Hydraulic Shovel vs. Wheel Loader

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Agenda

- Shovel vs. Wheel Loader
  - Application
  - Breakout Force
  - Productivity
  - O&O Costs
- Production Studies
  - Hydraulic Excavator vs. Wheel Loader
  - Hydraulic Front Shovel vs. Wheel Loader

General Operation

Wheel Loader	Category	Front Shovel
Loose, Blasted, Free Flowing	Range of Material	Compacted, Unblasted
Large Loading Area (25m)	Loading Area	Small Loading Area
Level, Stable, Dry	Condition of Pit Floor	Unlevel, Loose, Wet
60 to 80 psi	Ground Pressure	15 to 30 psi
Lower Bank (1/3 less)	Height of Bank	Higher Bank
Always Bottom to Top	Selectivity	Any Point on Pile

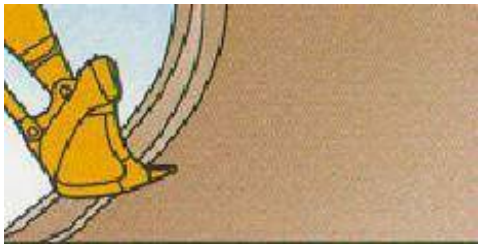
General Operation

Lower	Breakout Force	Higher
Approximately 45.0 Seconds	Cycle Time	Approximately 30.0 Seconds
High: Approx. 20 mph	Travel Speed	Low: Approx. 2 mph
Wait to Spot	Truck Change	Already Spotted
Limited Visibility	Visibility into Bed	Great Visibility
Not Required	Support Equipment	Occasionally

