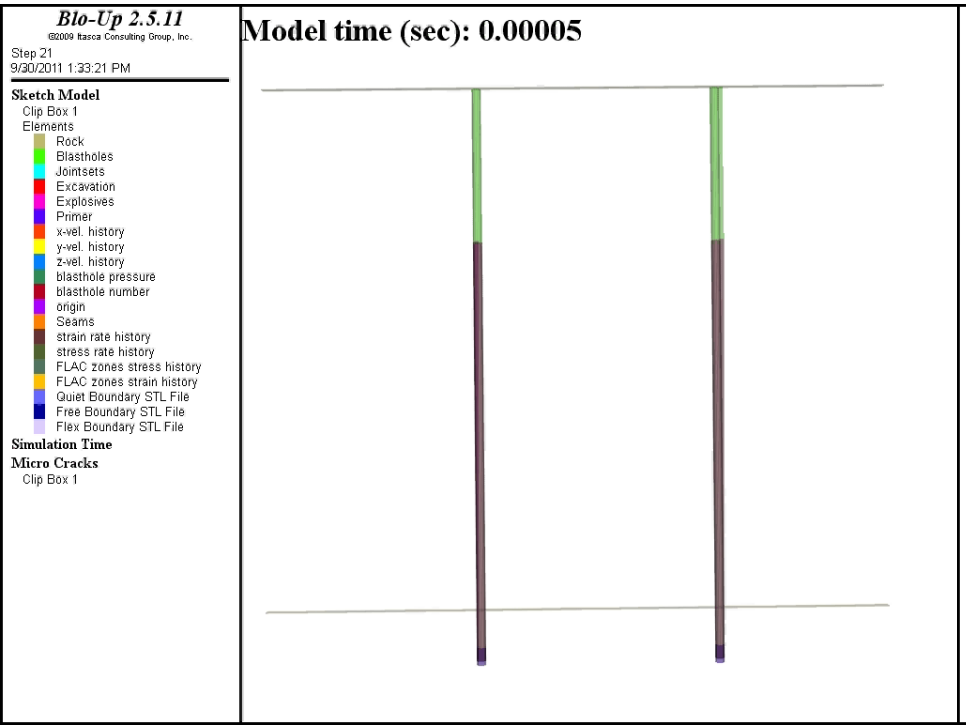
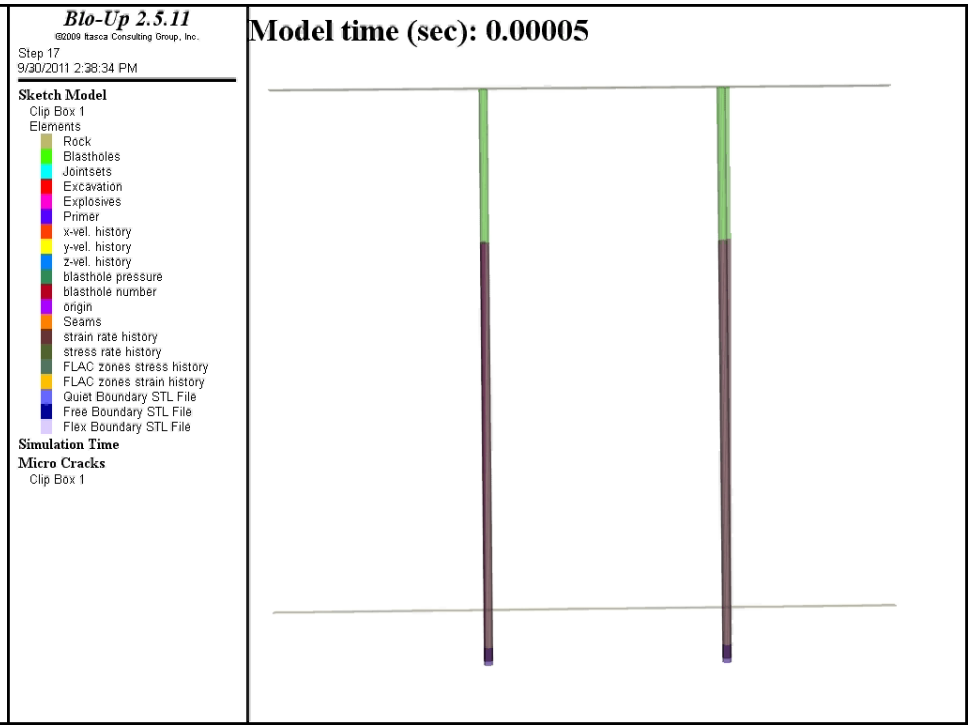
HSBM (Timing Effects on fracturing)





