Haul & Load
Improving Existing Operations
Volvo Construction Equipment

Improving Processes. Instilling Expertise.

Course Agenda

- Purpose and Goal
- A Test
- Where's the money??
- Practical cost improvement "today"
- Practical cost improvement for "tomorrow"
- Conclusion

QUARRY ACADEMY

Haul & Load – What can you affect today

Course Purpose

- Offer quick hitting ideas to improve productivity or lower costs of your current mobile fleet
- Important - This is an open dialogue not a lecture.

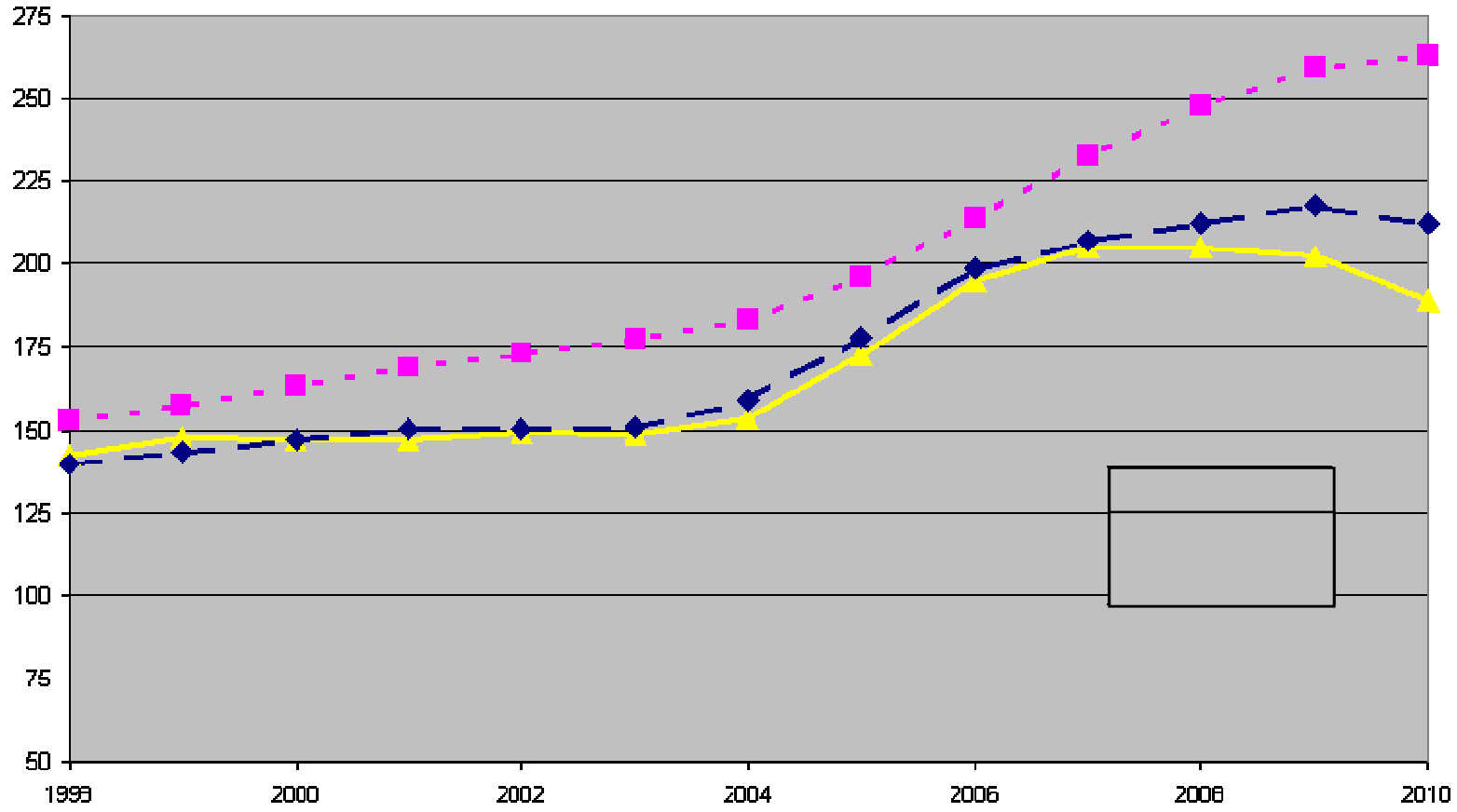
Goal

- Take home at least three ideas for basic but significant cost/process improvement in your operations.

QUARRY ACADEMY

Haul & Load

A Test



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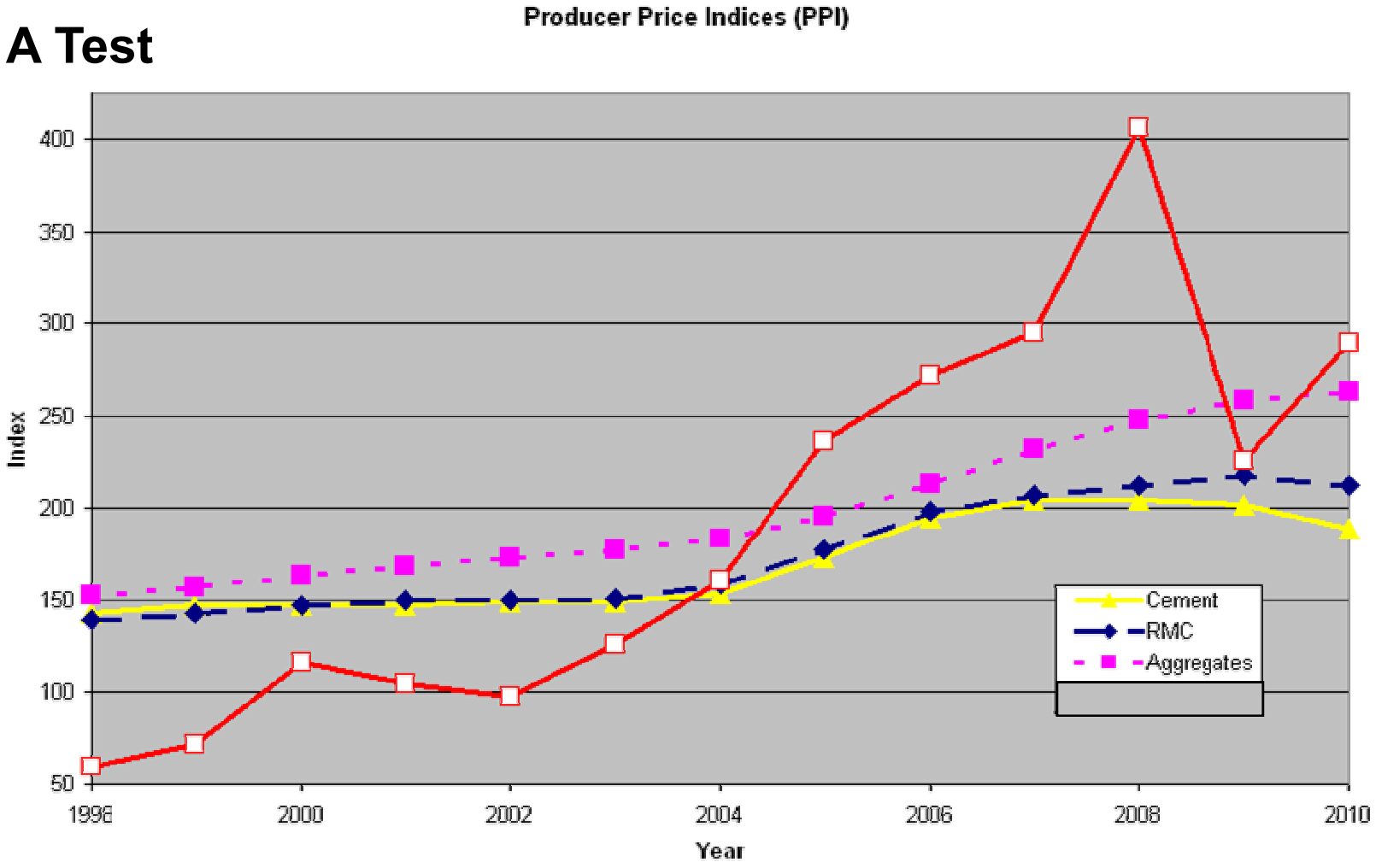
Haul & Load

A Test



Source: US Dept of Labor

QUARRY ACADEMY

Haul & Load

Observations

- Cost control
  = **business viability** in this market
  = **competitive advantage** in a recovering market?
- Operationally
  - What can you control
  - What is beyond your control

Focus for Today

- Actions to improve cost/ton?
  - Change **what** you do
  - Change **how** you do it
  - Change what you **use** to do it

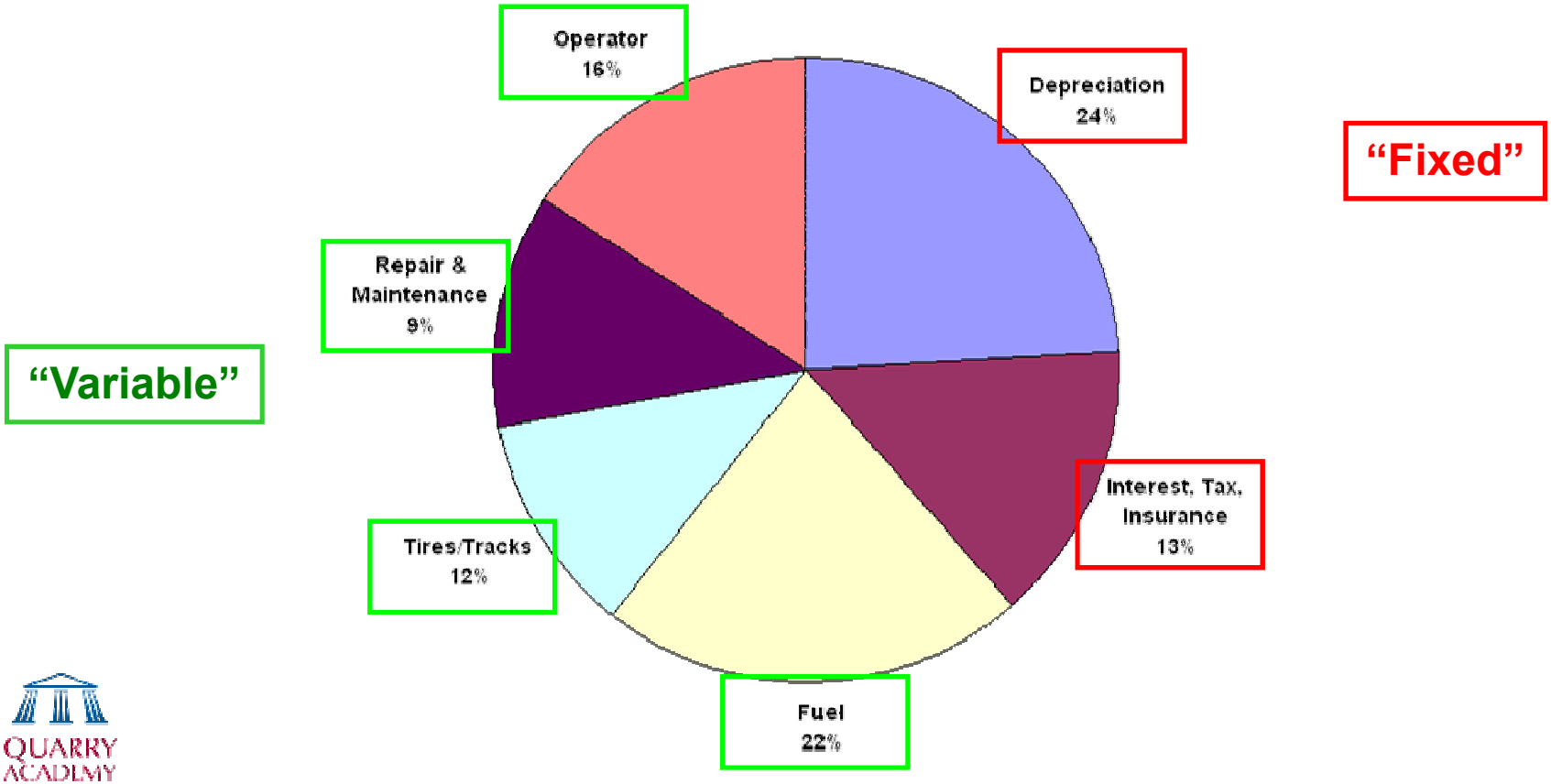
	---- Effective Timeframe ----	
	Short Term	**Long Term**
	"Today"	**"Tomorrow"**
Change **what** you do	**Y**	**YYY**
Change **how** you do it	**YYY**	**YY**
Change what you **use** to do it	**Y**	**YYY**

QUARRY ACADEMY

Haul & Load

O & O Definition = “Owe and Owe”?