Application

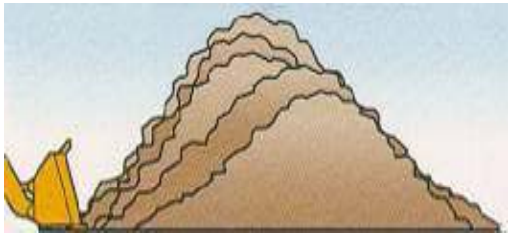
Shovel

Tightly Blasted Material
& Material at the Toe
of the Blast

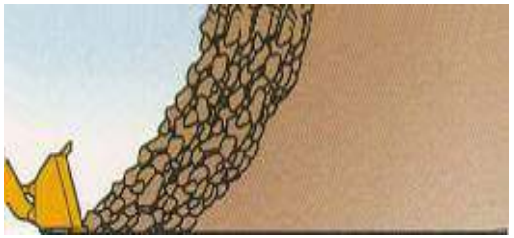


Consolidated Material
Unblasted Material

Wheel Loader

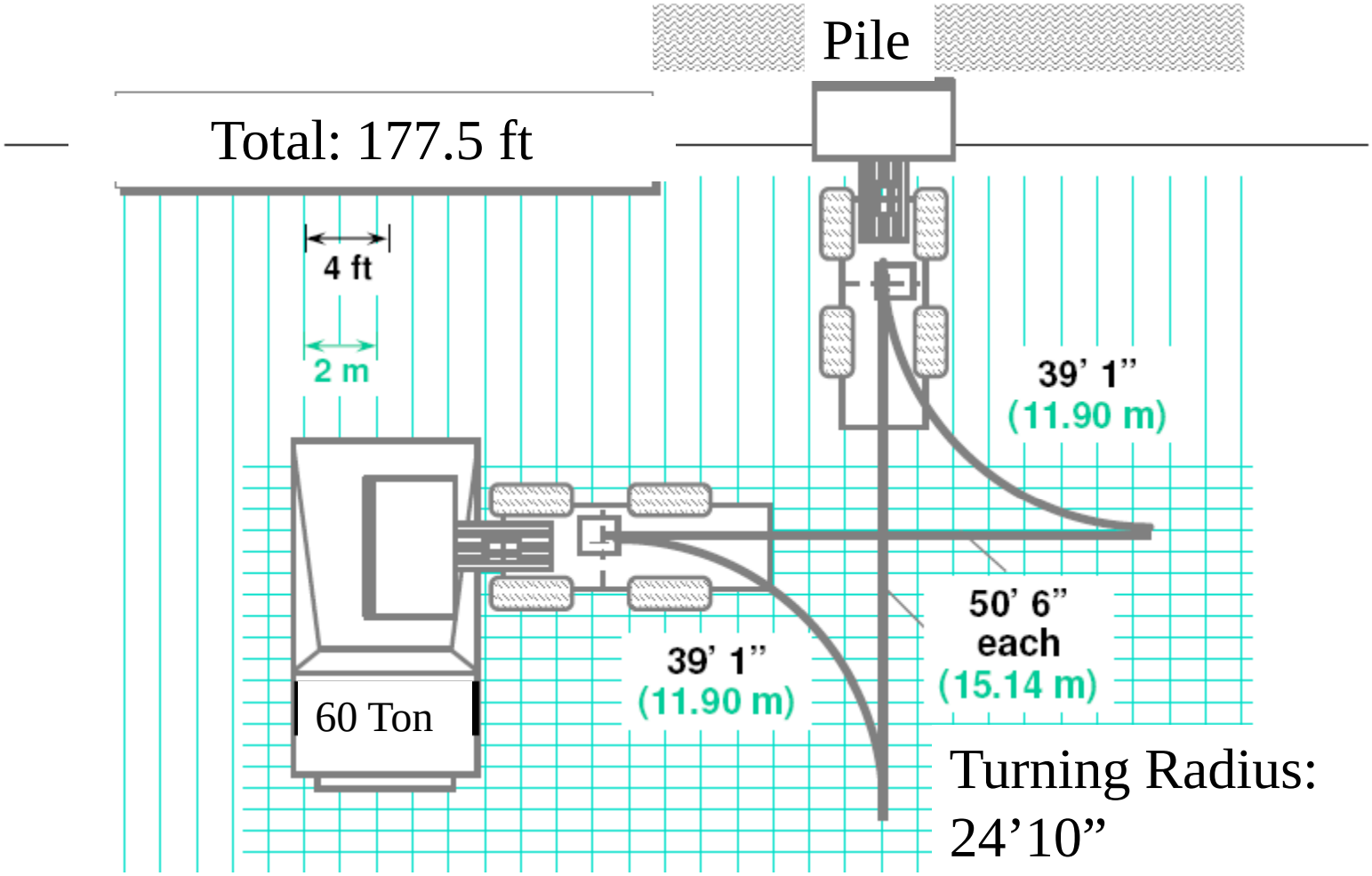


Free Flowing Material
Unconsolidated Material
Stock Piles Materials



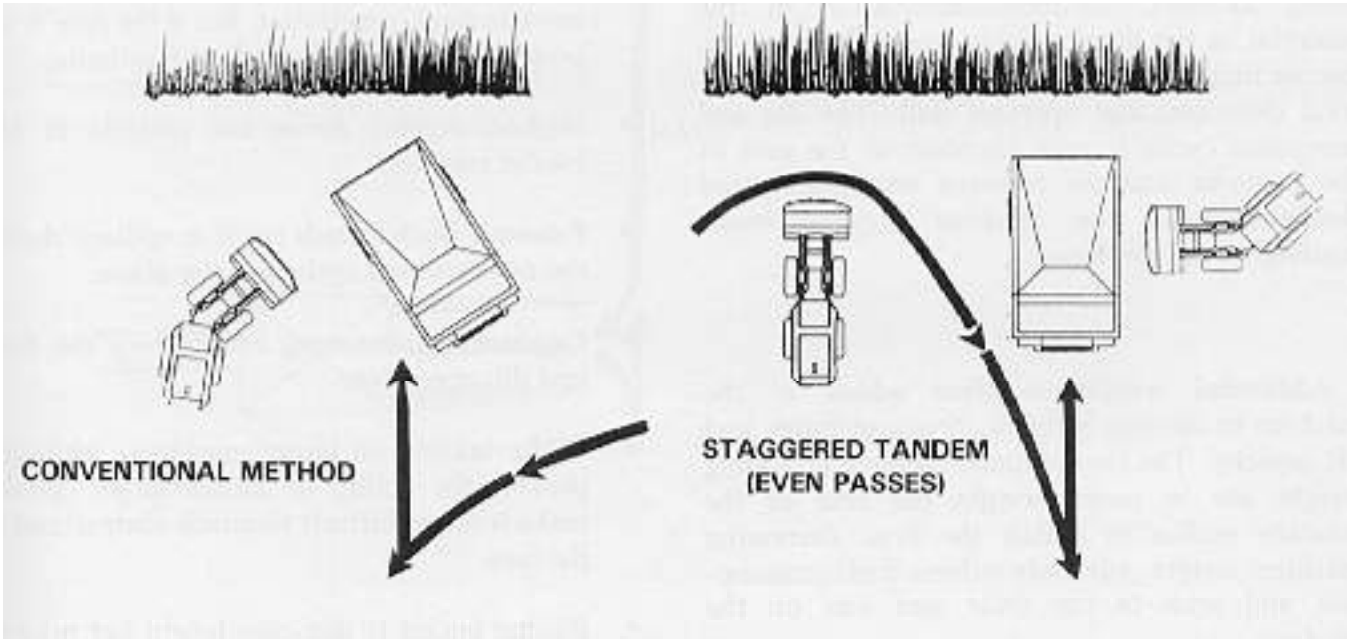
Very Well Blasted &
Fragmented Materials

Wheel Loader Operation

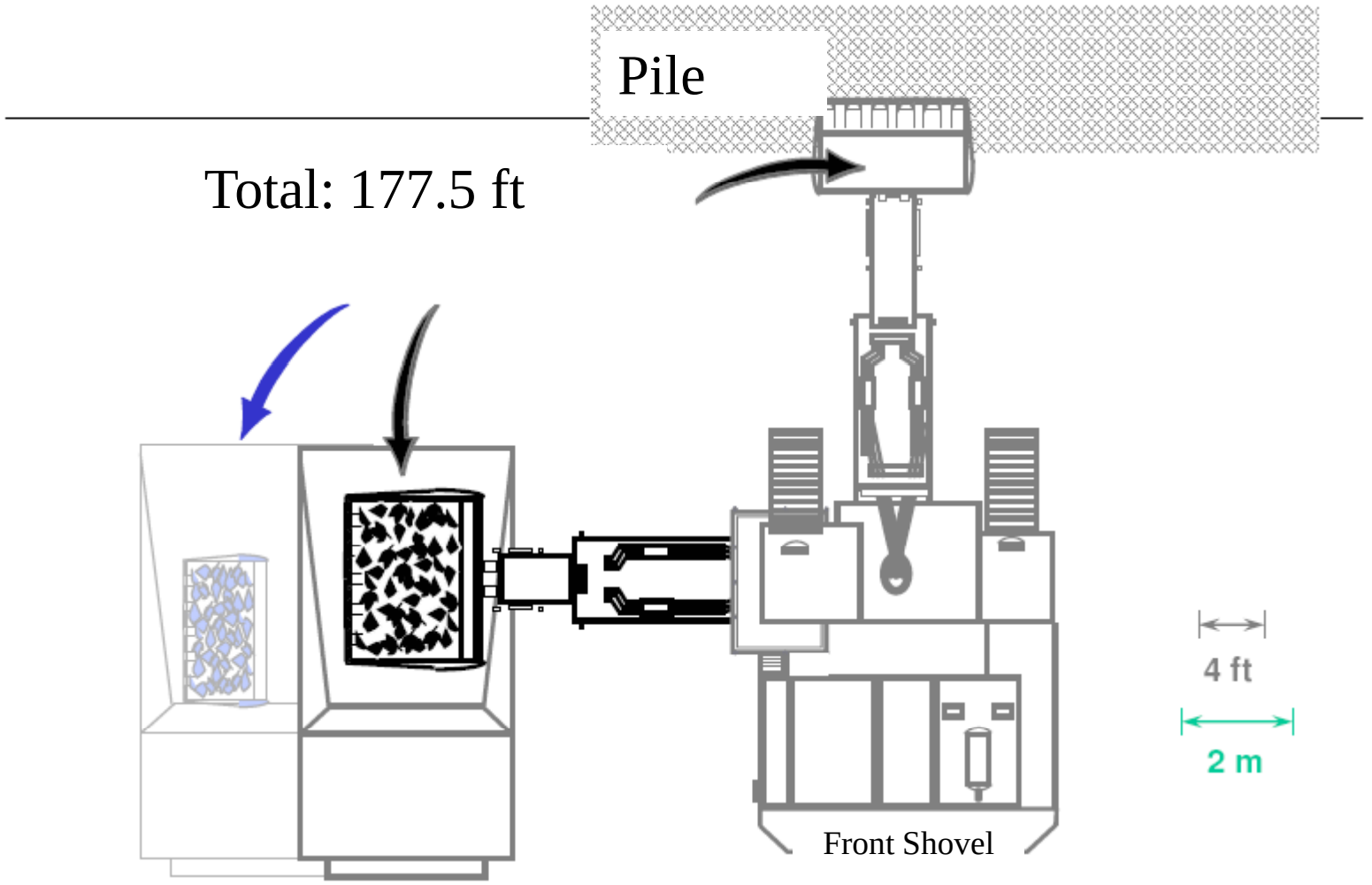


Wheel Loader Operation

- **Wheel Loader Applications**
  - Requires lots of room at the loading area
  - Lot of movement at the face to load the trucks
  - Greater skill on the part of the truck driver to position haul truck