0 ms delay

10 ms delay

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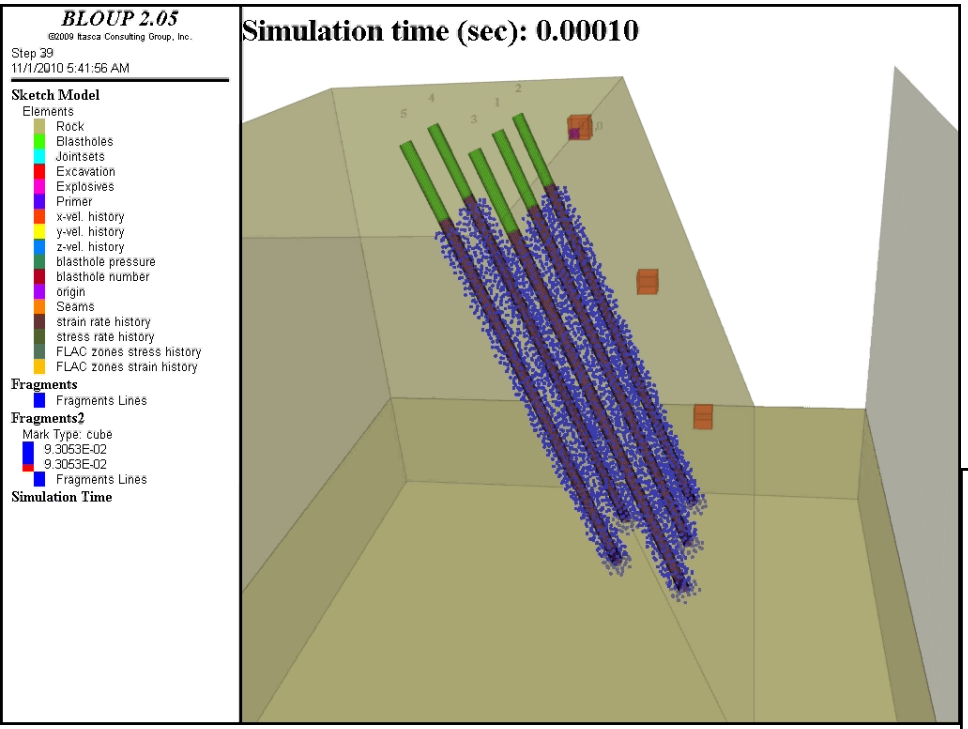
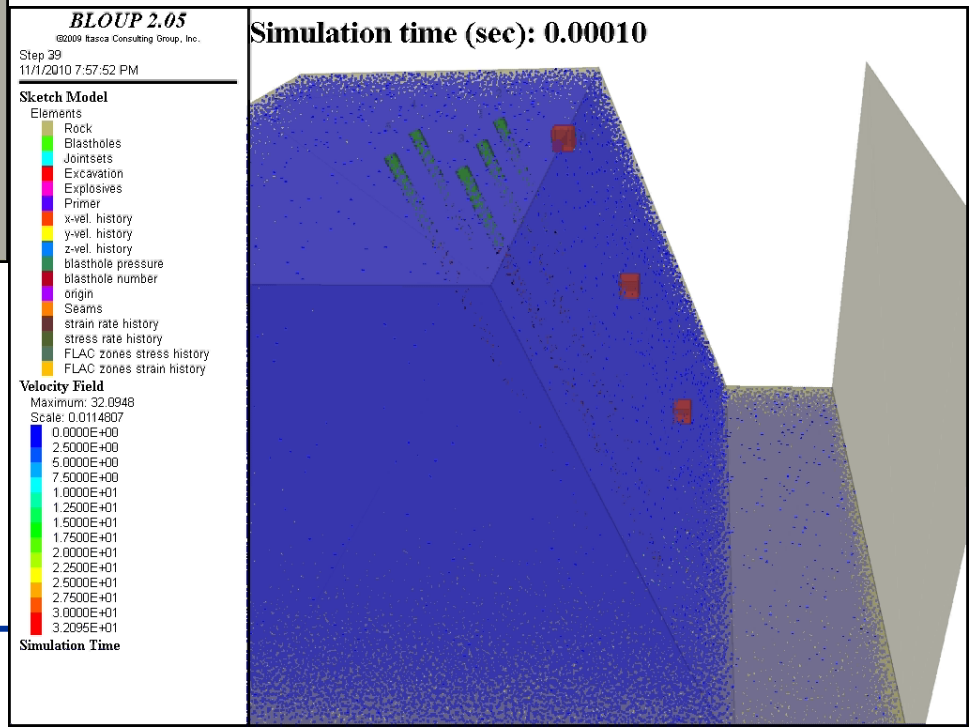
HSBM Model of Quarry Blast



Fractures

Velocity



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FAS-Blast Model Scenarios

- **Granite**
- **Bench height – 60 ft**
- **Joint spacing of 4 ft (dipping out of face)**

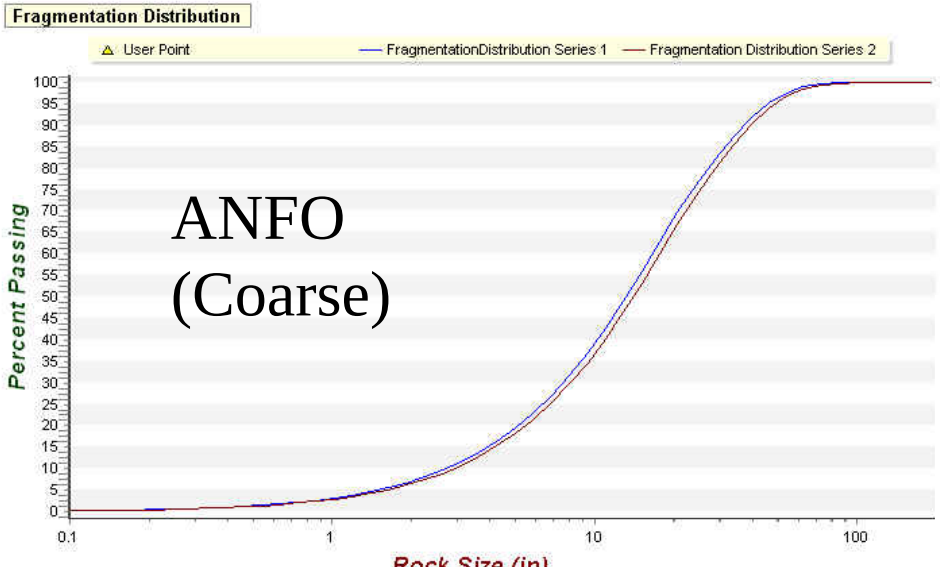
Scenario	Hole Diameter	Explosive
#1	6 inch	ANFO
#2	4 ½ inch	50/50 blend
#3	4 ½ inch	Large diameter packaged

