Rigid Frame Truck vs. ADT

Grant Martin

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Agenda

- Load/Haul System
- Maximizing Production in Haul Trucks
- Rigid Frame Trucks vs. Articulated Trucks
  - Overview
  - Haul Road
  - Body Design
  - Frame Design
  - Drive-Train
  - Payload
- Owning and Operating Costs

Load/Haul System

- **Key factor in any haulage system**
  - **Understand the application**
  - **Utilize the correct loading tool**
  - **Achieve ideal pass match with selected haul trucks**
    - Typically less than or equal to 4.00 passes
  - **Maximize the loading tools utilization**
    - Insure the loading tool is trucked properly

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Maximizing Haul Truck Production

1. Haul over the shortest possible distance when moving materials
2. Minimize the handling of materials
3. Expend the minimum amount of energy to move the maximum amount of material
4. Equipment must maximize utilization and return on investment
5. Select equipment appropriate to the terrain and weather

Overview

- **Rigid Frame Truck**
  - Maintained Haul Road
  - Greater Payload Capabilities
  - Rear Wheel Drive
  - Steep Grades are a Concern
  - Heavy Duty Frame
  - Heavy Duty Body Design

- **Articulated Truck**
  - Poorly Maintained Haul Road
  - Limited Payload Capacities
  - All Wheel Drive
  - Negotiates Steep Grades
  - Lighter Frame
  - Lighter Body

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Haul Road

- **Rigid Frame Trucks - Disadvantages**
  - **Require a well maintained haul road**
    - Typically requires support equipment
      - Motor Grader
      - Wheel Loader
    - Must protect tires
  - **Reasonably level loading and dumping conditions**
    - Frame and cab do not oscillate (rigid)
    - Want to minimize the twisting on frame and suspension
  - **Poor under footing conditions effect production**
    - Makes rigid frame trucks uneconomical to operate
  - **Must maintain the proper grade; less than 12.0%**
    - Can operate on up to 20.0% grades

Haul Road, Cont.

- **Rigid Frame Trucks - Advantages**
  - **Based on a well maintained haul road**
  - **Capable of very high speeds**
    - Both loaded and unloaded
  - **Can haul across greater distances**
    - Greater than 1.0 mile (Approx: 1.5 km)

Downhill Haul

Long Uphill Haul

Haul Road, Cont.

- **Articulated Trucks - Disadvantages**
  - **Inefficient on long flat hauls**
    - Maximum hauling speed is limited
  - **Limited to short distance hauls**
    - Typically less than 1.0 mile (1.5 km)
  - **Maximum speed on grade is limited**
    - Long uphill hauls
  - **Limited Payload**
    - Typically a maximum of 40.0 tons
    - Rumors of moving to 50.0 tons

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Haul Road, Cont.

- **Articulated Trucks - Advantages**
  - **Well suited for unmaintained roads**
    - Good speed on poor terrain
  - **Gradability is excellent**
    - Maximum grade of 35.0%
  - **Loading and dumping on uneven terrain**
  - **Excellent flotation**
    - Can work in very sloppy conditions

Haul Road, Cont.

Earth moving systems

	General capabilities	Grades	Considerations
SCRAPERS	Suitable for a broad range of material and underfoot conditions. Highly maneouverable. Work-alone capability	Single engine, usually limited to 15%. Tandem powered to 25%	Best applied in soil and clay materials, but usable with caution in rocky materials.
ARTICULATED TRUCKS	Two axle units fit most poor underfooting and carrier rockier material. Three-axle units carry less rocky material, but have better flotation.	Can work on grades as steep as 35%.	Designed for flotation and traction in construction and well-shot quarry applications. Use caution with hard rocks.
RIGID-FRAME TRUCKS	Broad material appetite and matches a variety of loading tools. Well-maintained haul roads are desirable.	Limited to 8 to 10% on continuous grades. Can climb short grades as steep as 20%.	Ton-mile-per-hour important on long hauls. Proper match with loading tool is important.

SOURCE: Caterpillar

Haul Road, Cont.