Front Shovel Operation



Productivity

- **Shovel Applications**
  - **Less Room**
  - **Smaller Benches**
  - **Tighter Shots**
  - **Toe of Shot**

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Productivity Comparison

Front Shovel		Wheel Loader	
Bucket Capacity	9.2 yd^3	Bucket Capacity	8.0 yd^3
Cycle Time	23 to 25 Seconds	Cycle Time	36 to 39 Seconds
Cycles Per Hour	138 to 156	Cycles Per Hour	92 to 100
Fill Factor	95.0%	Fill Factor	95.0%
Maximum Production	1,468 to 1,660 t/hr	Maximum Production	957 to 1,040 t/hr

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Floor Conditions

- **Wheel Loader**
  - Needs a Level, Stable Floor
    - Must Protect Tires (Huge Investment)
  - Floor Must be Dry
    - Traction Force Key to Wheel Loader Operation
  - Higher Ground Pressure
    - Typically 60 to 80 psi

Floor Conditions

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Floor Conditions

- **Front Shovel**
  - Can Work on Unlevel Floor
    - Often Works on Blasted Material
  - Floor Can be Wet
    - Breakout/Penetration Force Dependent on Hydraulics
  - Lower Ground Pressure
    - Typically 15 to 30 psi

Floor Conditions

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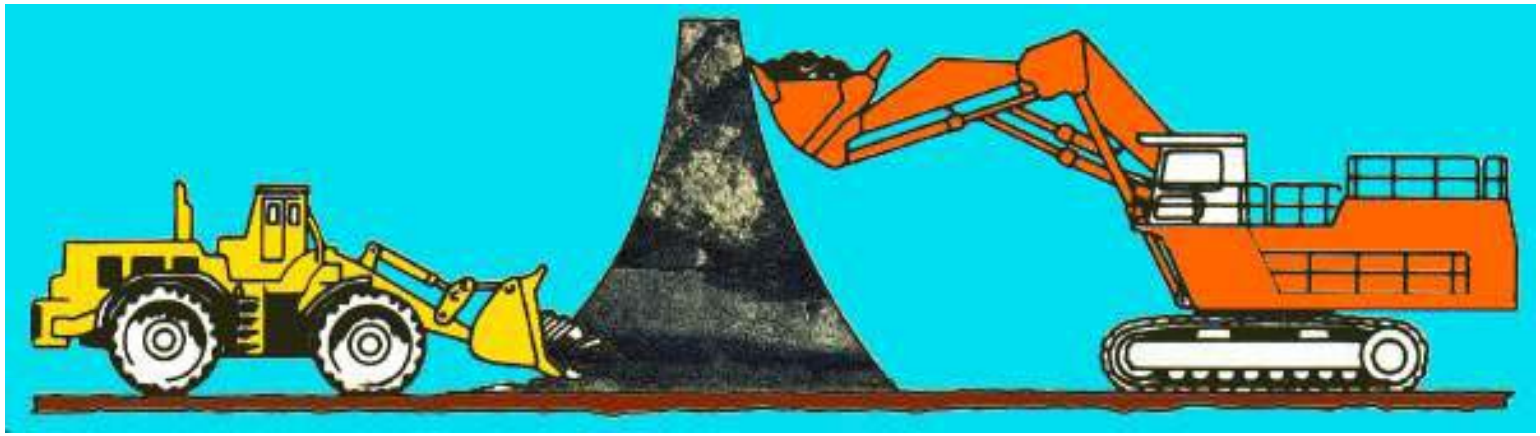
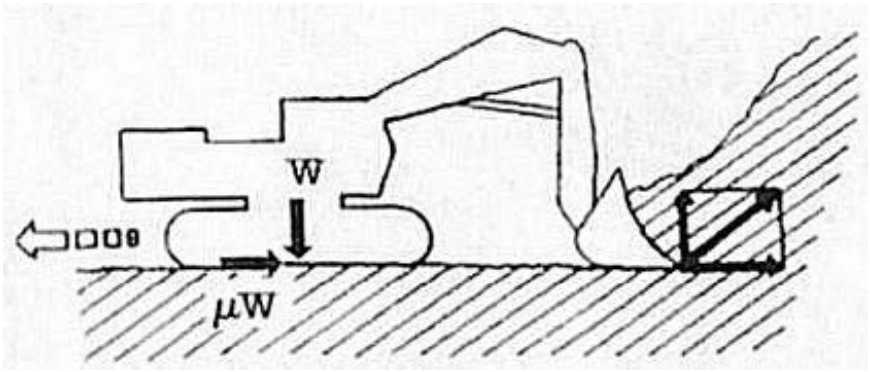
Selectivity

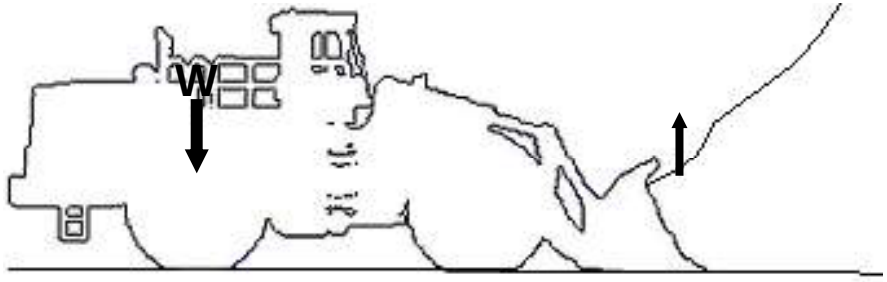


- ***Excavator can dig at many levels of the face.***

Breakout Force



- **Hydraulic Excavator (Shovel)**
  - **Breakout Force**
    - **Created by Hydraulic forces from front attachment and weight of machine.**
  - **Crowding Force**
    - **Created by Hydraulic forces from front attachment and weight of machine.**



- **Wheel Loader**
  - **Breakout Force**
    - **Created by lift and tilt cylinder**
  - **Crowding Force**
    - **Dependent on Traction Force**