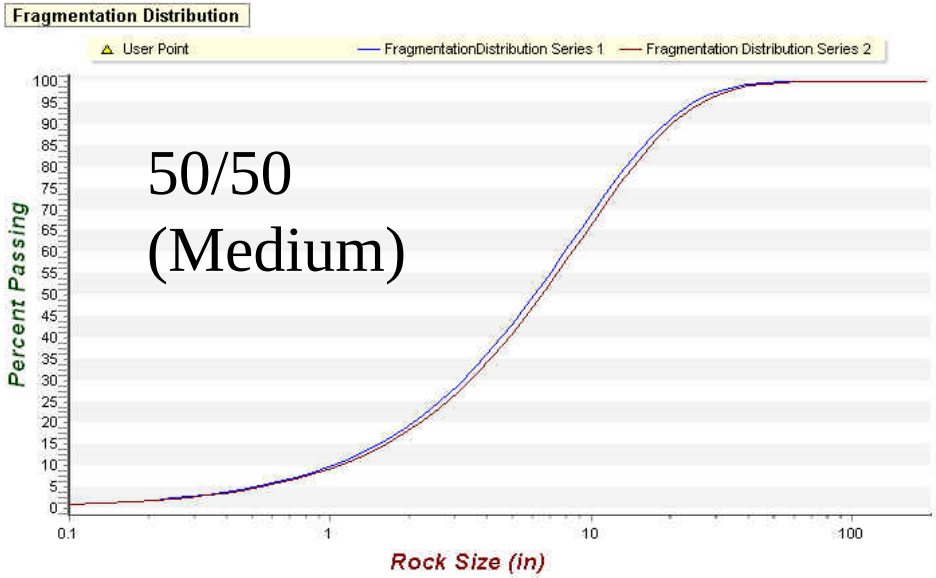
FAS-Blast

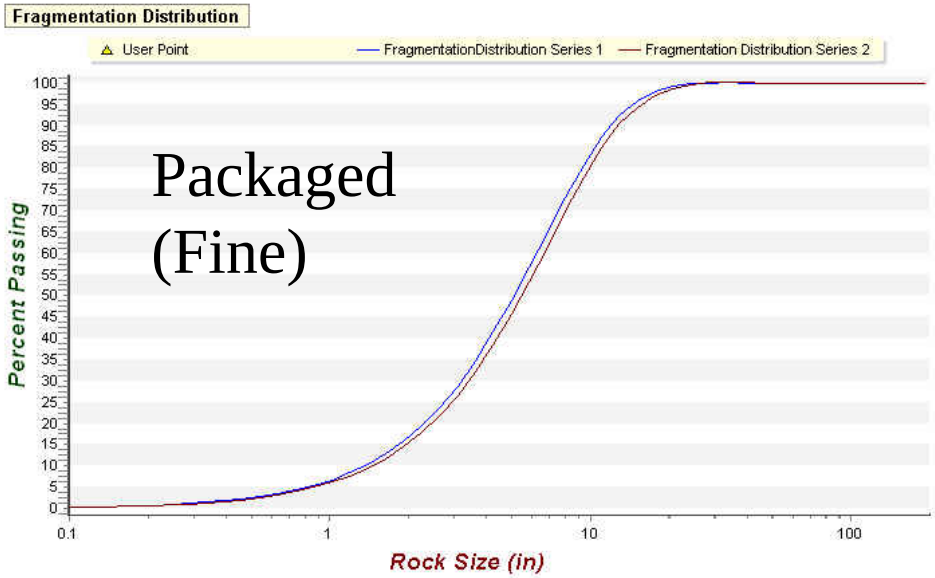
Model Simulations

Drilling & Blasting Costs

Scenario	Hole Diameter	Explosive	Pattern	Powder Factor	D&B Cost
#1	6 inch	ANFO	14x14	1.76 ton/lb	$0.302/ton
#2	4.5 inch	50/50 Blend	9x13	1.38 ton/lb	$0.317/ton
#3	4.5 inch	Large diameter packaged	11x15	1.66 ton/lb	$0.553/ton







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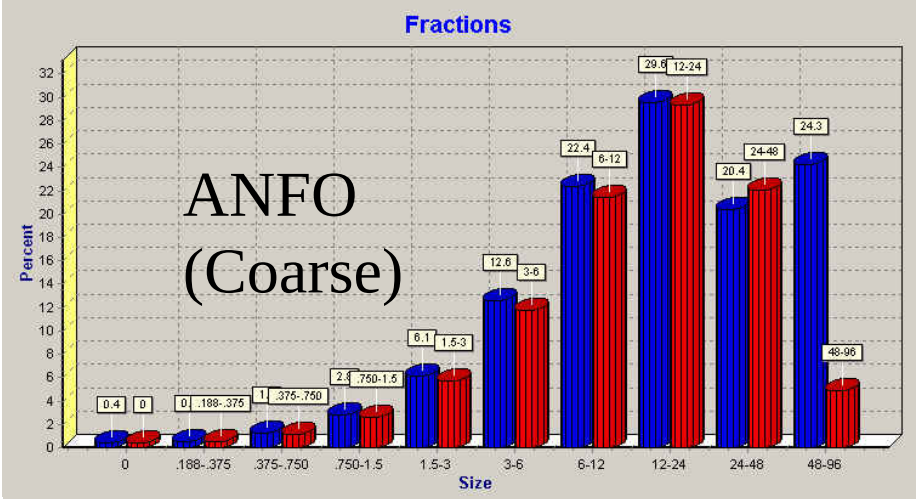