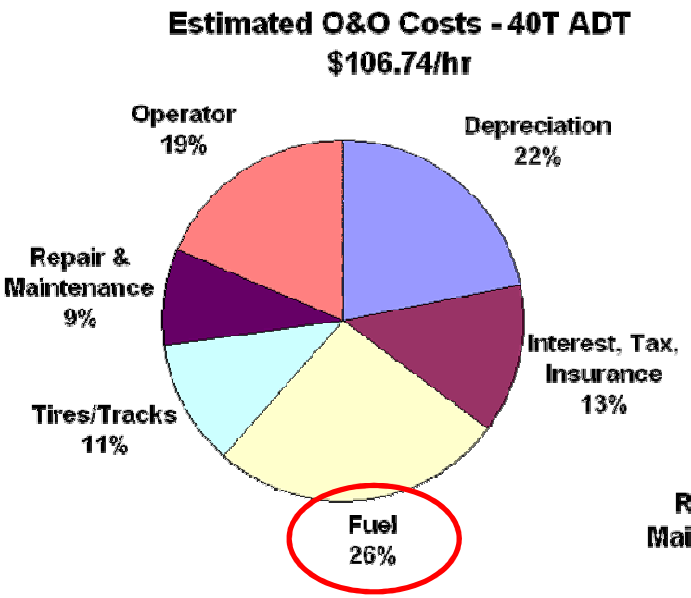
- Ownership and Operating costs
  - Ownership = Cost of capital or asset, depreciation – “Fixed”
  - Operating = Cost of operating the asset – “Variable”

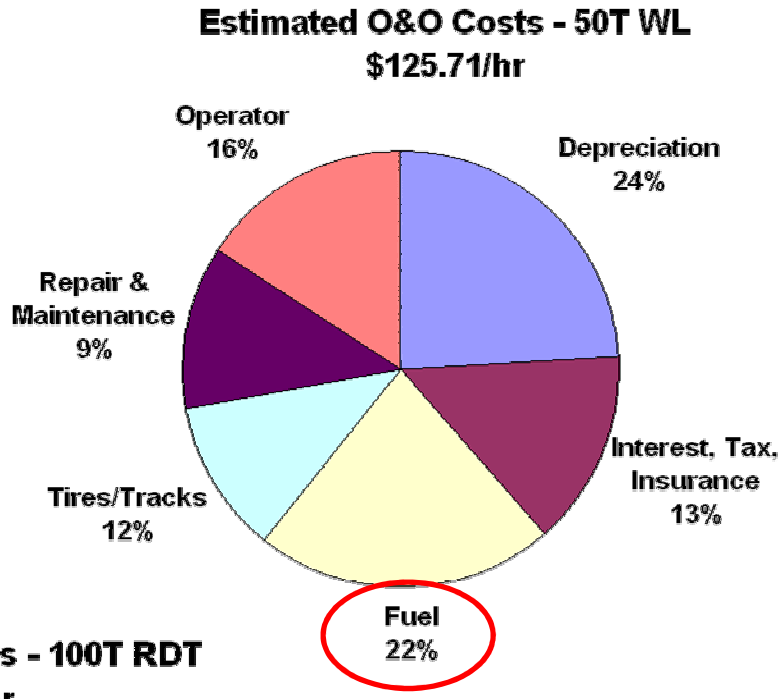


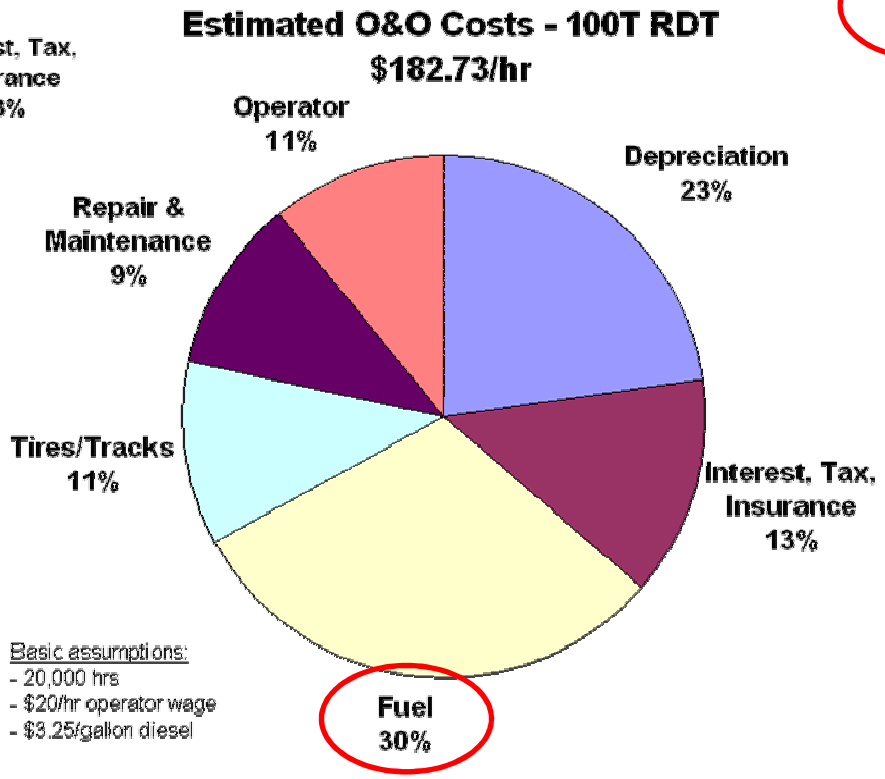
QUARRY ACADEMY

Haul & Load

Where's the $$?







Basic assumptions:
- 20,000 hrs
- $20/hr operator wage
- $3.25/gallon diesel

QUARRY ACADEMY

Haul & Load

O & O Definition = “Owe and Owe”?

- Ownership and Operating costs
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QUARRY ACADEMY

Haul & Load

Practical Approaches - TODAY

- **Success Stories – real, tangible cost reduction via:**
  - Operator improvement
  - Evaluating data
  - Fleet benchmarking

QUARRY ACADEMY

Haul & Load – Operator Performance

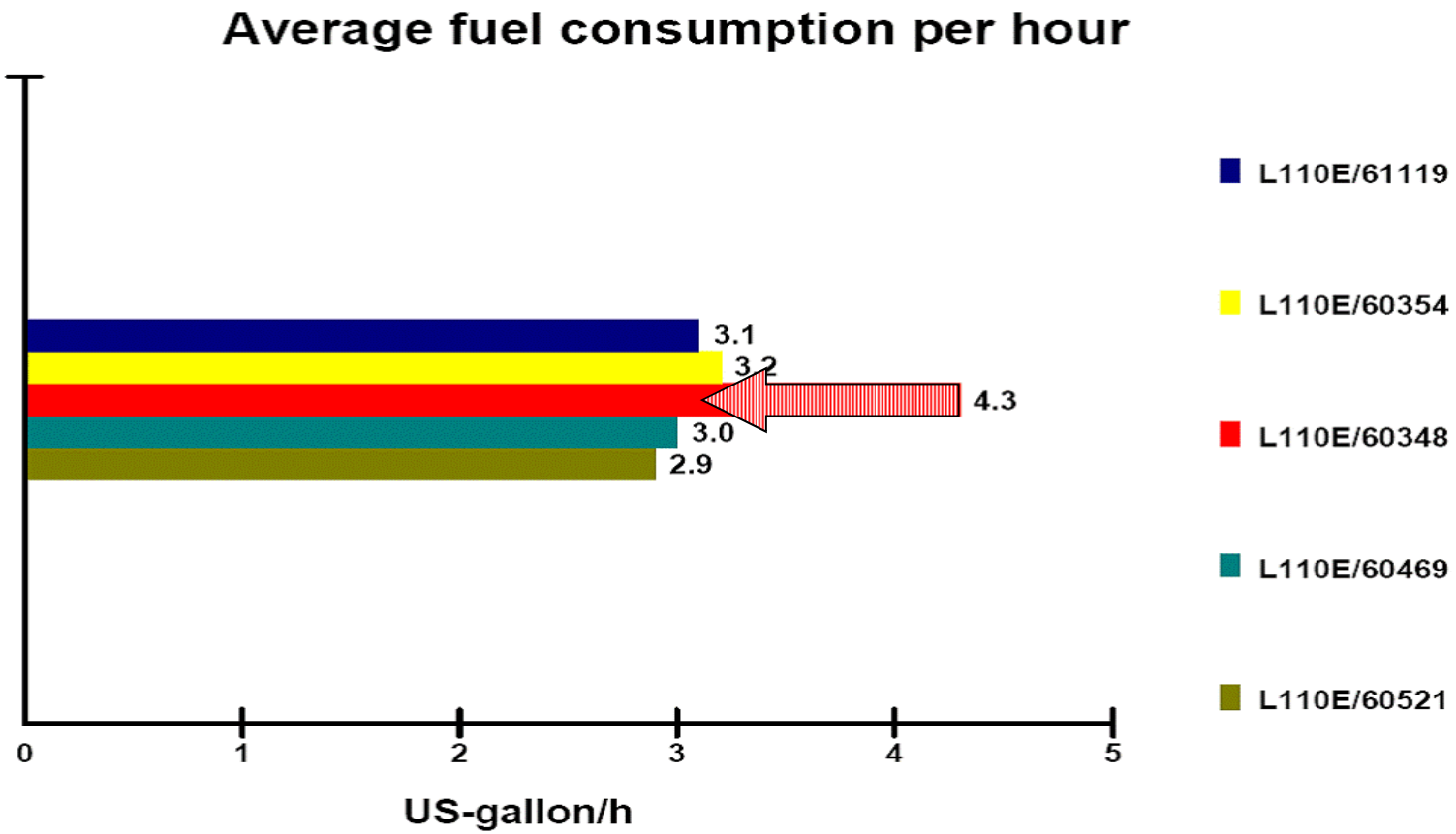
Example #1 – 5 x wheel loaders

- Cost improvement desired
- **Action Taken** – Leveraged the dealer as a resource
  - Reviewed the machine and data history

QUARRY ACADEMY

Haul & Load – Operator Performance

Example #1 – 5 x wheel loaders



QUARRY ACADEMY

Haul & Load – Operator Performance

Example #1 – 5 x wheel loaders

- One machine = 1.2 gal/hour more → **$7,800 more cost /year**
  - Over 5 years → $39,000.
- **Next Actions Taken** – with dealer
  - Checked machine and operating conditions
  - Provided operator training

What Changed?