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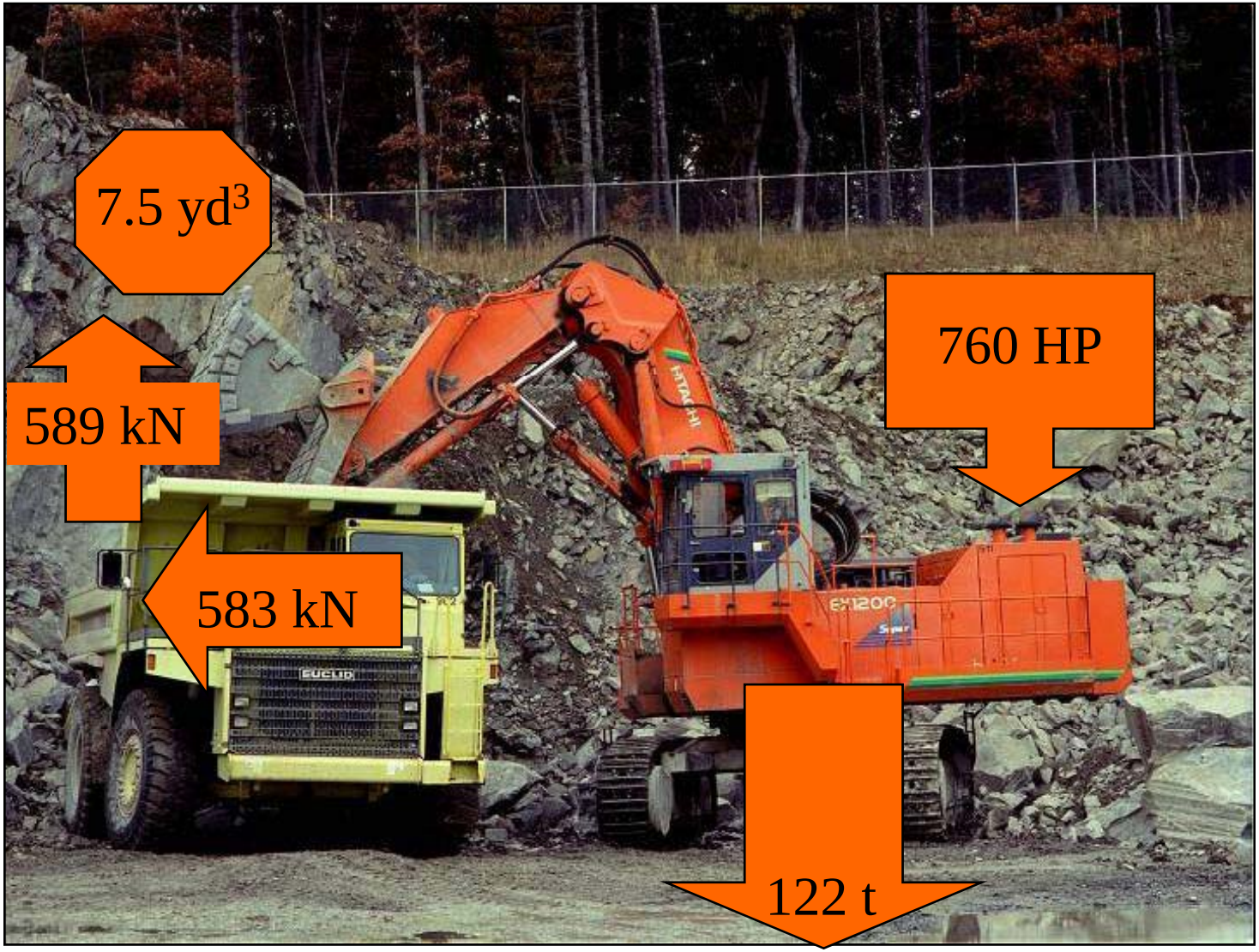
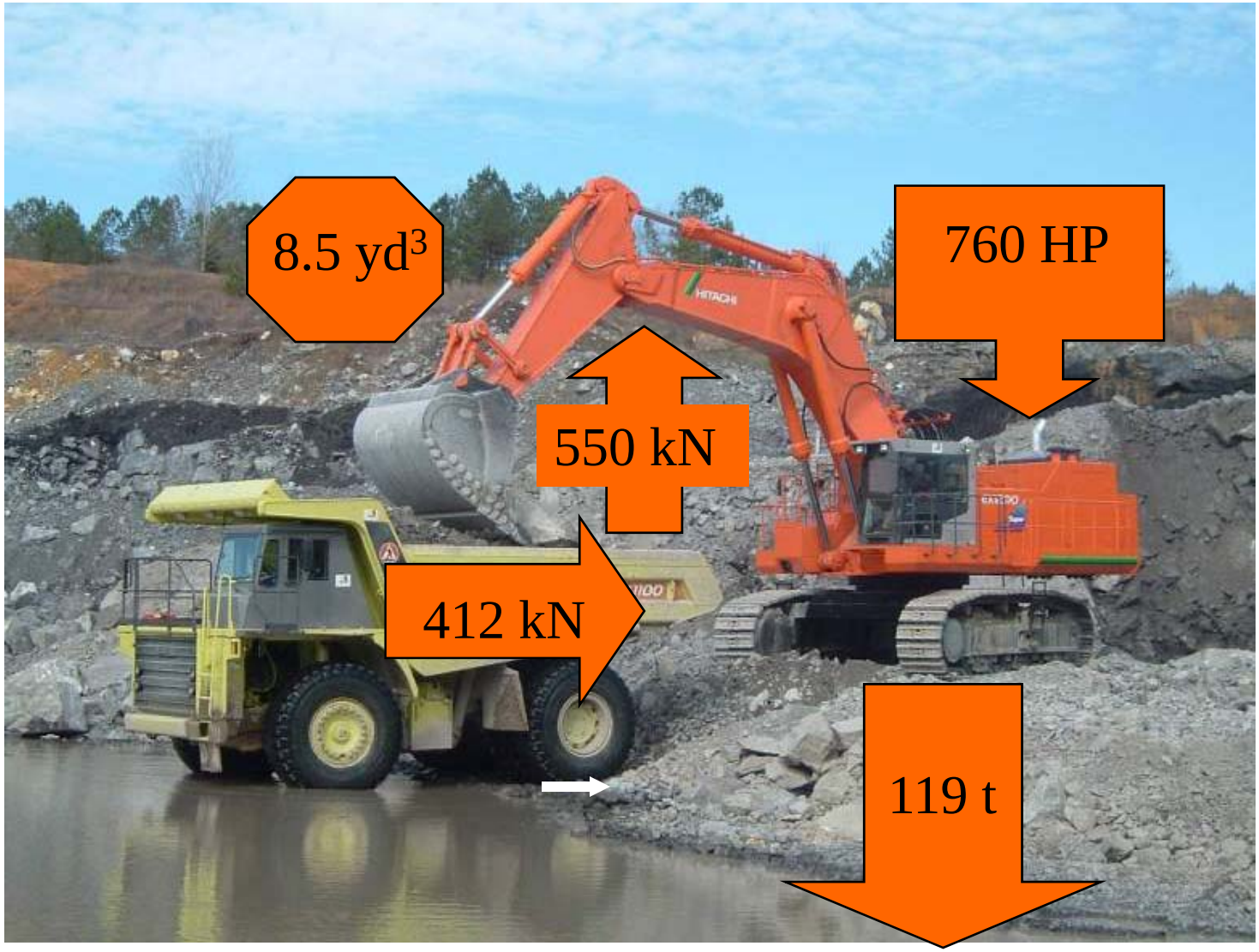
Breakout Force