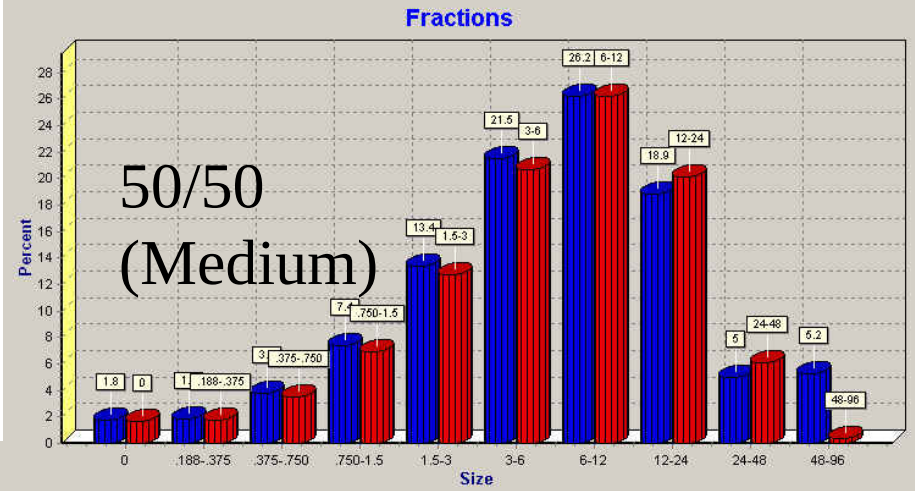

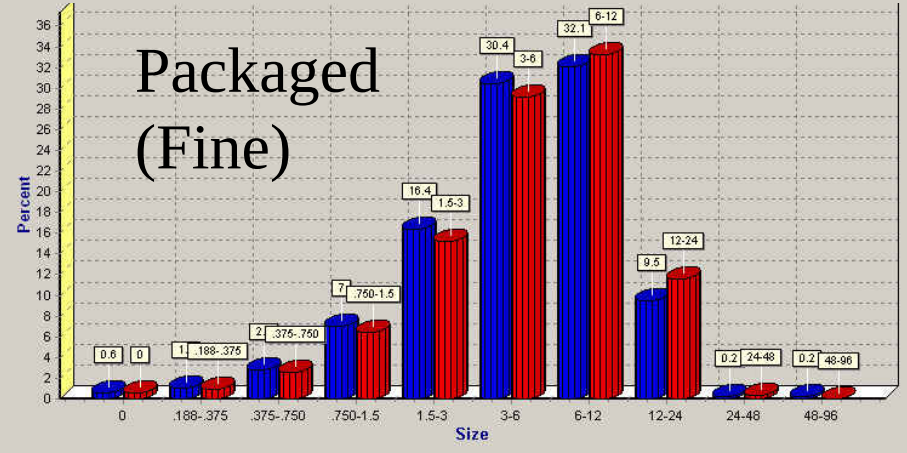

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Total Costs

	Coarse Blast	Medium Blast	Fine Blast
Primary Crusher	60” x 44”	48” x 44”	48” x 32”
Setting CSS (In)	6.5	6.5	6.5
Cost ($US)	850,000	550,000	450,000
Secondary Crusher	S4800	S4800	S4800
Setting CSS (In)	1.9	1.9	1.9
Cost	500,000	500,000	500,000
Tertiary Crusher	2 x H6800	2 x H6800	2 x H6800
Setting CSS (In)	0.65	0.65	0.65
Cost	1,000,000	1,000,000	1,000,000
Cost: Steelwork/Electrics	6,000,000	4,000,000	4,000,000
Capital Cost	8,350,000	6,050,000	5,950,000
Blasting Cost/ton	1.4	1.5	1.8
Crushing Cost/ton	1.95	1.75	1.65
Payback over 5 Years/ton	1.00	0.70	0.68
Total Cost per ton	4.35	3.95	4.13
TPH Handled	650	650	650
TPYHandled	1,950,000	1,950,000	1,950,000
If Average product Price = $7	5,167,500	5,947,500	5,596,500
Operating Potential/year =	22,478,625	23,492,625	23,113,545
Optimal Profits =	-1,014,000	**379,080**	-379,080

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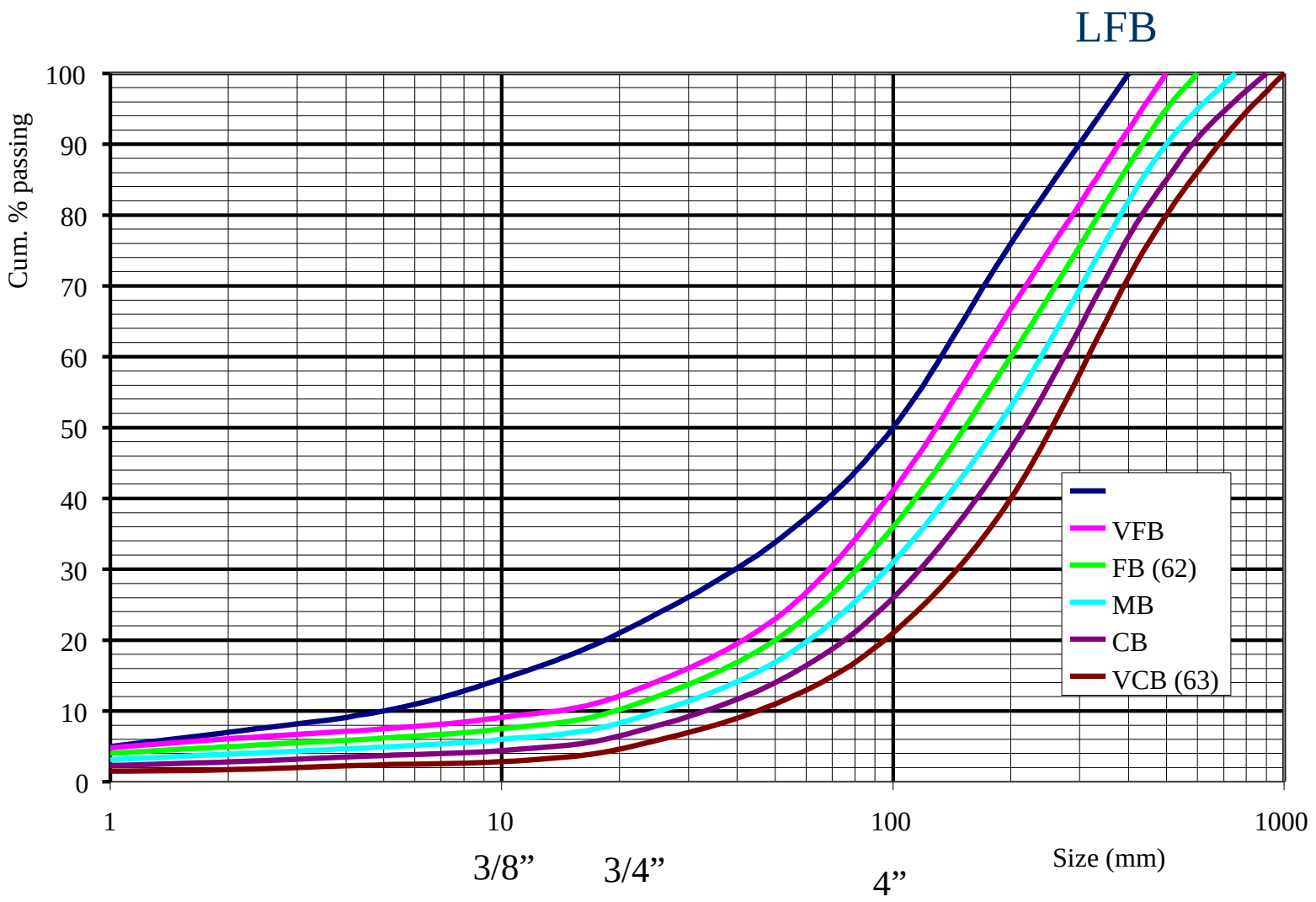
Total Costs