Application guide

	WHEELED TRACTOR SCRAPERS			ARTICULATED TRUCKS	RIGID
	Single Engine	Twin Engine	Auger	2- or 3-axle	TRUCKS
Site Condition					
Hard Surface	Good	Good	Good	Good	Excellent
Soft Ground	Fair	Good	Good	Excellent	Poor
Greasy Surface	Poor	Good	Good	Excellent	Poor
Steep (25%+) Grades	Poor	Good	Good	Excellent	Poor
Haul Length					
More than 5 km	Poor	Poor	Poor	Fair	Excellent
1.5 to 5 km	Good	Good	Good	Good	Excellent
0.1 to 1.5 km	Excellent	Excellent	Excellent	Excellent	Good
Material					
Dirt	Excellent	Excellent	Excellent	Excellent	Excellent
Sand and Gravel	Good	Good	Good	Excellent	Excellent
Shot Rock less than 300 mm	Fair	Fair	Good	Very Good	Excellent
Shot Rock between 300 to 500 mm	Poor	Poor	Good	Fair-Good (with liners)	Excellent
Shot Rock more than 500 mm	Not Recommended	Not Recommended	Good	Not Recommended	Excellent

SOURCE: Caterpillar

Body Design

- **Rigid Frame Truck**
  - **Body is built for quarry applications**
  - **Thicker steel utilized in floor and sides**
  - **Utilize horizontal floor and side rail stiffeners**
  - **Great at absorbing impact**
    - Shot rock larger than 500 mm
  - **Provides loading tool operator a large target area**

Body Design

- **Articulated Truck**
  - **Utilizes a lighter body**
    - Ribbed body design
  - **Steel in body is not as thick**
    - Must maintain low GMW
    - Governed by tires
  - **Impact loading is a huge concern**
    - Shot rock less than 300 mm
    - Must add heavy duty body liners

Frame Design

- **Rigid Frame Truck**
  - **Full fabricated, box section main frame**
  - **Utilize high strength alloy steel**
  - **Superior resistance to bending and torsional loads**
  - **Built to support increased payload**

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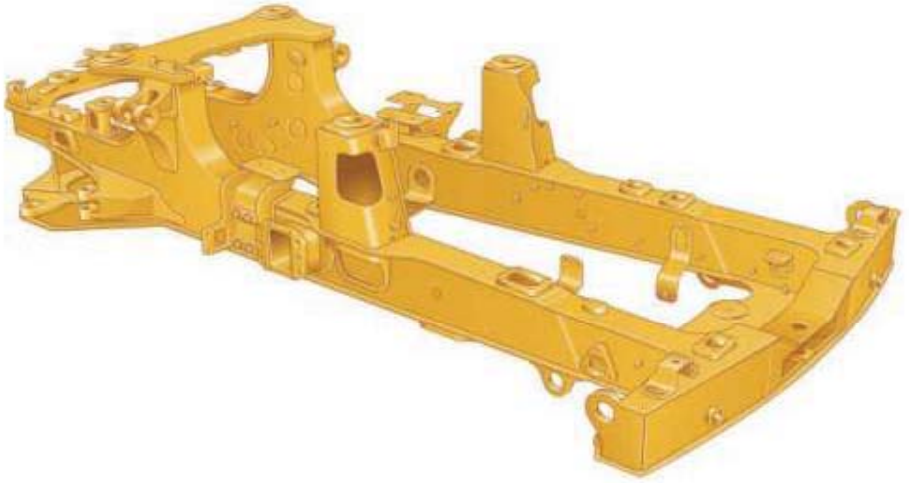
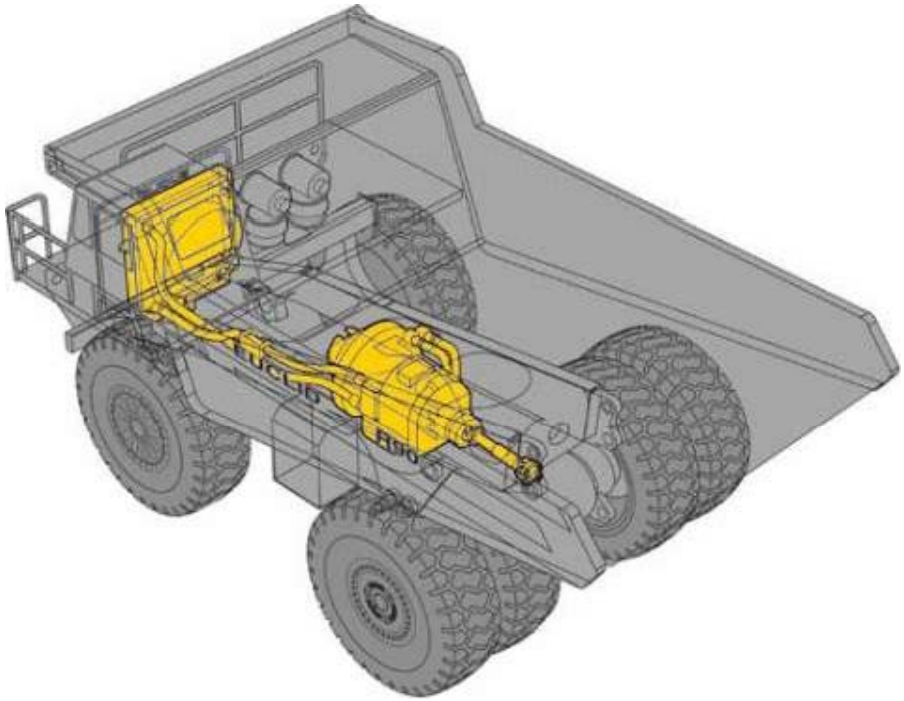
Frame Design