Breakout Force



Breakout Force Comparison

Model	Shovel	Loader	% Difference
Bucket Capacity (yd^3)	15.7	15.7	--
Operating Weight (lbs)	421,000	209,278	101.2
Crowding Force (lbf)	158,760	N/A	--
Breakout Force (lbf)	136,270	138,360	-1.51
Bucket Width (in)	128	190	
Unit Breakout Force (lbf/in)	1,064.6	728.2	46.2

Travel Speed/Mobility

- **Wheel Loader**
  - **Average travel speed of approximately 20 mph**
  - **Very good when blending materials**
  - **Travels from face to face at a high rate of speed**
  - **Can even perform Load and Carry Operations**

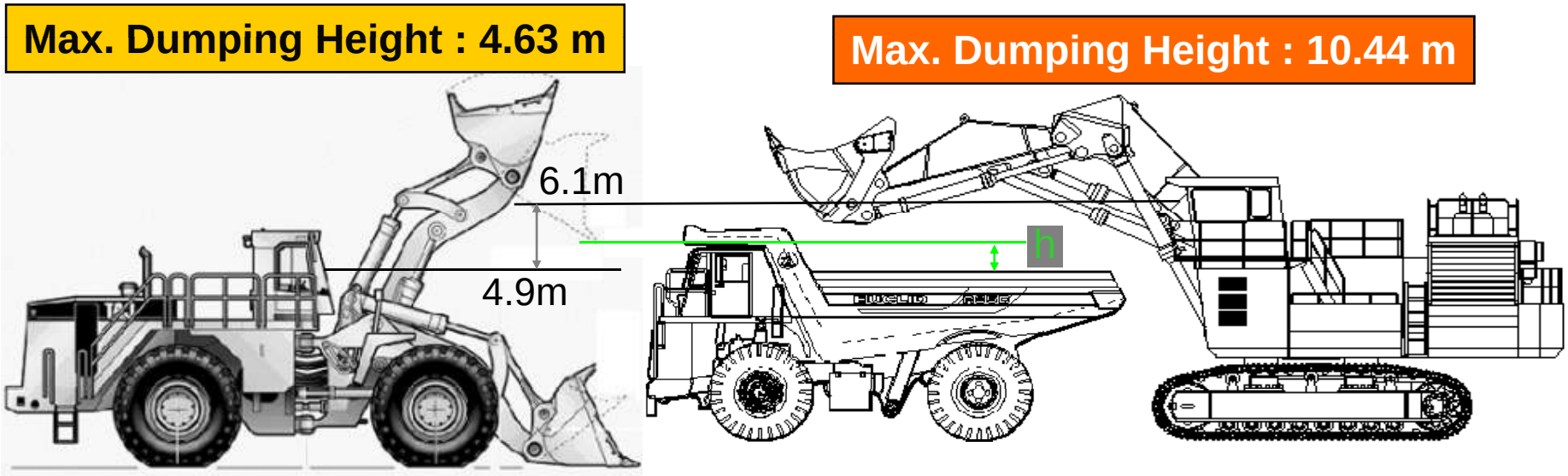
- **Front Shovel**
  - **Average travel speed of approximately 2.0 mph**
  - **Mobility is a major deterrent**
  - **Can blend materials, but another loading tool must assist**
  - **Primarily works one face during a single shift**
    - Very time consuming and expensive to move from face to face during a shift
  - **Solutions do exist to assist in the moving of mining excavators/shovels**

Travel Speed/Mobility

- Independent Structures separated by two wheels
- Minimize wear to undercarriage
- Travels at 20 km/hr, Slopes of 15^{o}
- Requires 3 minutes of preparation