Scenario	D&B Cost	Crushing Cost	Payback over 5 yr	Total Cost
#1 (coarse)	$0.302/ton	$1.95/ton	$1.00/ton	$3.252/ton
#2 (med)	$0.317/ton	$1.75/ton	$0.70/ton	$2.767/ton
#3 (fine)	$0.553/ton	$1.55/ton	$0.68/ton	$2.783/ton

Blast Curves



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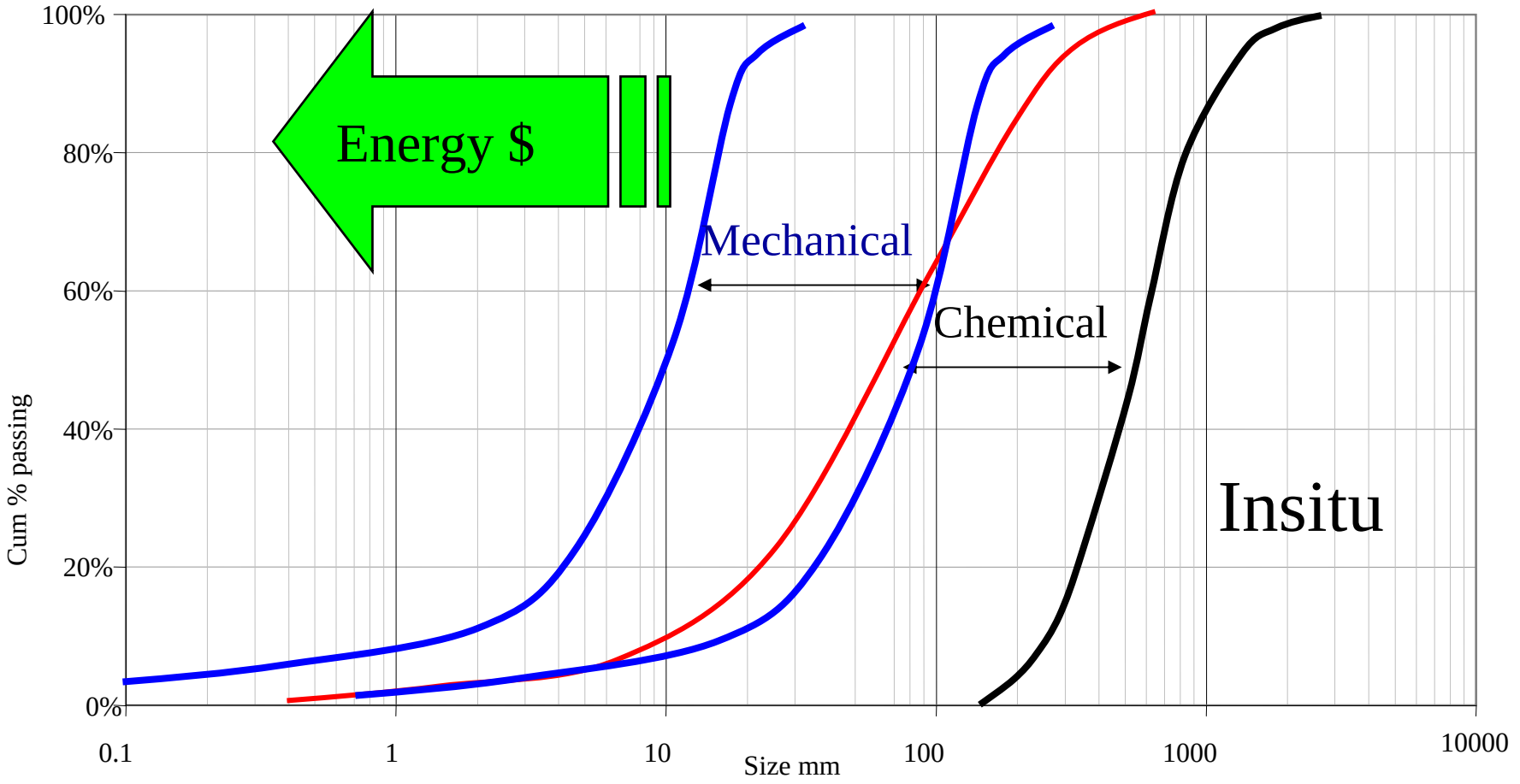
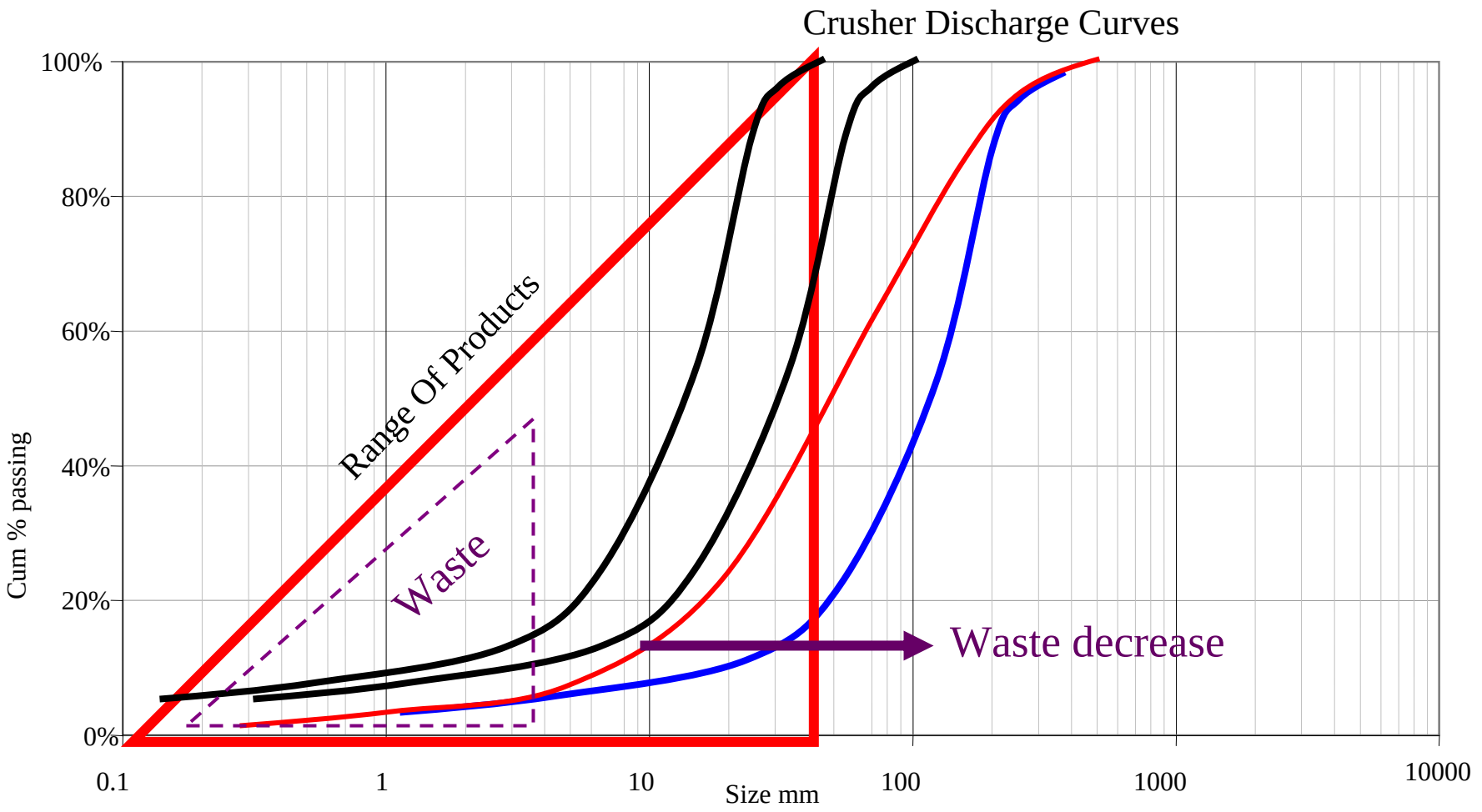
Rock Breakage Chemical & Mechanical