- **Articulated Truck**
  - **Body and cab move independently of one another**
  - **Entire truck can flex as it moves over uneven terrain**
  - **Helps increase the tractive effort when moving through tough terrain**
  - **Overall lighter frame**



Drive-train

- **Rigid Frame Truck**
  - **Simple flow of energy from engine to drive axle**
  - **Steering and transmission components are well protected**
    - Ground clearance
  - **Extended service life on main components**



Drive-train

- **Articulated Truck**
  - **More complex power flow from the engine to the wheel**
  - **More drive-train components**
    - Increased maintenance
  - **Drive-train and steering components are subject to a shorter life**
  - **Some models have 3 axles**
    - Increased maintenance

Drive System

- **Articulated Truck**
  - **Utilizes AWD Drive**
    - Provides better traction during adverse conditions
    - Allows the truck to traverse very muddy conditions
    - Utilize a diff-lock system to deliver torque to tires which need it
      - All weather capabilities

- **Rigid Frame Truck**
  - **Utilizes Rear Wheel Drive**
    - Allows for higher speeds
    - Requires optional equipment for adverse conditions
      - Utilize traction control

Payload

- **Rigid Frame Trucks**
  - **Quarry Trucks: 40.0 to 100.0 tons**
  - **Mining Trucks: 150.0 to 400.0 tons**
    - Utilize electric drive system
      - Greater fuel efficiency
  - **Economy of scale**
  - **Significant Productivity Gains**
- **Articulated Trucks**
  - **Maximum payload of 50.0 tons**
  - **Lacks Economy of Scale**

Owning and Operating Costs

- **Rigid Frame Trucks**
  - **Economical Life of 40,000 hours**
    - Some mines and quarries = 100,000 hours

- **Articulated Trucks**
  - **Economical Life of 8,000 to 10,000 hours**
  - **Typically due to shorter drive train life**

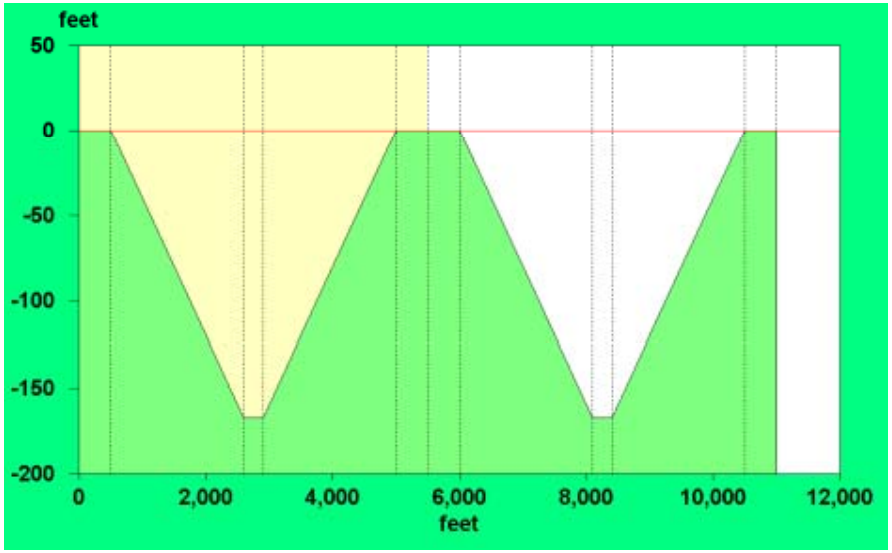
Owning and Operating Costs

- **Owning Cost**
  - **Based on Capital Consumption and Holding Cost**
  - **Only differences in price and useful life**
  - **All other values held constant**
    - Taxes, Insurance, Trade in Value