- Training – work **with** the machine, not against it. Outcomes:
  - High torque at low RPM engine, load-sensing hydraulics
    → Noise/smoke don't equal production.
  - Better bucket loading while burning less fuel.
  - Utilize differential locks to reduce tire spin.

→ Reduced consumption to the fleet average, with no loss in productivity.

QUARRY ACADEMY

Haul & Load – Operator Performance

Example #2 – 5 x wheel loaders

- Compost producer in NC
- **Operator training provided as part of continuous improvement**
- **Before** Operator Training
  - Average fuel consumption — 6.3 gal/hr
  - Average tire life — 2,000 hr per set.
- **After** Operator Training
  - Average fuel consumption — 4.7 gal/hr **(1.6 gal/hr savings)**
  - Average tire life (est.) — 4,000 hr per set.

- **Fuel Savings per fleet** — **up to $52,000 per year**
  (1.6 gal/hr x 5 units x 2,000 hr x $3.25/gal)

  → **Plus additional savings from improved tire life. . .**

QUARRY ACADEMY

Haul & Load – Operator Performance

Wheel Loader – Example #2 – compost producer in NC

What changed?

- Old “pedal-to-the-metal” mentality:
  - Expensive in fuel and noise, but also tire life, component life.
- **Onboard data**
  - Targeted the training
  - Validated the improvement
  - Quantified the improvement.

QUARRY ACADEMY

Haul & Load – Operator Performance

Onboard Data

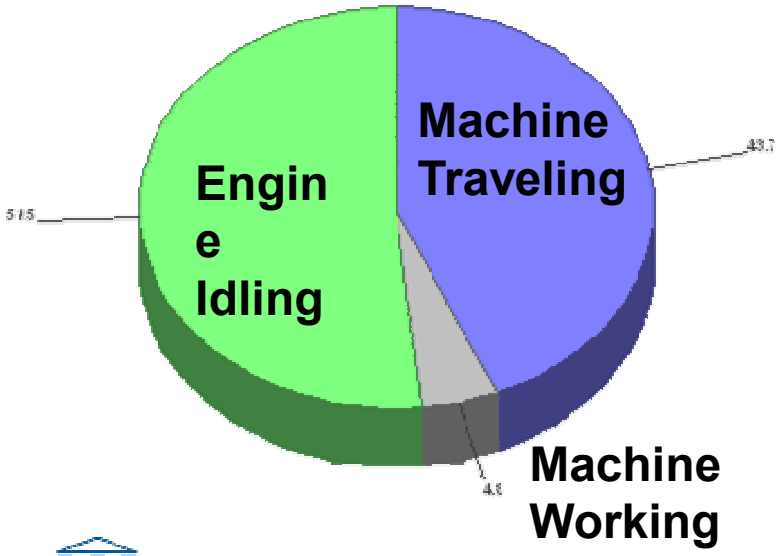
- **Idle time and Engine speed**

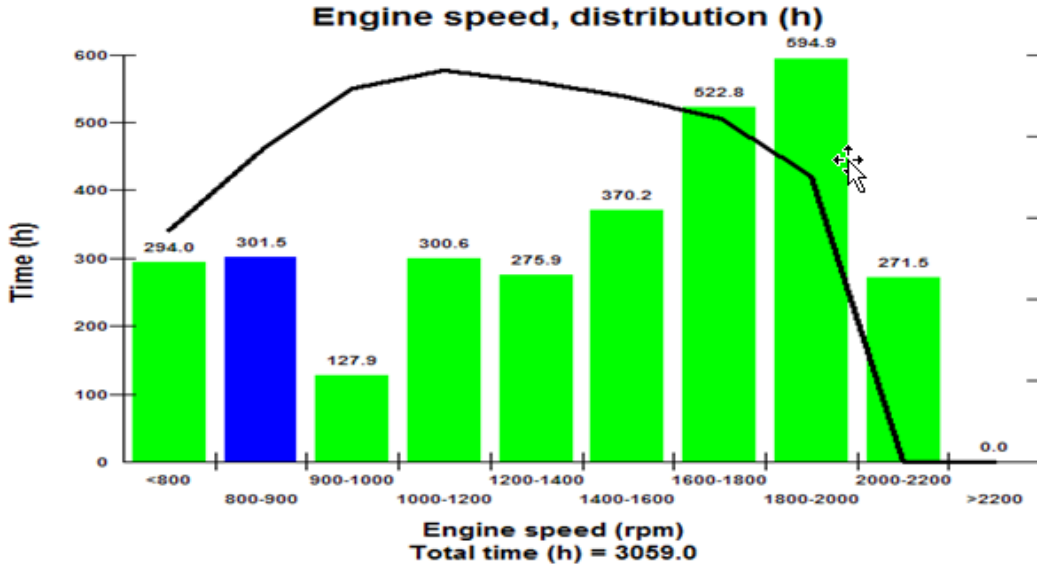
  What is a typical idle time (%) in a day, for a loader?

  What engine RPM range is used?

- **Idle time – can be 30-55% on smaller sites.**

  … Waiting on trucks, smoke breaks, lunch, shift change …it adds up.



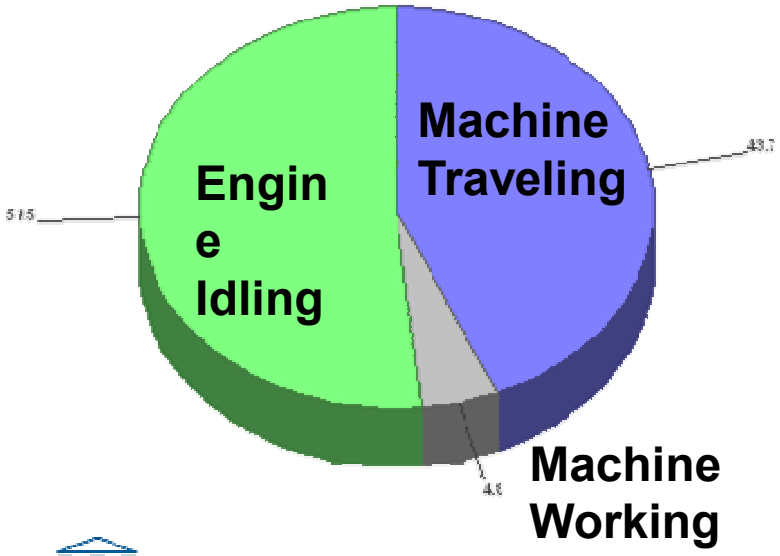


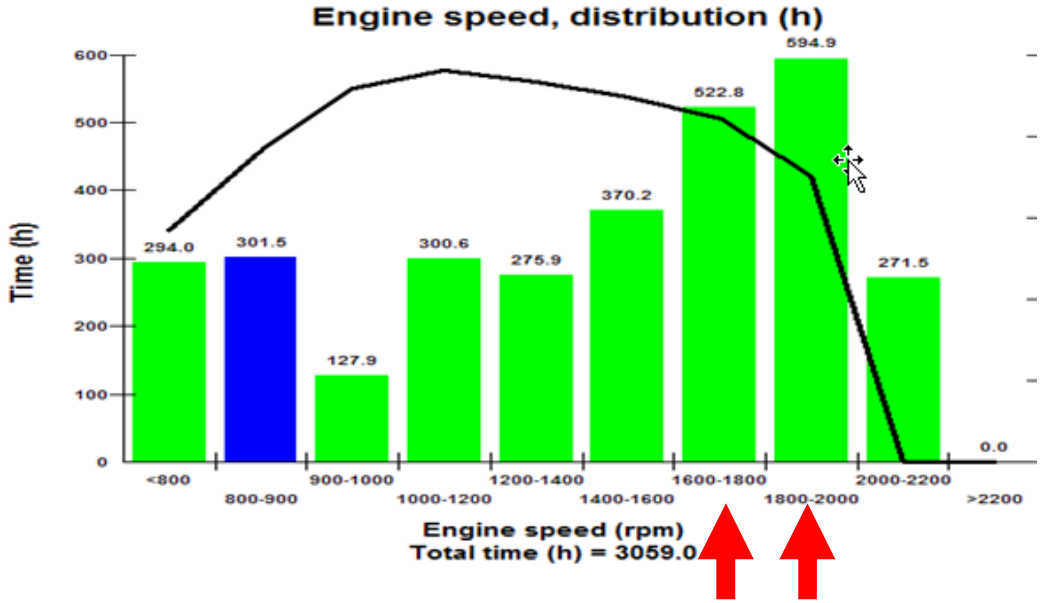
QUARRY ACADEMY

Haul & Load – Operator Performance

Onboard Data

- **What else affects fuel consumption?**
- Working at excessive engine RPMs
  - "Pedal-to-the-metal" mentality can be counter-productive.
  - Utilize auto-idle functions to save a lot of fuel (an available function …)
  - Engine auto-shutdown (another available function)



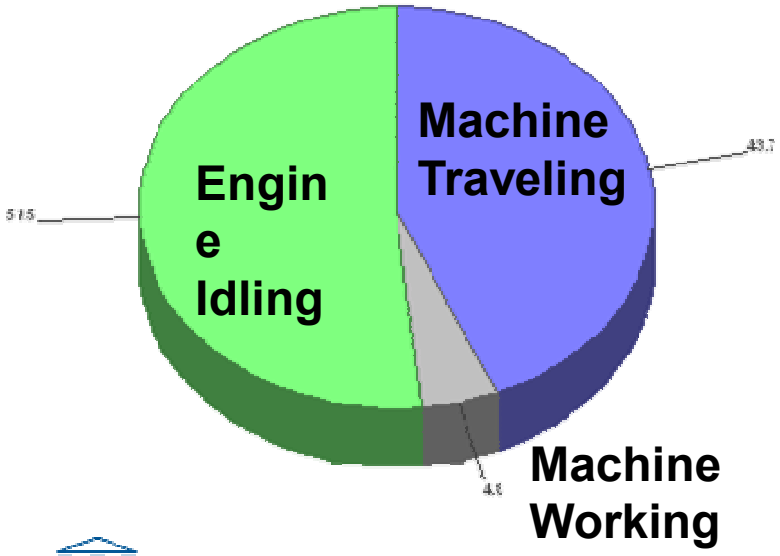


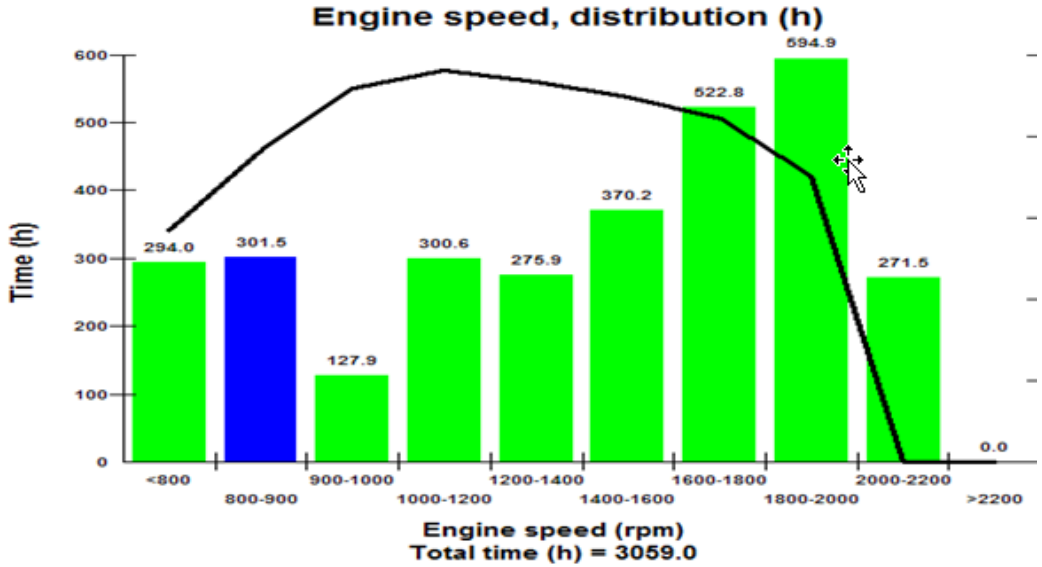
Haul & Load – Operator Performance

Onboard Data

Last questions:

- Idling - a big deal?
- Operator incentives?