Blasted End Product

Fine Blast Large Hole Diameter

Medium Blast Smaller Hole Diameter



¼” ½¾1” 2” 4“

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Effects on Production Yield related to Chemical Crushing

- **Under Break = Chemical**

- **Secondary Handeling**
- **Secondary Breakage**
- **Re-handling**
- **Reduced Production**
- **Increased Energy Usage**
- **Waste**

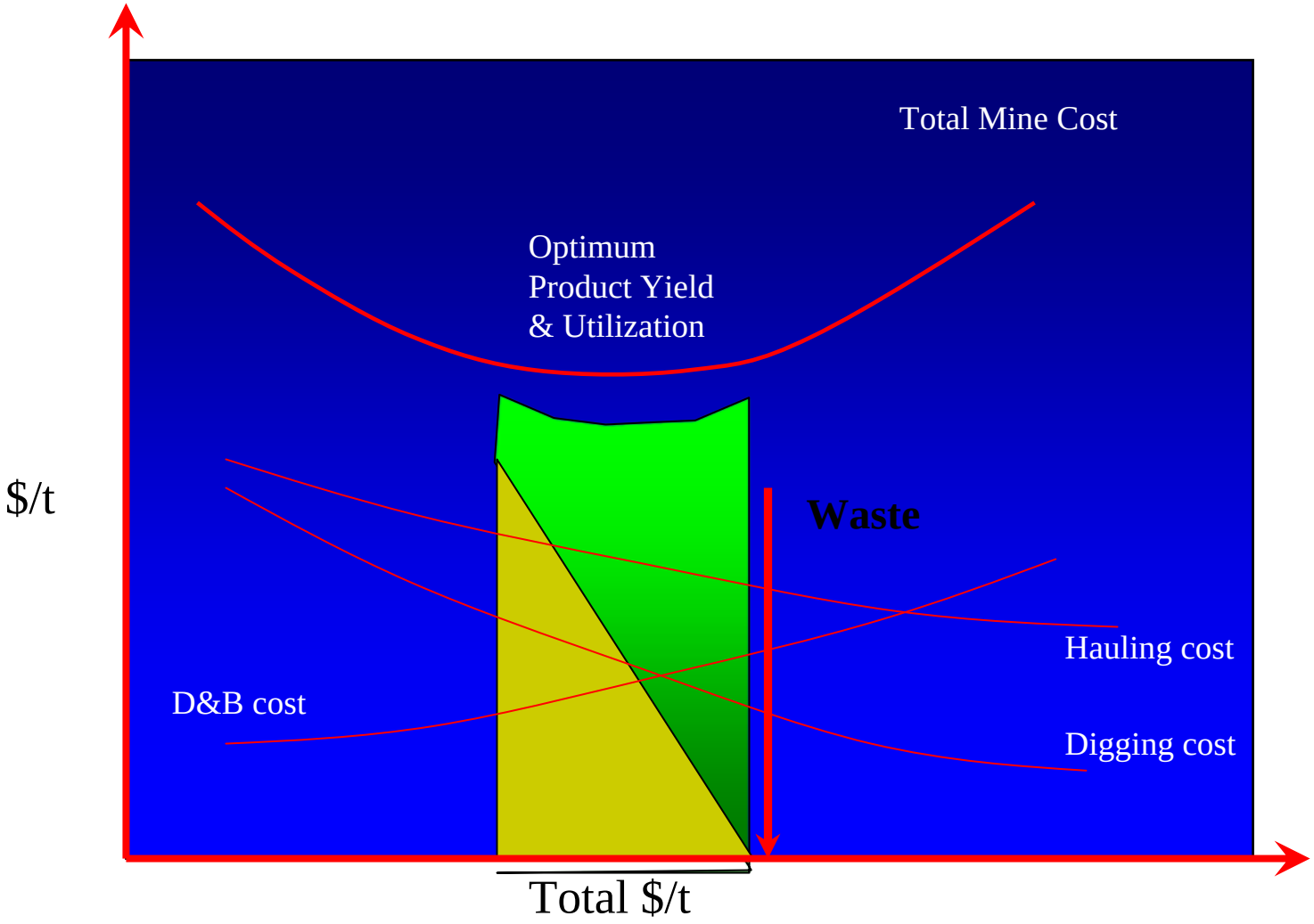