Equipment	List Price	Useful Life	Owning Cost
40.0 Ton Rigid Frame Truck	$617,910	40,000 hours	$21.11/hr
40.0 Ton Articulated Truck	$555,160	10,000 hours	$27.12/hr

Owning and Operating Costs

- **Consult Study**
  - **Haul Road**
    - 1000 feet and 5500 feet
    - Grades of 8.0% and -8.0%
    - Rolling resistance of 2.0%



Owning and Operating Costs

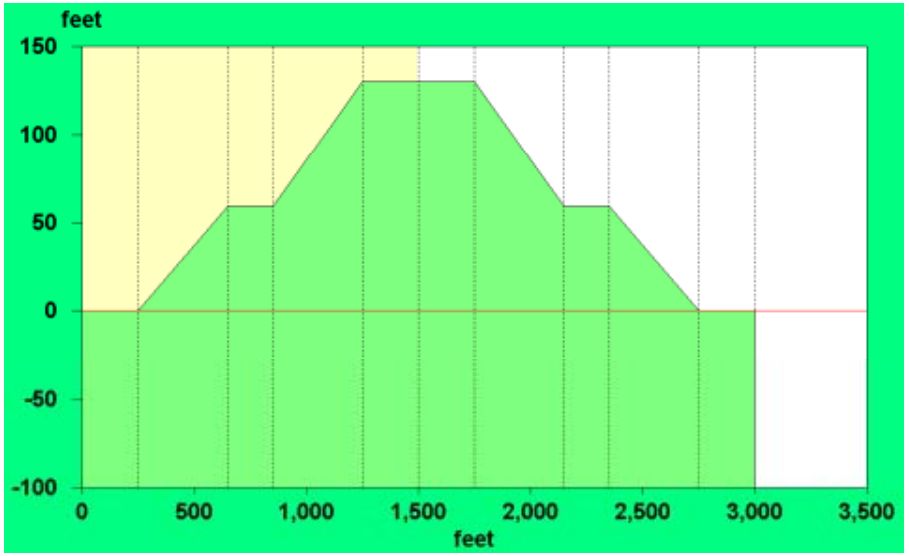
Equipment	HR Length	Cycle Time		Production (tons/hr)	Cost Per Ton (US$/ton)
Rigid Truck	1000’	3.530 min		1,156.40	**$0.221/ton**
		0.67 min Loaded	0.50 min Unloaded		
Artic Truck	1000’	4.069 min		1,074.42	**$0.365/ton**
		0.92 min Loaded	0.59 min Unloaded		

Owning and Operating Costs

Equipment	HR Length	Cycle Time		Production (tons/hr)	Cost Per Ton (US$/ton)
Rigid Truck	5500’	8.229 min		1,156.40	**$0.366/ton**
		3.69 min Loaded	2.18 min Unloaded		
Artic Truck	5500’	11.455 min		1,074.42	**$0.713/ton**
		5.92 min Loaded	2.97 min Unloaded		

Owning and Operating Costs

- **Consult Study**
  - **Haul Road**
    - 1500 feet – Overburden Stripping
    - Grades of 15.0% and 18.0%
    - Rolling resistance of 12.0%



Owning and Operating Costs

Equipment	HR Length	Cycle Time		Production (tons/hr)	Cost Per Ton (US$/ton)
Rigid Truck	1500’	8.383 min		1,035.87	**$0.609/ton**
		4.84 min Loaded	0.98 min Unloaded		
Artic Truck	1500’	6.690 min		1,157.98	**$0.513/ton**
		3.55 min Loaded	0.78 min Unloaded		

Summary

	Rigid Frame Truck	Articulated Truck
Haul Road	Well Maintained Haul Road	Unmaintained Haul Road, Rough Terrain
Body Design	High Strength Steel, Built for Impact Loading	Lighter Body, Impact Loading is a Concern
Frame Design	Large Steel Frame, Resists Bending and Torsional Loads	Body and Cab move Independently of one another, allows the frame to flex over uneven terrain
Drive-train	Simple system, Well Protected Components	Complex Power Flow from Engine to Wheels, Components subject to a shorter life
Drive System	Rear Wheel Drive	AWD
Payload	Payloads up to 400.0 tons	Limited to a Maximum Payload of 50.0 tons

Questions?

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