Haul & Load – Operator Performance

Example #3 - 3 x 25t Excavators

- Working with grapples in a recycling yard - busy jobsite

  3 shift operation, remote-monitoring showed **30% idle time**

  In consultation with his dealer, the owner made an **incentive plan** for his operators for any fuel savings over a 90 day period.

- **Results:**

  15% reduction in idle time

  → saved 3 gal/machine/day → 810 gallons saved over the test period.

  Reduced max engine RPM and utilized the auto-idle feature

  → saved 5 gal/machine/day → 1350 gallons saved over the test period.

- **Total = 2,160 gallons saved over 90 days**

  → **$7,020 saved** ($3.25/gal)

  → extrapolate to 1 year = $28,080.

  → extrapolate to 5 yrs = $140,400.

QUARRY ACADEMY

Haul & Load – Operator Performance

A. Conclusions - Training

- **Expensive technology isn't necessary to save fuel**

  Optimize operator performance, TODAY
  → continuous training, monitor data and evaluate.
  → a little training $ can save a lot $$ in fuel.

  Review you operations, TODAY
  → change how you do things.
  → empower operators to save.

- **In these 3 examples, the savings potential <u>per unit</u> over 5 years:**

  Ex #1 $39,000 saved per unit

  Ex #2 $52,000 saved per unit

  Ex #3 $46,800 saved per unit.

  …in fuel alone. Plus benefit to tires . . .

- **How does this compare to your annual training budget??**

QUARRY ACADEMY

Haul & Load - Optimize Equipment

Existing Equipment

- **What about older equipment**
  - No on-board data?
  - No capital budget?
- **“Old fashioned” improvement**
  - Manual time studies
  - Idle time, fuel usage, cycle times, travel times over a day
- **Observe and try new things**
  - Minimum throttle required to get the material
  - Is the operator utilizing all gears or just holding 2nd gear
  - Are the bucket & tires appropriate for the job.
- **Re-measure idle times, cycle times, fuel usage, and travel times.**

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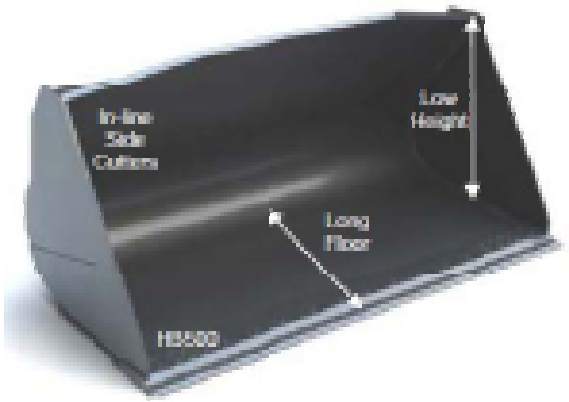
Haul & Load - Optimize Equipment

Existing Equipment – Example #4

- **Re-Handling or Yard/Load-Out: a unique application**

  Switch to a re-handling bucket: 7%+ efficiency measured



- **Tire** type/upkeep – Review with your tire dealer:
  - Do you run L4's or even L5's on your re-handling loader? L3's probably save $!
  - Tire pressures, specs and compounds?

  → 5% fuel efficiency gain is realistic

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Haul & Load - Optimize Equipment

Existing Equipment – Example #4

- **Optimize machine for the current job**
- **Ex: Re-handling**
  +12% efficiency possible with the right bucket and tires

(if 6.6 gph → that's $5000+ saved / year)

+ Intangibles: visibility, spillage

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Haul & Load - Optimize Equipment

Tires Briefly

L2:

- When good traction is important.
- Sandy road with few/no sharp stones
- Load/carry, material handling.

L3:

- All types of load/carry.
- Stable roads, higher speeds.

L4:

- Digging aggressive material
- When cut protection is needed.
- Ex: handling blasted rock.

L5:

- Digging extremely difficult material.
- Low travel range and speed.
- Ex: Toughest quarries and mining.

Increasing tread depth, also increasing weight and reducing TMPH!

QUARRY ACADEMY

Haul & Load - Optimize Equipment

B. Conclusions - Existing Equipment

- **Specifications – Tires and bucket make a difference**

  → Use the latest/best bucket design for your application

  → Use the best-suited tire for today's operations

  - Better performance is possible at a lower cost.
    - longer tire life, less expensive, less fuel - all in one
- **Applications – Same loader digging in the pit and for re-handling?**
  - How often is it digging vs. re-handling?
    - **L5 vs. L4 vs. L3 tires = $$$$**

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Haul & Load - Optimize Operations

Example #5 – Truck Loading

QUARRY ACADEMY

Haul & Load - Optimize Operations

Example #5 – Truck Loading

As shown on video

Max Production (approx) *

- 20 trucks / hour
- 709 tons hour

* 30 second spot time.

If spot time = 15 seconds?

Max Production (approx)

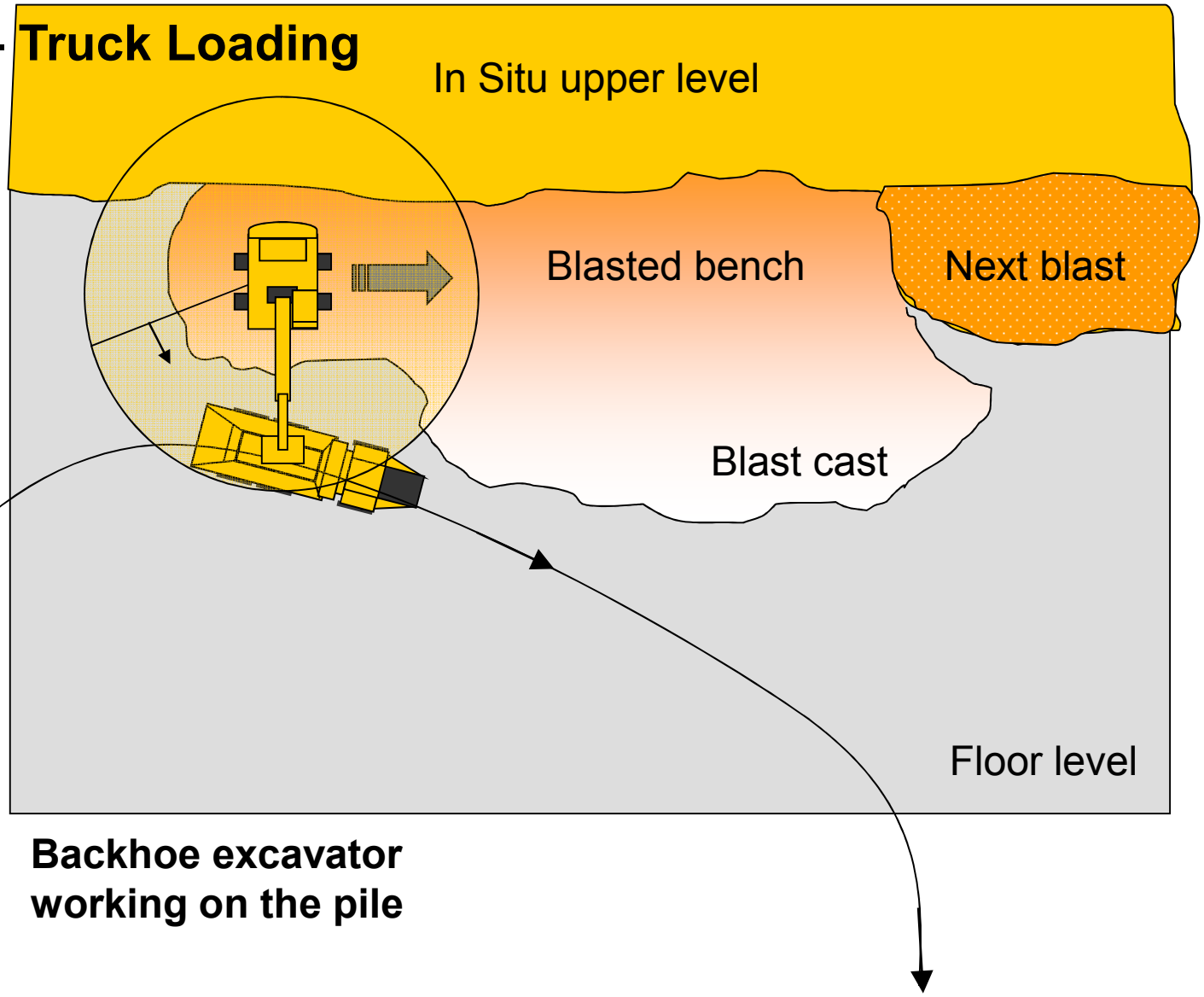
- 23 trucks / hour
- 815 tons hour
  - **15% improvement**

+106 ton/hr x 8 hr = 848 tons / day = $____ ?