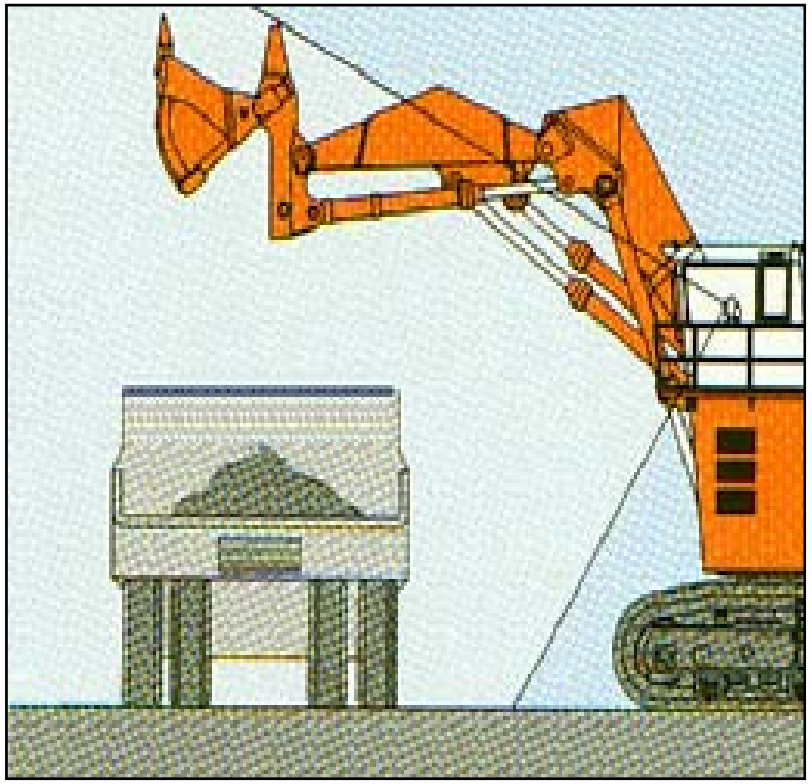
Visibility

- **Operator Eye Level**
  - **Shovel has higher eye level for operator**



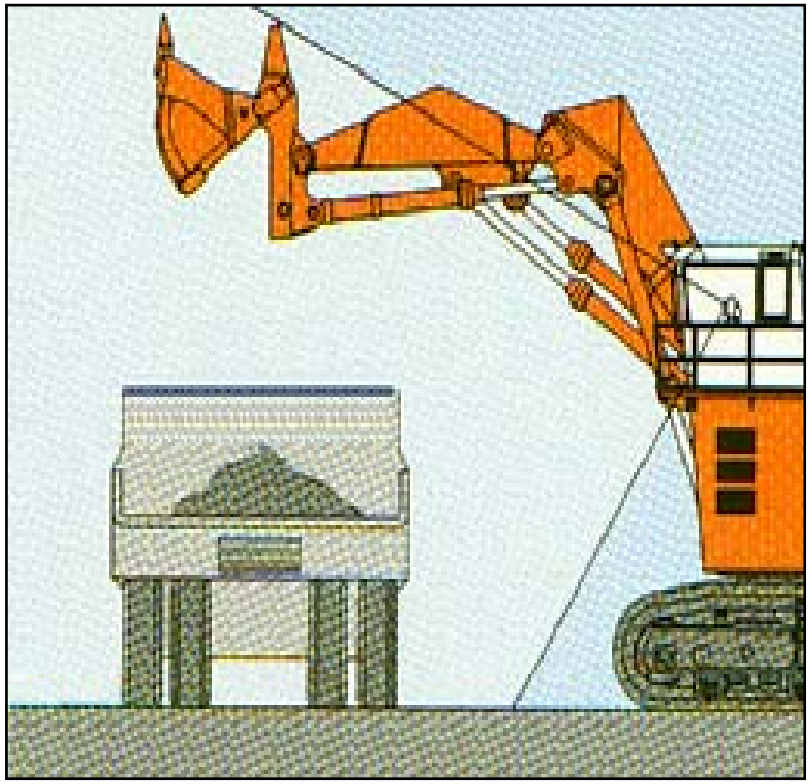
Visibility

- **Shovel/Excavator**
  - **Easier to see in bed of truck**
    - Uniform loading (centered)
    - Equally distributes weight front to rear
    - Equally distributes weight side to side
      - Provides better tire life
      - Wear on truck bed is minimized



Visibility

- **Wheel Loader**
  - **Less visibility into bed of truck**
    - Typically loads on driver side
    - Weight distribution is heavy on loading side and to the rear
    - Occasionally overloads tires on loading side
      - Reduces tire life
      - Increases wear on truck bed



Operator Comfort

Operator Comfort

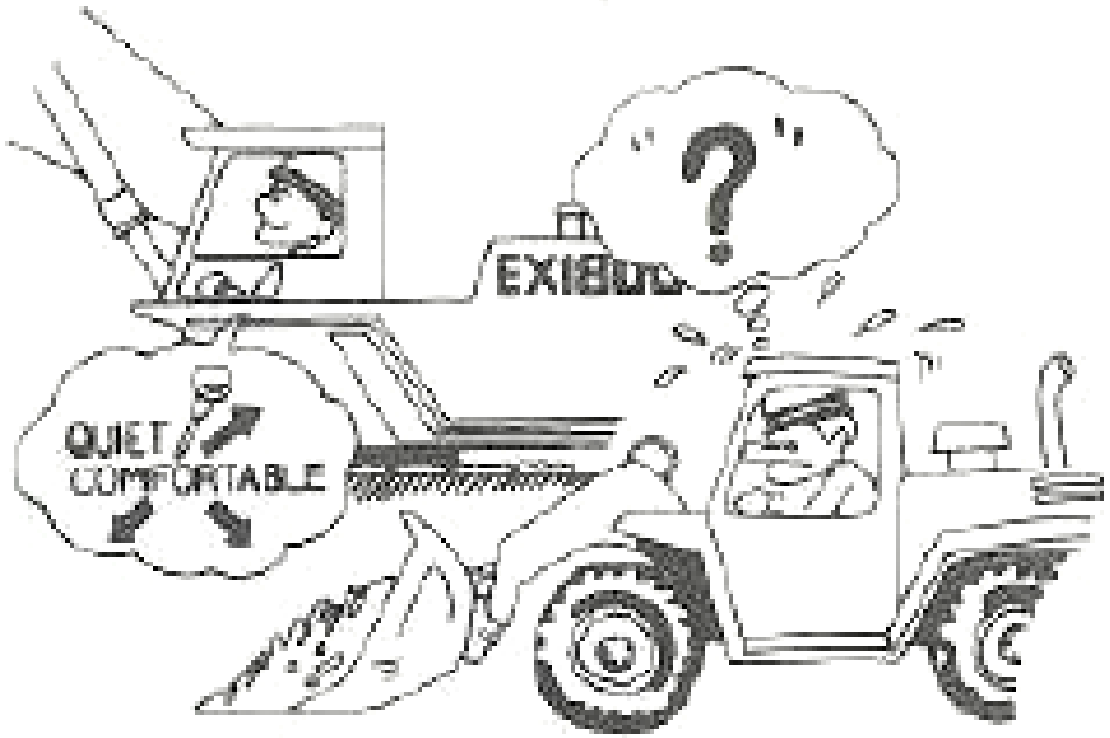
- **Shovel/Excavator**

Operator Comfort

- **Wheel Loader**

Operator Comfort

- **Shovel – level and foot operation**
- **Short Swing of Machine vs. Complete Travel of Wheel Loader**
- **Loader Travels at face and at truck, and reversing all day**



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Estimated Owning and Operating Cost

- **Front Shovel**
  - **Typically a higher up front capital cost**
    - Off set by machine useful life
  - **Provides high productivity and a low cost of ownership**
  - **Undercarriage is a large replacement item**
  - **Versatility is minimized**

- **Wheel Loader**
  - **Typically a lower up front capital cost**
  - **High cost of operation and lower production**
  - **Tire life plays a huge role in operating costs**
  - **Provides excellent versatility**