Loss =+/- Available Profit Ton

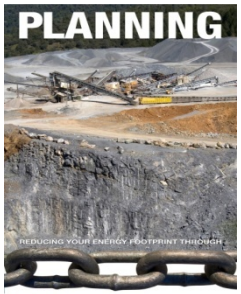
- Over Break = Chemical

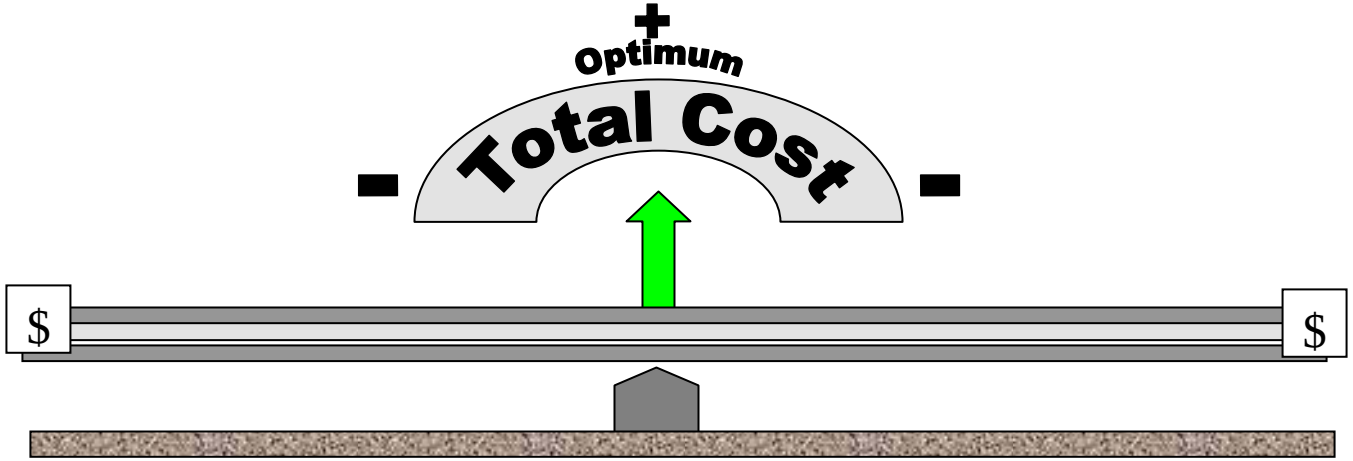
- Secondary Handling Waste
- Lost Energy In Process
- Waste Pile Management
- Reduced Production
- Reduced Product Resistance
- Increased wear

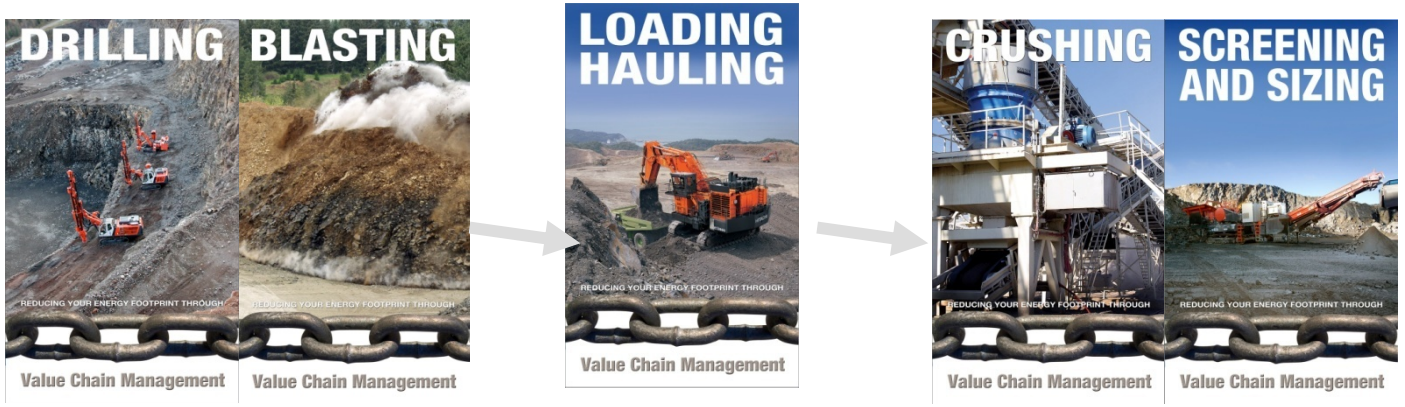
Loss =+/- Available Profit Ton

Lowest Operation Costs Long Term









Makeing The Right Stuff !