QUARRY ACADEMY

Haul & Load - Optimize Operations

Example #5 – Truck Loading



+ productivity
+ safety

Backhoe excavator working on the pile

QUARRY ACADEMY

Haul & Load - Optimize Operations

Example #5 – Truck Loading

15 second spot time
<20 second cycles

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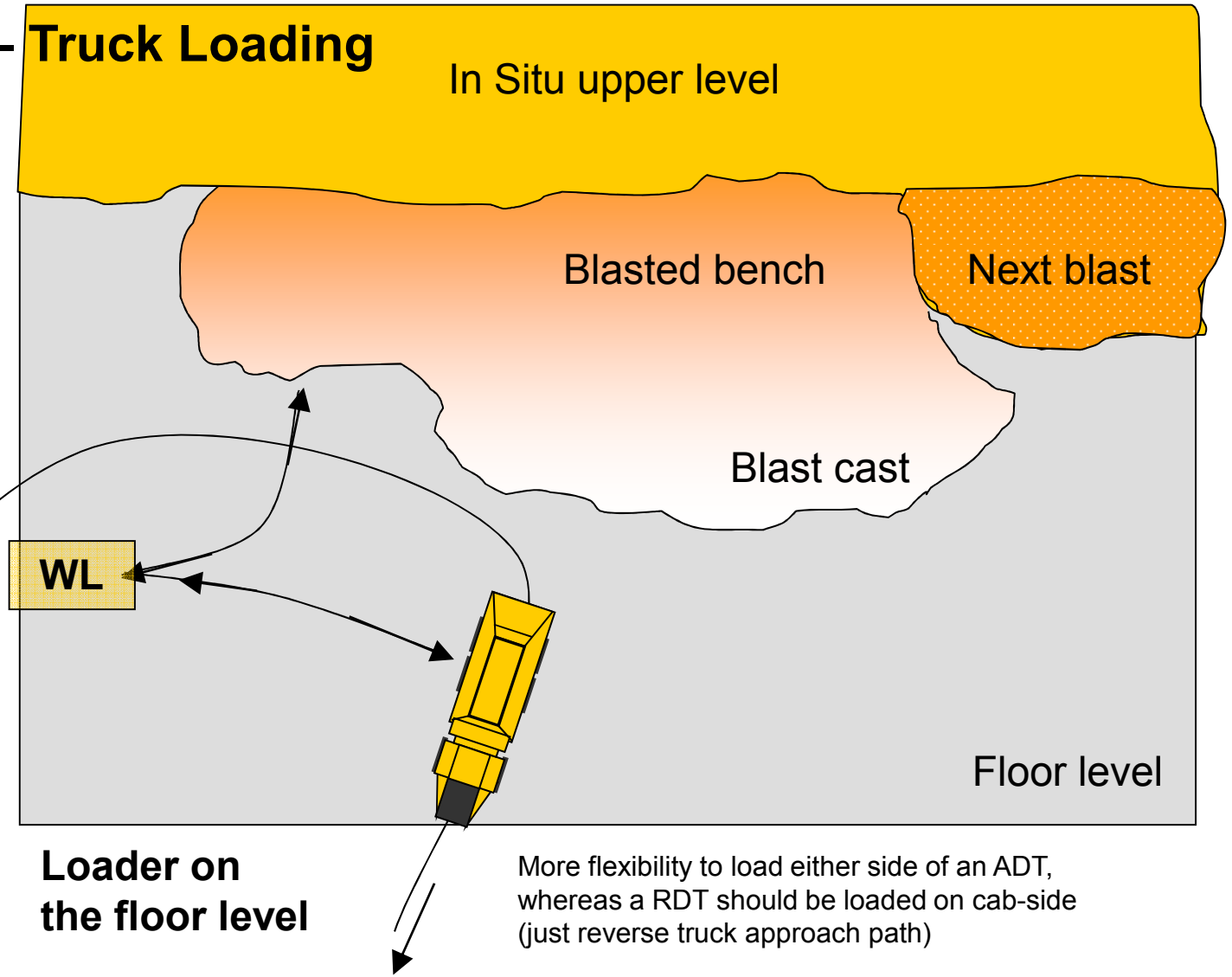
Haul & Load - Optimize Operations

Example #5 – Truck Loading



+ productivity
+ safety

Loader on the floor level

More flexibility to load either side of an ADT, whereas a RDT should be loaded on cab-side (just reverse truck approach path)

QUARRY ACADEMY

Haul & Load - Optimize Operations

Example #6 – Loading Practice

QUARRY ACADEMY

Haul & Load - Optimize Operations

Example #6 – Loading Practice

Use Gravity

- Uphill grade at the dump can assist deceleration and backup, reducing braking.
- Avoid sharp turns before grade to keep momentum and minimize braking.

+ fuel efficiency
- brake wear

QUARRY ACADEMY

Haul & Load - Optimize Operations

Example #7 – Hauler Drive Mode

- Is 6x6 mode always needed?

  → in quarries 6x4 is often sufficient

+ fuel efficiency
+ tire life
+ drive train life

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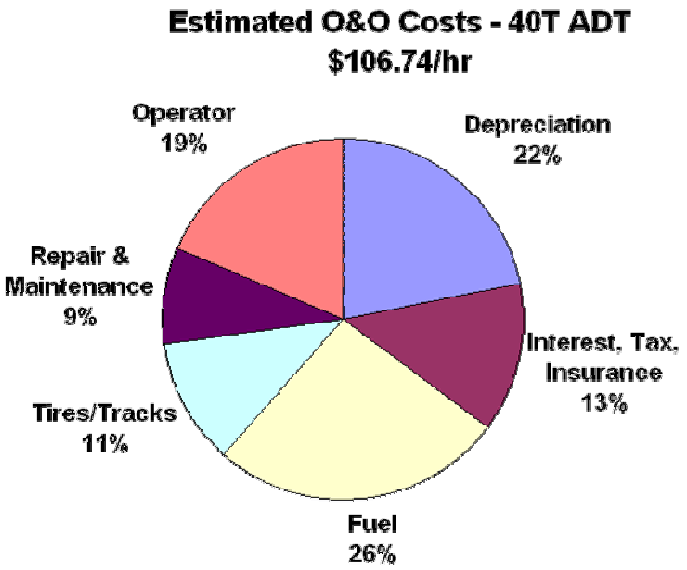
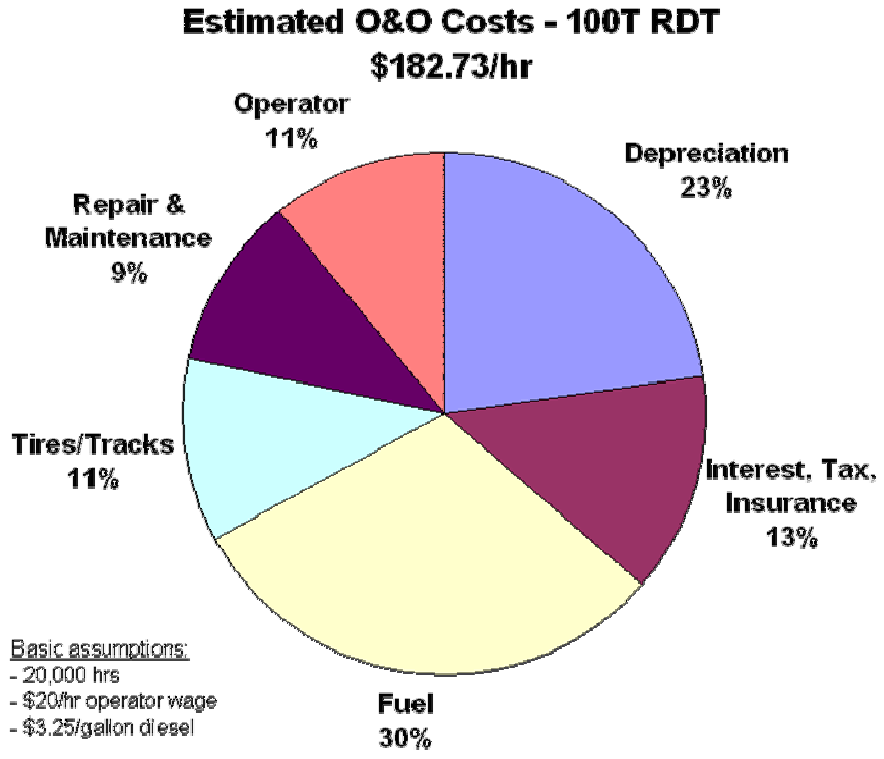
Haul & Load - Optimize Operations

Example #7 – Hauler Drive Mode





= $3,950 / year

= $7,500 / year

5%+ + fuel efficiency
+ tire life
+ drive train life

QUARRY ACADEMY

Haul & Load – What you can affect today

Final Conclusions

- Operator training – it's worth it!
- Optimize machines to suit your current applications
  - Buckets
  - Tires
- Optimize operations
  - Traffic patterns
  - Match drive mode to conditions

QUARRY ACADEMY

Haul & Load – What you can affect tomorrow

Course Purpose

- Long(er) term ideas to significantly change your operation to maintain future competitiveness.
- Important - This is an open dialogue not a lecture.

Goal

- Take home at least one idea for process/equipment/ or method improvement study to be done at your site.

QUARRY ACADEMY

Haul & Load - Optimize Operations

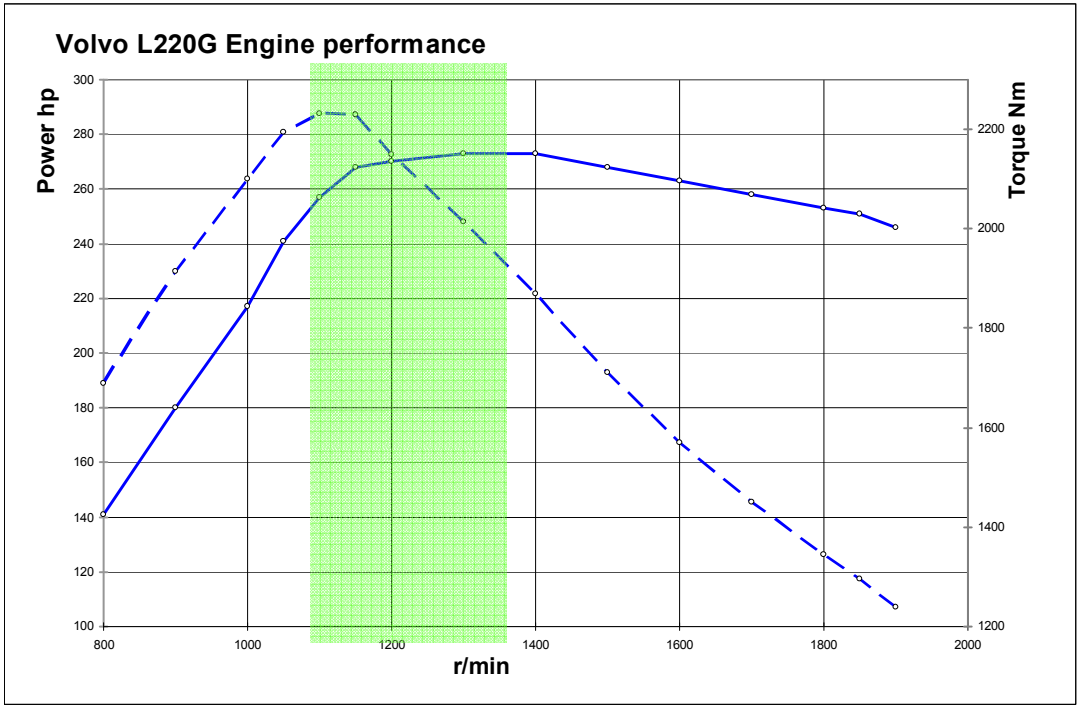
Example #8 – TEAMWORK with CEMENT

QUARRY ACADEMY

Haul & Load – What you can affect tomorrow

Purchasing Criteria

- Ongoing training
- Monitoring systems
- Specifications
  - Lockup transmissions
  - Net vs. gross HP
  - Boom suspension (ride control)
  - Buckets and tires
- Fuel saving features
  - Auto-idle function
  - Auto-shutdown function
  - Hi torque/low RPM engines
  - Load sensing hydraulics vs gear pumps



1100-1350 rpm

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Haul & Load – What you can affect tomorrow

Purchasing Criteria – All Equipment is not created equal

- Do you test? Do the homework and compare!

Pit Loading Test	Loader A	Loader B	Loader C	Loader D
Grand total Tons	7203.7	6341.9	6742.9	6662.1
Tot. Avg. Tons/Hr.	938.3	831.7	894.1	845.5
Tot. gallons used	115.5	123.2	150	180
Tot. Tons/gal.	62.4	51.5	45.0	37.0

- A little means a lot even for just one piece of equipment!
- Just fuel difference – how much will you save with the increased tons/hr.?