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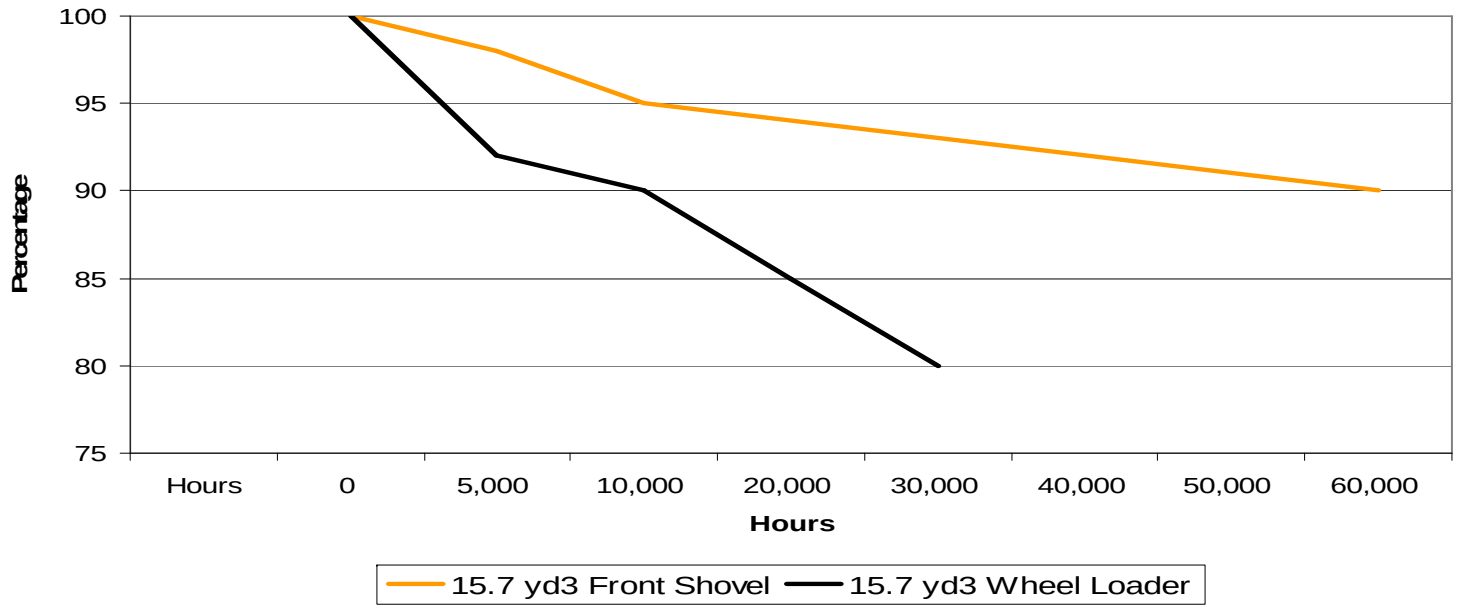
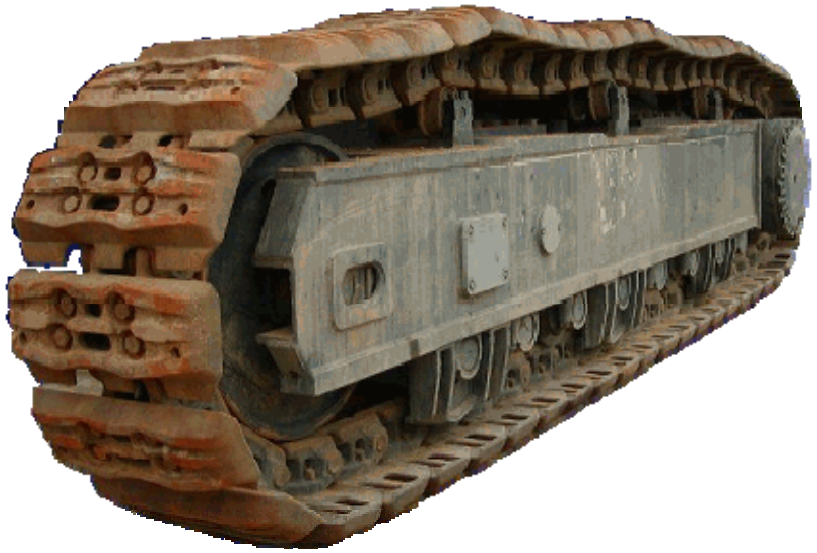
Owning Cost

- **Expected Production Life as Primary Loading Tool**
  - **15.7 yd^3 Front Shovel = 60,000 hours**
  - **15.7 yd^3 Wheel Loader = 30,000 hours**
- **Expected Mechanical Availability**



Operating Costs

- **Tires vs. Undercarriage**
  - **Cost per Hour for tires = $72,000/7,500 = 9.60 US$ per hour**
  - **Cost per Hour for undercarriage = $190,000/30,000 = 6.33 US$ per hour**
  - **Tire Availability and Inflation**



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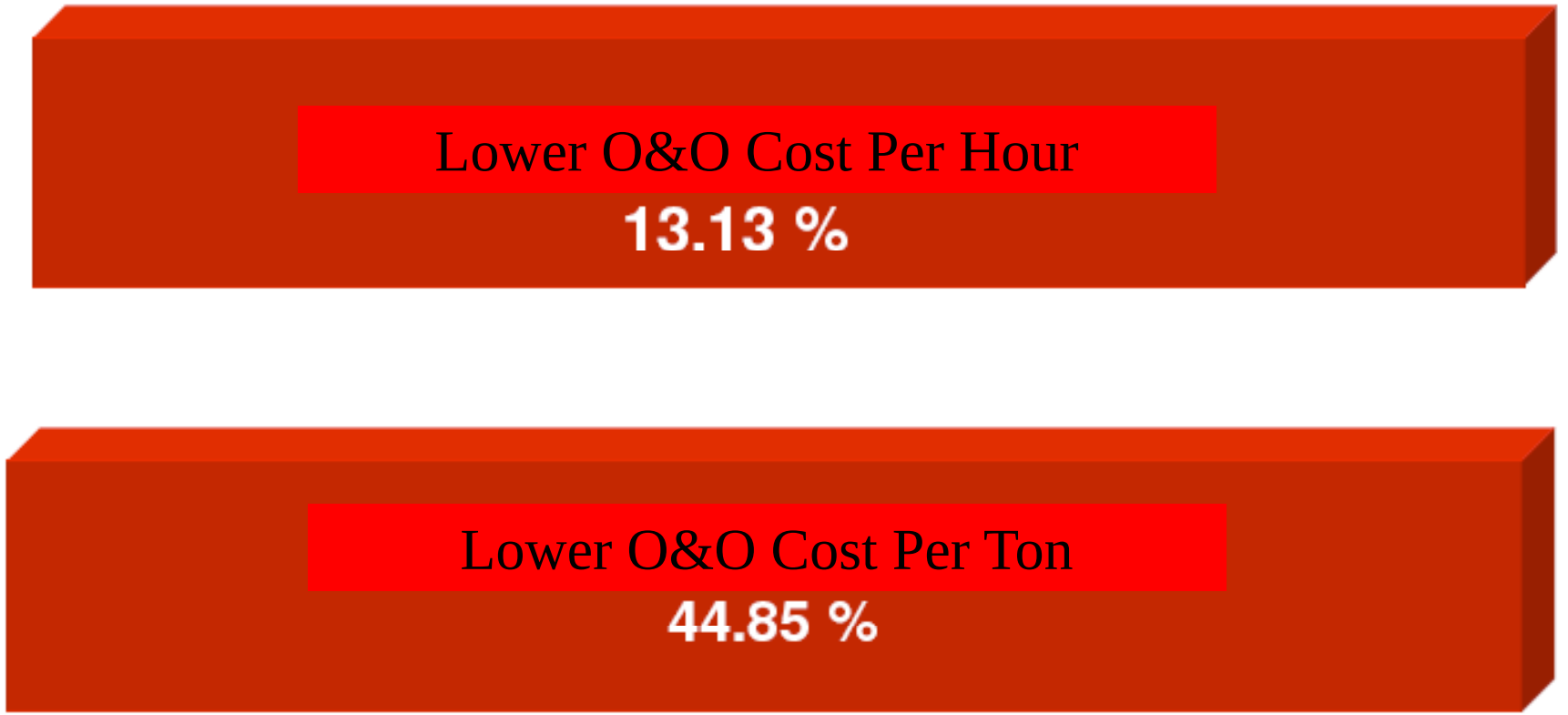