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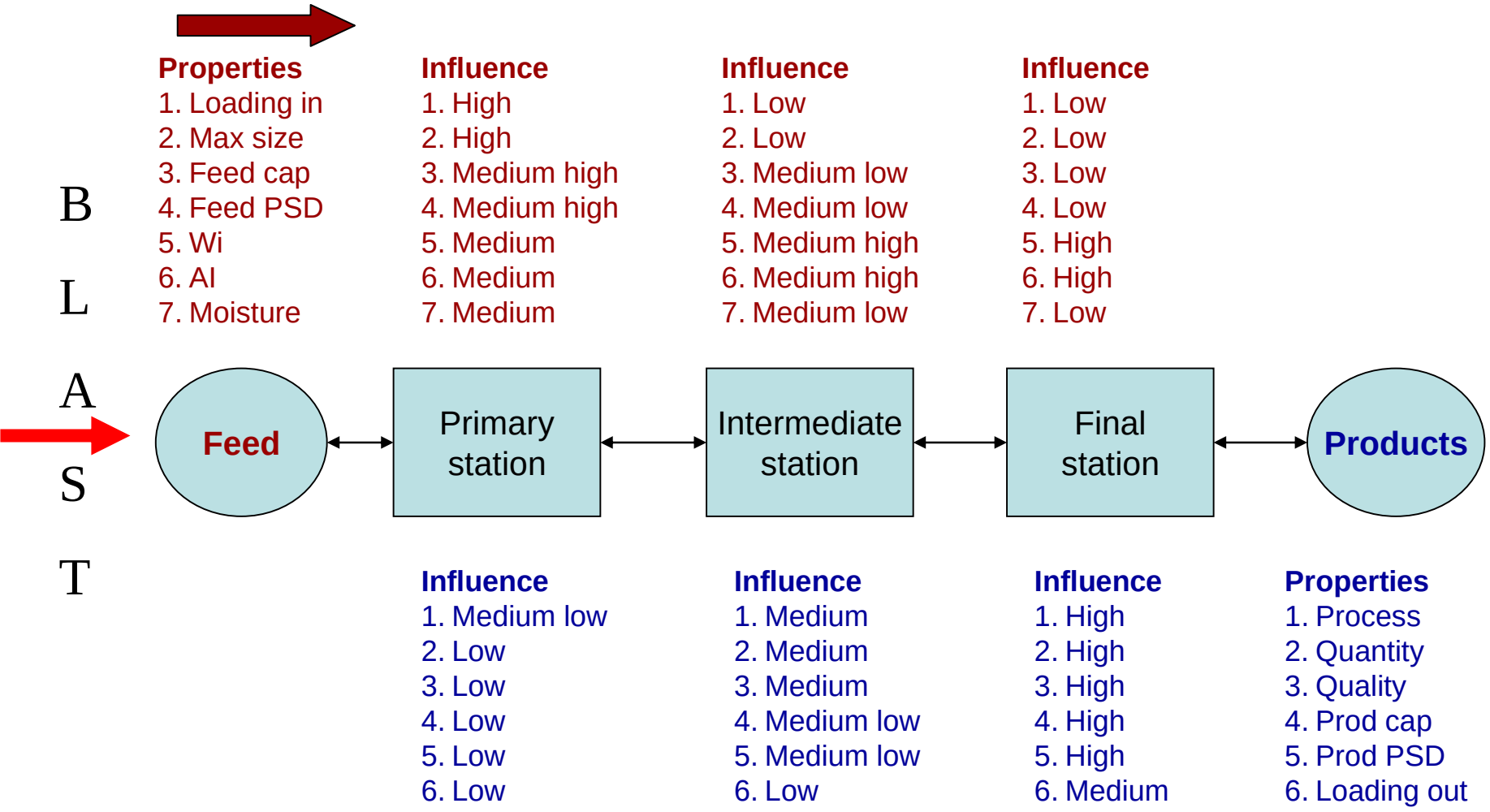
Fines Reduction Through Chemical & Mechanical Adjustments

Size	MM	Blast Fine	Blast Medium	Total Fine	Fines Reduction
1"	25	65	60		
3/4"	19	55	38	68	0
1/2"	12.5	40	26	48	0
3/8"	9.5	28	20	35	0
# 4	4.75	15	11	18	5
# 8	2.36	10	6	12	4
# 16	1.18	5	4	8	2
# 30	0.6	4	3	4	2
# 50	0.3	3	2	3	1
# 100	0.15	2	1	2	1
# 200	0.075	1	0	1	0
					15

Mechanical Crushing Influence On Product



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Aggregate Production & Costs of Waste

USA Annual Productions

1.2 Billion Tons “BLASTED”

Canada Annual Productions
(Highest Annual Stone consumption Per Capita)

400- Million Tons
“BLASTED”

- **Combined Annual Productions 1.6 Billion Tons USC !**
- **About 30 % is either Under or over desired Spec 25% Under / 5% Over !**
- **30% costs twice as much as its worth ?**
- **Potentially 15-25% is wasted or Half of Canada’s Annual requirements !**

Take home messages

- ”Prepare” Your Organization for a Long Process
- Geology will Challenge the results @ Times
- Work with the Geology & adjust as needed
- The Powder factor / Pattern will require small adjustments
- Video & Review @ Blast / Belt Cuts @ Before secondary ”Must”
- Gather Production data , Plant and Product ’Manage well”
- Adjust The Crushing stages individually
- Flow Chart and set the Model , track the Changes .
- Capacity normally Can decrease when Blast Fraction Increases , remeber its Yield Not through Put .
- Balance between Sheared Particles & Crushed Particles

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