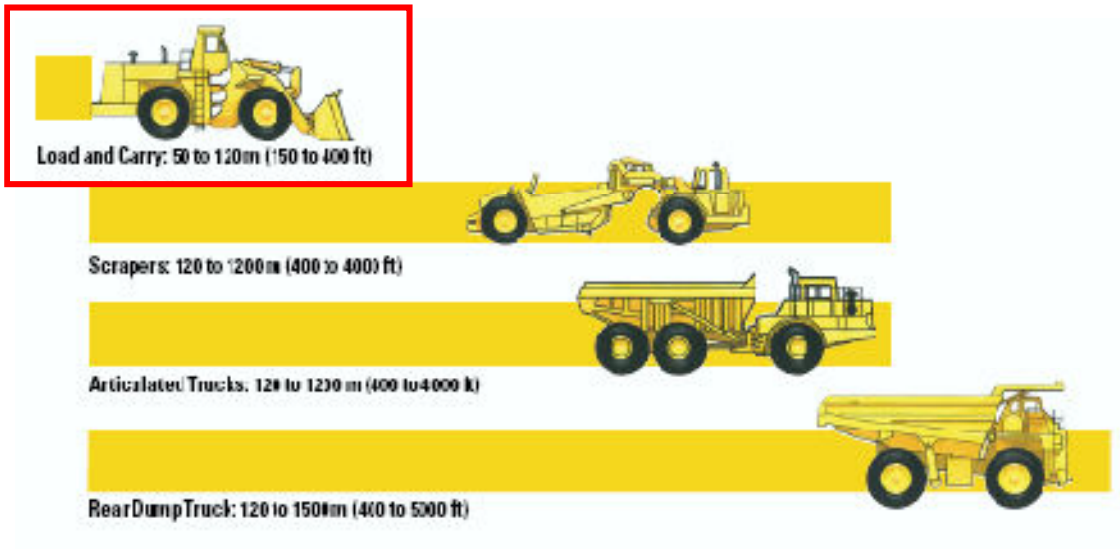
Gallons at 800 tons/hr.	12.8	15.5	17.8	21.6
Annual Difference	$0	$16,286	$29,819	$52,728

QUARRY ACADEMY

Haul & Load – What you can affect tomorrow

Load & Carry

- Do you need trucks?
- Here's the traditional view.
- The goalposts are moving:
  - Breakeven closer to 650' (200m) due to technology advances.



Benefits

- Fewer mobile machines: less operators, less traffic.
- Lower investments
- More flexibility on ramp/hopper design

QUARRY ACADEMY

Haul & Load – What you can affect tomorrow

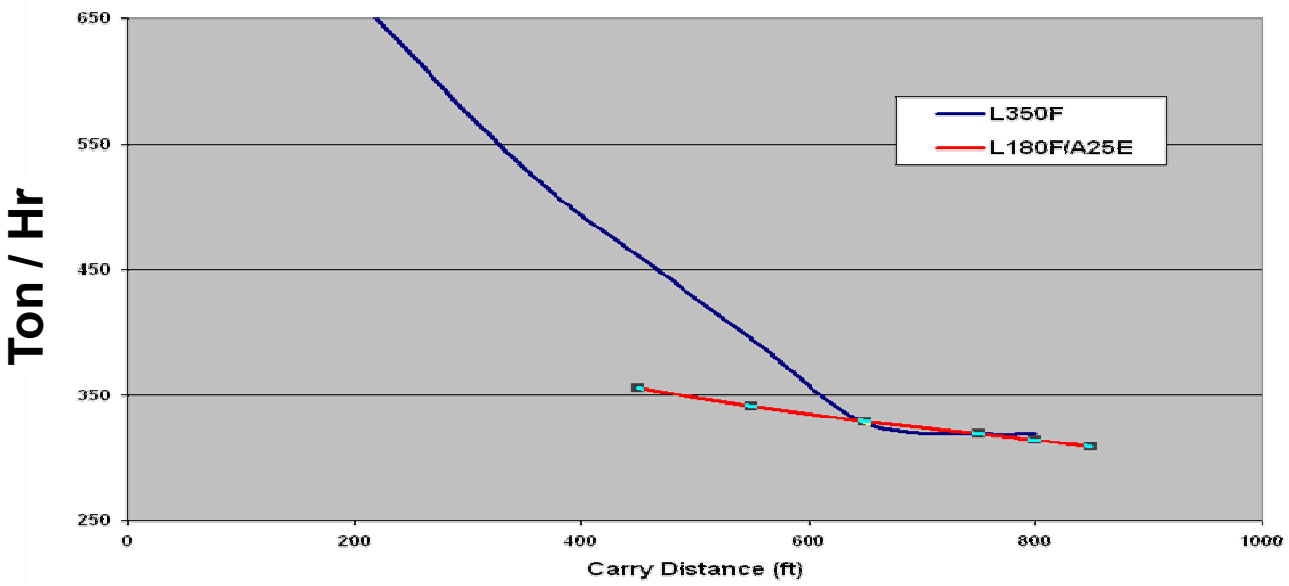
Load & Carry

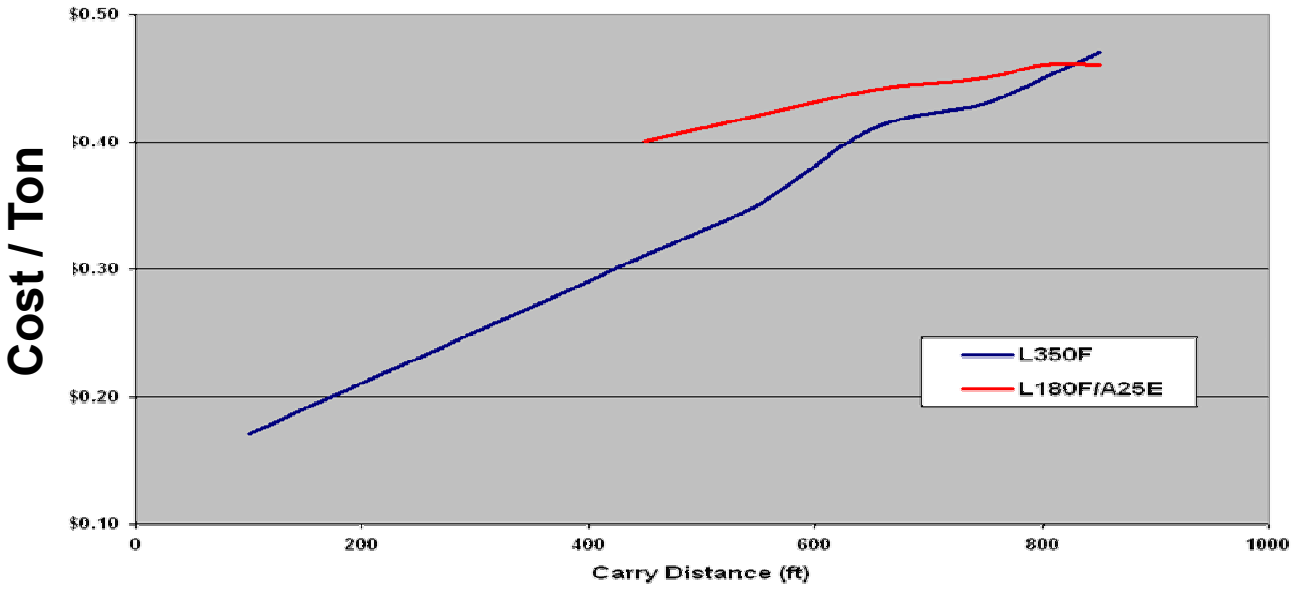
QUARRY ACADEMY

Haul & Load – What you can affect tomorrow

Load & Carry

- L350F vs.
  L180F + A25E





QUARRY ACADEMY

Haul & Load – What you can affect tomorrow

Best Loading Solution

Alternatives

1. Wheel loader
2. Crawler excavator, backhoe
3. Crawler excavator, face shovel
4. Massive scale mining - continuous miner, cable shovel, dragline

QUARRY ACADEMY

Haul & Load – What you can affect tomorrow

Best Loading Solution

Criteria	Wheel Loader	Backhoe Excavator	Face Shovel
Productivity	YY	YYY	YY
Direct Digging	YY	YYY	YY
Mobility	YYY	Y	Y
Flexibility	YYY load/carry, coupler	YY hammer, ripper, coupler	
Bucket Selection	YYY	YYY	Y
Selection/Boulder handling	YY	YYY	Y
Truck Loading	side loading	side or rear	side loading
Loading Level	pit floor	bench or floor	floor
Needing Support Machines	YYY	YYY	Y
Reach	YY	YYY	YY
Capital Expense	YY	YY	Y
Resale	YYY	YY	
Running Costs	YY	YY	YY
Reliability	YYY	YYY	YY

Key	Rating
	poor
Y	fair
YY	good/excellent
YYY	exceptional

QUARRY ACADEMY

Haul & Load – What you can affect tomorrow

Benefits of Wheel Loaders

- **Mobility**
  - Possibility of load/carry on shorter distances (rule of thumb: up to 650ft)
  - Loading from different locations/depots to blend material
- **Utility**
  - Maintain roads, clean up loading area
- Additionally, with a quick coupler you can:
  - Do some odd or small jobs, for example clean around the conveyor
  - Use different buckets. The right bucket for the right purpose.
  - Easily switch to forks for block handling or material handling.

QUARRY ACADEMY

Haul & Load – What you can affect tomorrow

Benefits of Excavators

- Travel and Digging/Loading are separate modes
  - Faster load cycle times (swinging not traveling)
  - No/little undercarriage or tire wear during loading
- Handling variable material
  - Boulder handling, sorting
  - More reach
  - Better distribution of load in truck bed
- Bench management – less traffic by trucks
- Ancillary Jobs
  - Hammer/breaker
  - Quick coupler allows ripper attachment, other buckets

QUARRY ACADEMY

Haul & Load – What you can affect tomorrow

Best Hauling Solution

Alternatives

1. Road trucks
2. Articulated dump trucks
3. Rigid framed dump trucks
4. Mobile crusher/conveyor

QUARRY ACADEMY

Haul & Load – What you can affect tomorrow

Best Hauling Solution

	Criteria	2 Articulated Truck	3 Rigid Truck
	Power/Weight Ratio	YY	YYY
→	Payload Capacity	YY	YYY
	Top Speed	YY *	YYY
	Gradeability	YYY	YY
	Traction	YYY	Y
	Visibility	YY	Y
	Flexibility	YYY	YY
	Seasonality	YYY	YY
→	*Variable roads*	YYY	Y
	Loading Height	YYY	YY
	Transportability	YYY	Y
	Dimensions	YYY	Y
	Capital Expense	YY	Y
	Resale	YYY	Y
	Need Support Machines	YYY	Y
	Running Costs	YYY	YY
	Fuel Efficiency	YYY	YY
	Reliability	YYY	YYY

Key	Rating
	poor
Y	fair
YY	good/excellent
YYY	exceptional

*** FS greatly improves**

QUARRY ACADEMY

Haul & Load – What you can affect tomorrow

Machine Size

- Does your fleet still match your current (and coming) production needs?
- **TRENDS**
  - Equipment continuously gets bigger, faster, more productive.
    - … and more expensive.
  - Has market demand followed the same pattern?