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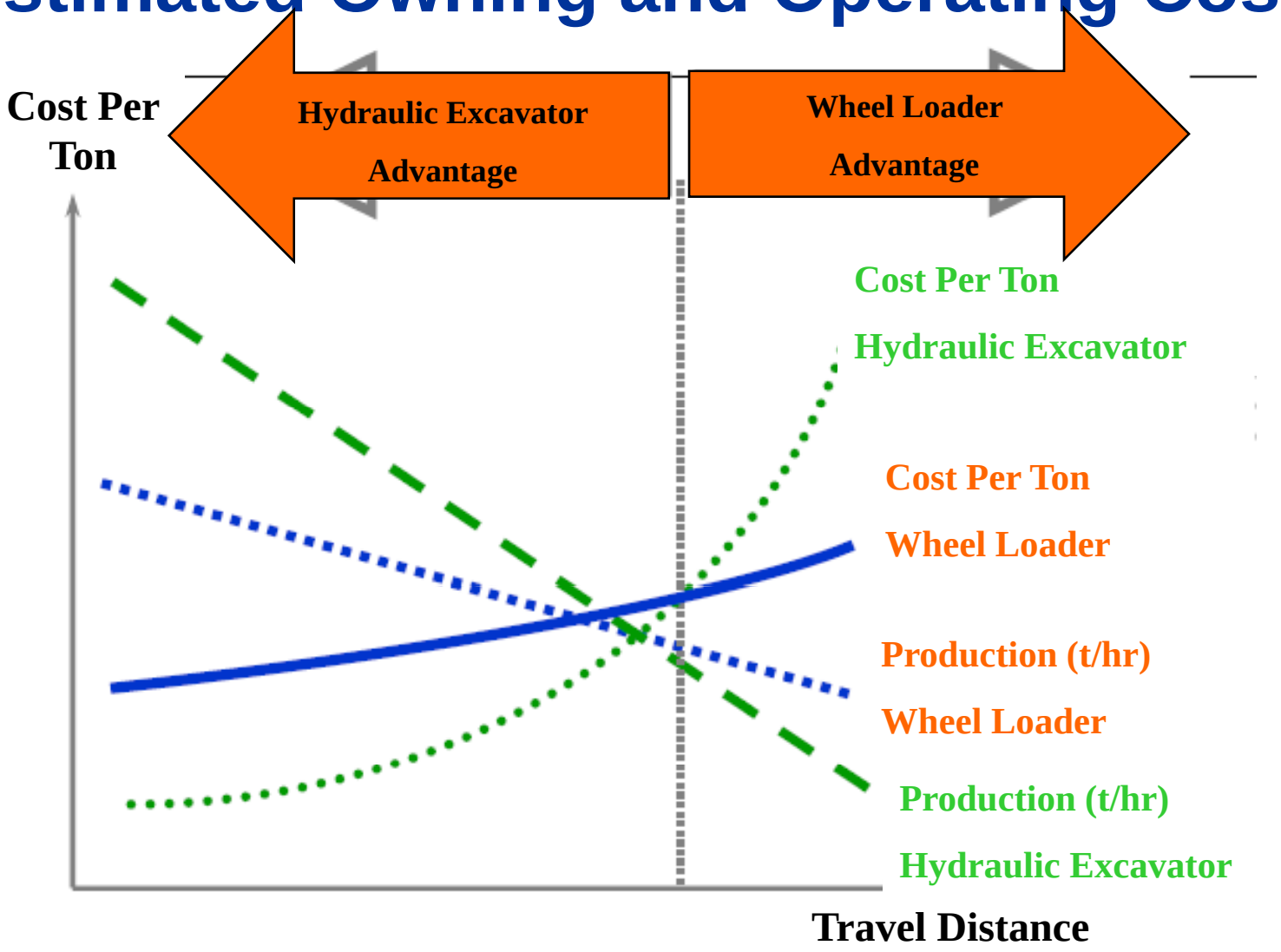
Estimated Owning and Operating Cost



Production Studies

- **Eastern US Coal Mine**
- **Loading Blasted Sandstone**

150 Ton Truck Loaded by a
15.7 yd^3 Hydraulic Excavator

100 Ton Truck Loaded by a
15.7 yd^3 Wheel Loader

Production Studies

	15.7 yd^3 Wheel Loader	15.7 yd^3 Hydraulic Excavator	15.7 yd^3 Hydraulic Excavator Advantage
Loading Times			
Avg. # of Passes	4.3	7.8	--
Avg. Payload Per Pass	21.8 tons	18.8 tons	--
Cycle Time (min)	0.68	0.43	36.8 %
Avg. Load Time (min)	2.27	2.90	--
Avg. Idle Time (min)	1.07	1.77	--
Production Results			
Total Time of Study (min)	73.13	82.78	--
Trucks Per Hour	16.0	13.0	--
Total Tonnage Loaded	1,768 tons	2,628 tons	48.6 %
Hourly Production	1,450.5 tons/hr	1,904.7 tons/hr	34.4 %
Hourly Production	677.0 bcy/hr	889.0 bcy/hr	31.3 %
Tons Per Operated Minute	24.18 tons/min	31.75 tons/min	31.3 %

Production Studies

- **Eastern US Quarry**
- **Loading Blasted Granite**

100 Ton Truck Loaded by a 15.7 yd^3 Hydraulic Shovel

Typical 100 Ton Truck Load

Production Studies

	Front Shovel	Wheel Loader	Percent Difference
Average Loading Tool Cycle Time:	0:00:29	0:00:52	44.0%
Average Load Time:	0:02:17	0:04:27	44.0%
Average Loading Tool Wait Time:	0:04:42	0:02:44	--
Total Loading Tool Wait Time	1:48:01	0:49:12	--
Total Time of Study:	3:22:30	3:28:59	--
Total Tonnage Loaded:	2,997	2,794	7.0%
Hourly Production:	888.0	802.2	11.0%

If Loading Tool Wait Time Goes to Zero

Average Loading Tool Cycle Time:	0:00:29	0:00:52	44.0%
Average Load Time:	0:02:17	0:04:27	44.0%
Average Loading Tool Wait Time:	0:00:00	0:00:00	--
Total Time of Study:	3:22:30	3:28:59	--
Total Tonnage Loaded:	7,650	3,883	97.0%
Hourly Production:	2,297	1,115	106.0%

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Summary

	Hydraulic Shovel	Wheel Loader
Digging	Large Digging Force	Small Digging Force
Loading	Higher Dumping Height	Small Dumping Clearance
Ground Condition	Can work on varying ground conditions	Can not work on soft ground
Operating Cost	Better fuel consumption and lower maintenance cost	Higher Operating Cost; especially tire cost
Operator Comfort	Lower vibration due to digging, swing, and loading operation is not combined with travel	Digging and dumping operation requires traveling; causing vibration
Safety	Longer digging reach	Necessary to be close to the digging face

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Questions?

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