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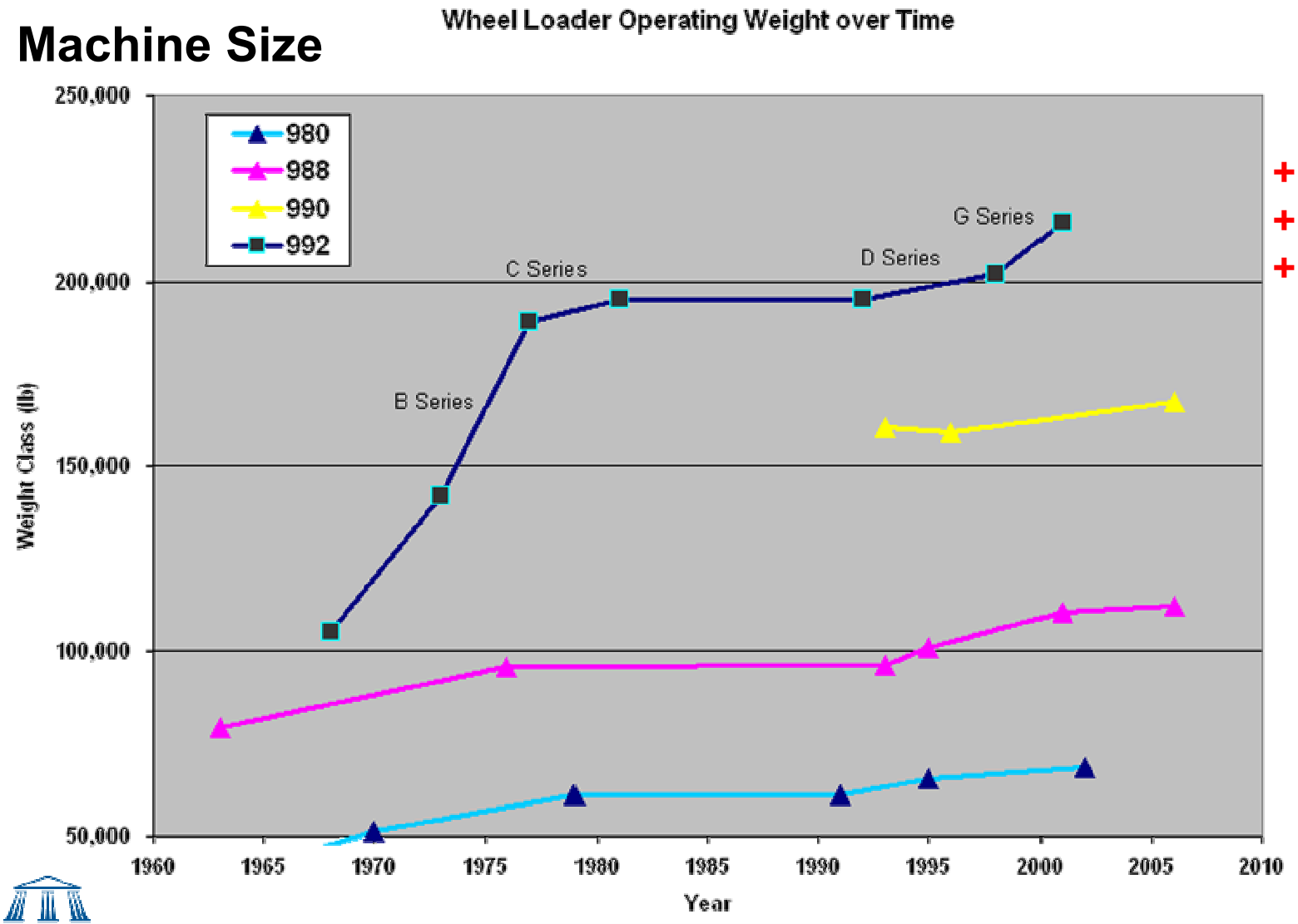
Haul & Load – What you can affect tomorrow

Machine Size



+ power
+ hydraulics
+ drive train

QUARRY ACADEMY

Haul & Load – What you can affect tomorrow

Machine Size – Optimal Wheel Loader Match

2700 lb/cyd

Boom / Trucks	Wheel Loaders**					
	L220F	Volvo L350F		Cat 988H	Cat 990H	Cat 992H
	Long	Std	Long	Either	Either	Either
	6.5 yd3	9.0 yd3	8.4 yd3	8.3 yd3	11.0 yd3	14.0 yd3
	5.0 m3	6.9 m3	6.4 m3	6.3 m3	8.4 m3	10.7 m3
A35E 37.0 Ton 33.6 t	4.22 4.0 Pass	3.64 3.0 Pass	3.27 3.0 Pass	3.39 3.0 Pass	2.49 2.5 Pass	1.96 2.0 Pass
A40E 43.0 Ton 39.0 t	4.90 5.0 Pass	3.53 3.5 Pass	3.81 3.8 Pass	3.84 4.0 Pass	2.99 3.0 Pass	2.28 2.3 Pass
40T Rigid 40.0 Ton 36.3 t	4.56 4.6 Pass	3.28 3.0 Pass	3.54 3.5 Pass	3.57 3.6 Pass	2.69 2.7 Pass	2.12 2.0 Pass
50T Rigid 50.0 Ton 45.4 t	5.70 5.7 Pass	4.10 4.0 Pass	4.43 4.0 Pass	4.46 4.5 Pass	3.37 3.4 Pass	2.65 2.6 Pass
60T Rigid 60.0 Ton 54.4 t	6.84 7.0 Pass	4.93 5.0 Pass	5.31 5.0 Pass	5.35 5.0 Pass	4.05 4.0 Pass	3.17 3.0 Pass
70T Rigid 70.0 Ton 63.5 t	7.98 8.0 Pass	5.75 6.0 Pass	6.20 6.0 Pass	6.25 6.0 Pass	4.71 4.7 Pass	3.70 3.7 Pass
100T Rigid 100.0 Ton 90.7 t	11.40 11.0 Pass	8.21 8.0 Pass	8.85 9.0 Pass	8.92 9.0 Pass	6.73 7.0 Pass	5.29 5.0 Pass

** Maximum counterweight and pin-on spade bucket size assumed.
Matching based on payload factor (body volume assumed to suit material density).

Key

3 - 4 Passes	Optimal matching
5 - 6 Passes	Secondary matching
Passes	Insufficient load height

2875 lb/cyd

Boom / Trucks	Wheel Loaders**					
	L220F	Volvo L350F		Cat 988H	Cat 990H	Cat 992H
	Long	Std	Long	Either	Either	Either
	6.5 yd3	9.0 yd3	8.4 yd3	8.3 yd3	11.0 yd3	14.0 yd3
	5.0 m3	6.9 m3	6.4 m3	6.3 m3	8.4 m3	10.7 m3
A35E 37.0 Ton 33.6 t	3.96 4.0 Pass	2.85 2.9 Pass	3.09 3.0 Pass	3.20 3.0 Pass	2.34 2.3 Pass	1.84 1.8 Pass
A40E 43.0 Ton 39.0 t	4.60 4.6 Pass	3.32 3.0 Pass	3.57 3.6 Pass	3.60 3.6 Pass	2.72 2.7 Pass	2.14 2.0 Pass
40T Rigid 40.0 Ton 36.3 t	4.28 4.0 Pass	3.09 3.0 Pass	3.32 3.0 Pass	3.35 3.4 Pass	2.53 2.5 Pass	1.99 2.0 Pass
50T Rigid 50.0 Ton 45.4 t	5.35 5.0 Pass	3.86 4.0 Pass	4.15 4.0 Pass	4.19 4.0 Pass	3.16 3.0 Pass	2.48 2.5 Pass
60T Rigid 60.0 Ton 54.4 t	6.42 6.0 Pass	4.63 4.6 Pass	4.99 5.0 Pass	5.03 5.0 Pass	3.79 3.8 Pass	2.99 3.0 Pass
70T Rigid 70.0 Ton 63.5 t	7.49 7.0 Pass	5.40 5.0 Pass	5.82 6.0 Pass	5.87 6.0 Pass	4.42 4.0 Pass	3.48 3.5 Pass
100T Rigid 100.0 Ton 90.7 t	10.70 11.0 Pass	7.71 8.0 Pass	8.31 8.0 Pass	8.38 8.0 Pass	6.32 6.0 Pass	4.97 5.0 Pass

** Maximum counterweight and pin-on spade bucket size assumed.
Matching based on payload factor (body volume assumed to suit material density).

Key

3 - 4 Passes	Optimal matching
5 - 6 Passes	Secondary matching
Passes	Insufficient load height

QUARRY ACADEMY

Haul & Load - Optimize Operations

Example #9 – HOW MANY PASSES?

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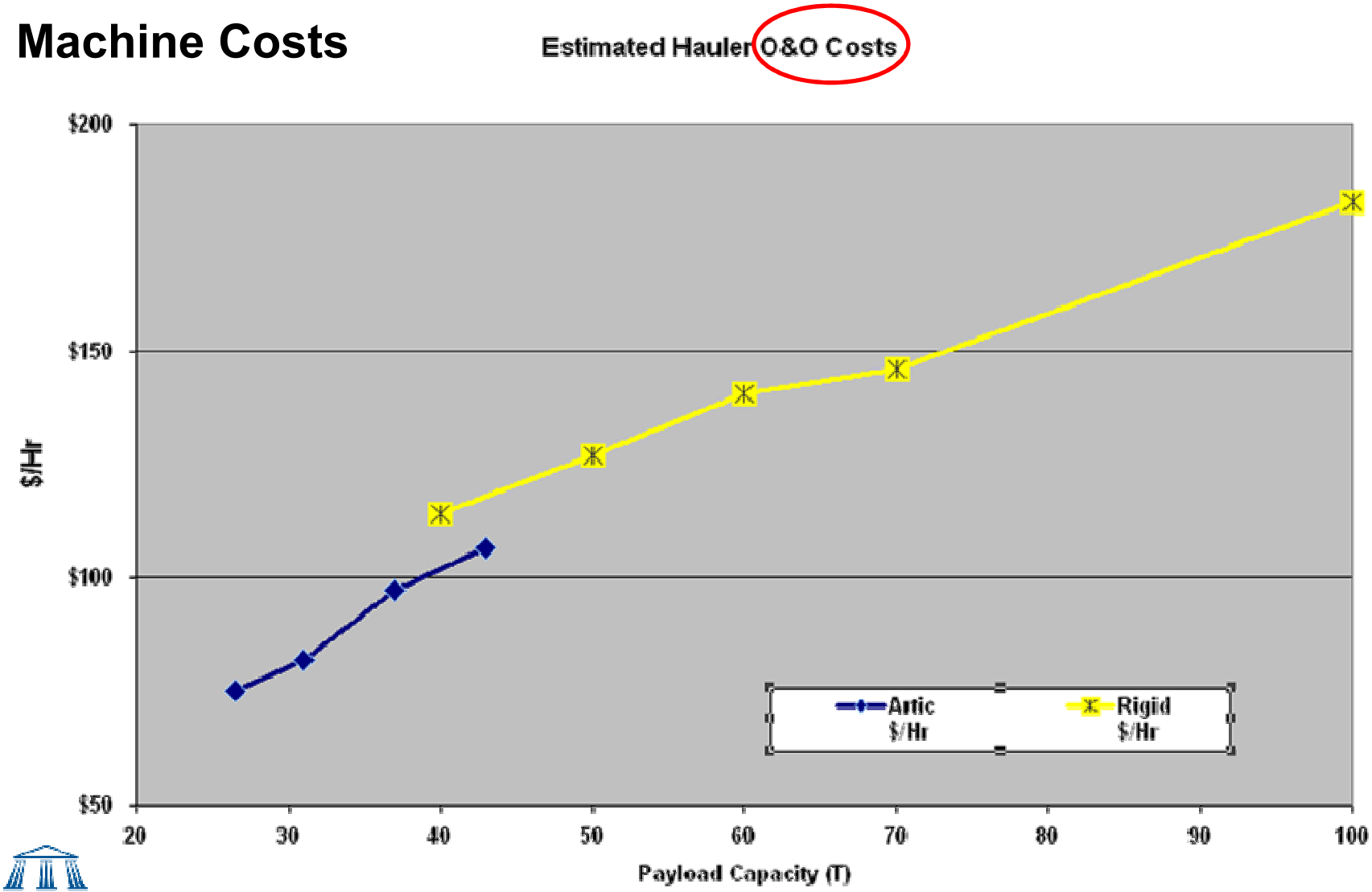
Haul & Load – What you can affect tomorrow

Machine Costs



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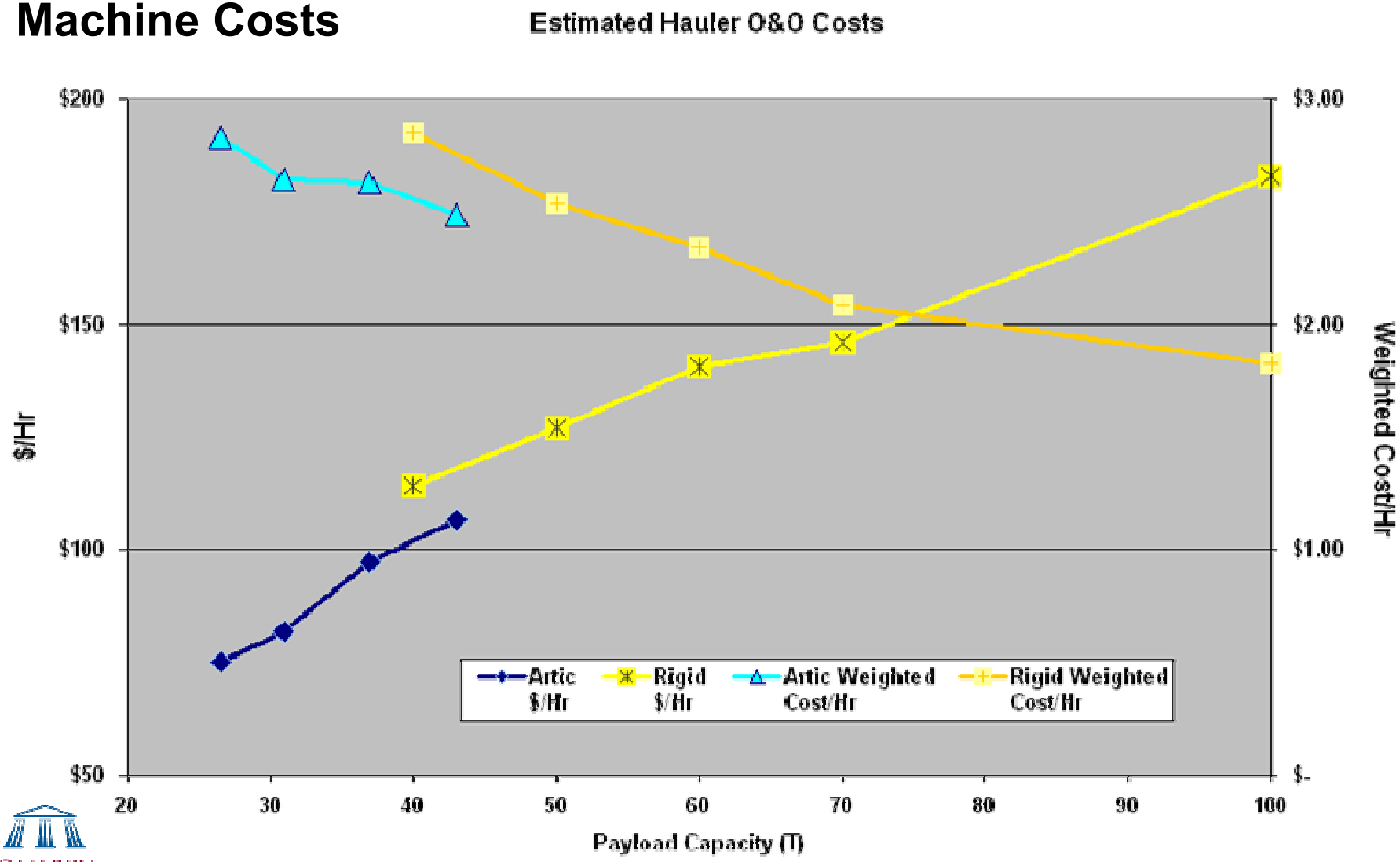
Haul & Load – What you can affect tomorrow

Machine Costs



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Haul & Load – What you can affect tomorrow

Decisions Decisions???

- So many alternatives
  - Best site layout – which routes, grades, turns, etc …
  - Load & Carry vs. Load and haul
  - How many trucks, what size trucks
  - Excavator vs. Loader vs. Load and Carry
- How do you figure all out without years of study
- What if you want/need to change something

It's easy – site simulation study!

- Most Equipment Manufacturers have software to do this for you

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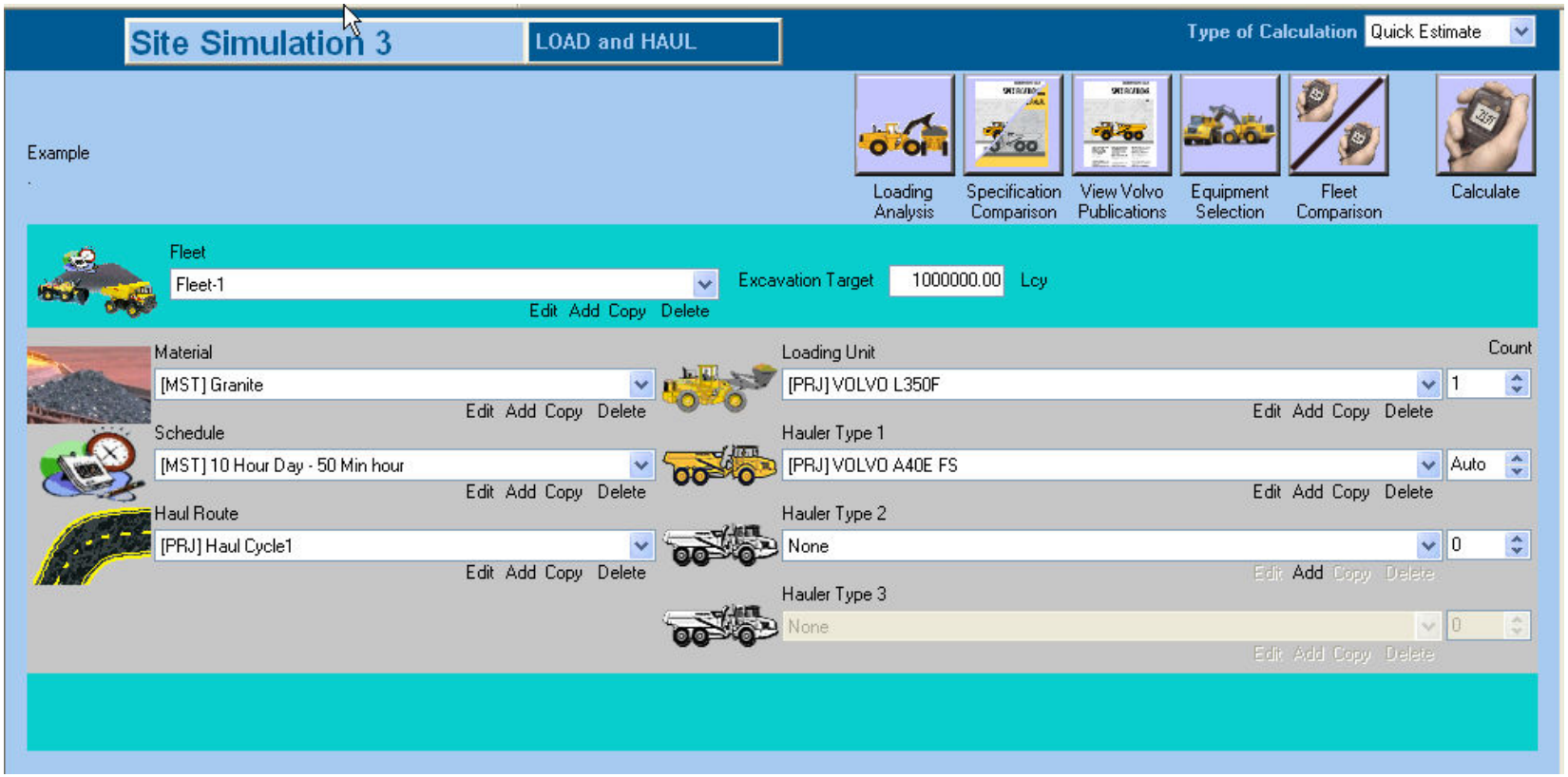
Haul & Load – What you can affect tomorrow

- Create just about any scenario and mix that you want
- Adjust details in every aspect until it is tuned to your liking



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Haul & Load – What you can affect tomorrow

Conclusions

- Don’t presume yesterday’s solution:
  - Performance, cost/value, and market demand ALL change.
  - Technology
  - Application
- Make informed decisions for your future mobile needs.
- Study different solutions.
- **Challenge the status quo!**

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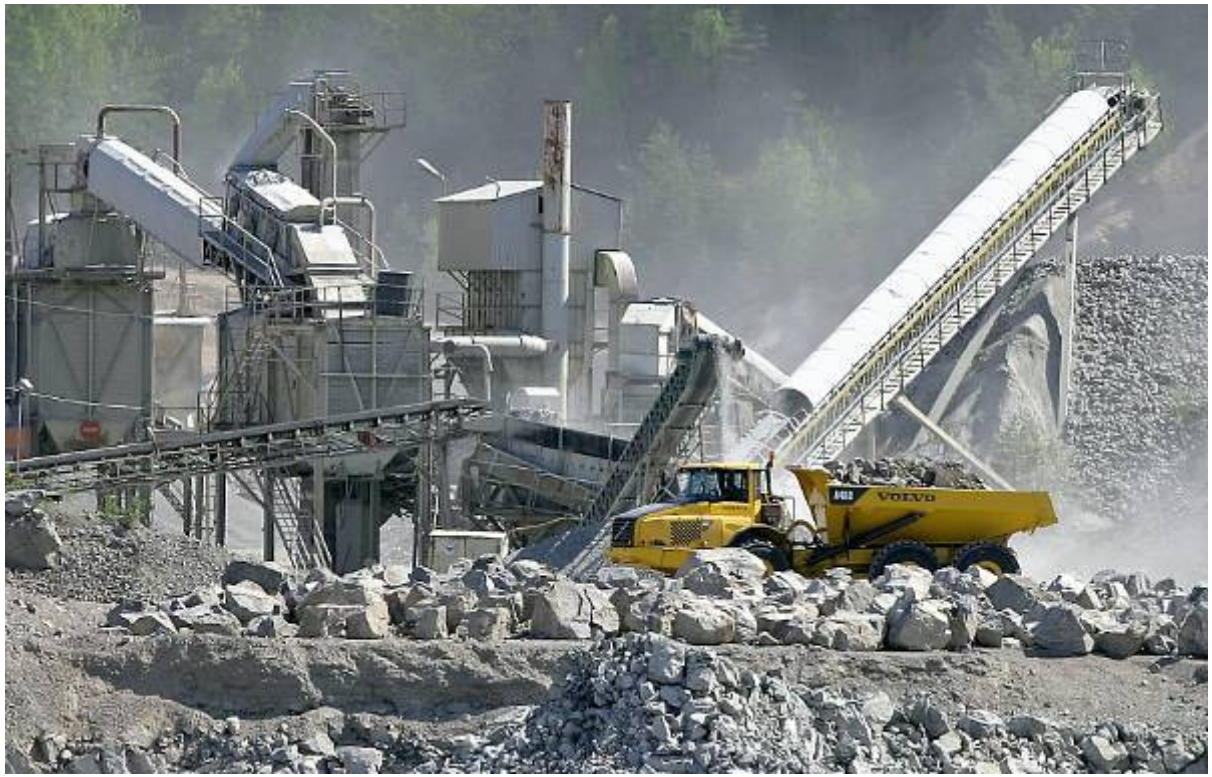
Haul & Load – Overall Conclusions

Today

- Find cost efficiencies, starting with fuel.
  - Leverage your operators and suppliers

Tomorrow

- Informed decisions in future planning.
  - Study different solutions
  - Again, leverage your suppliers.



Thank You!
Questions?

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