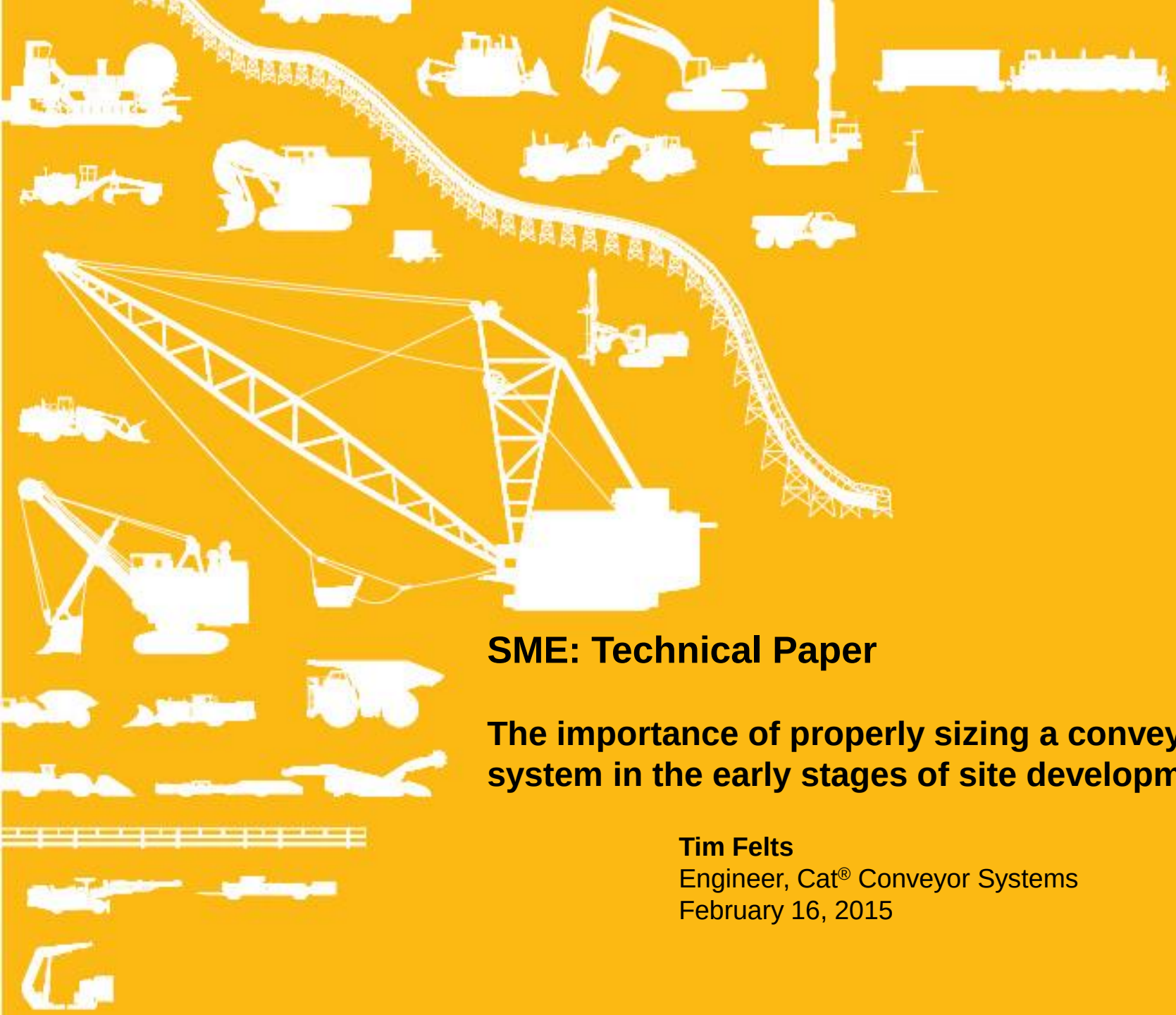


SME: Technical Paper

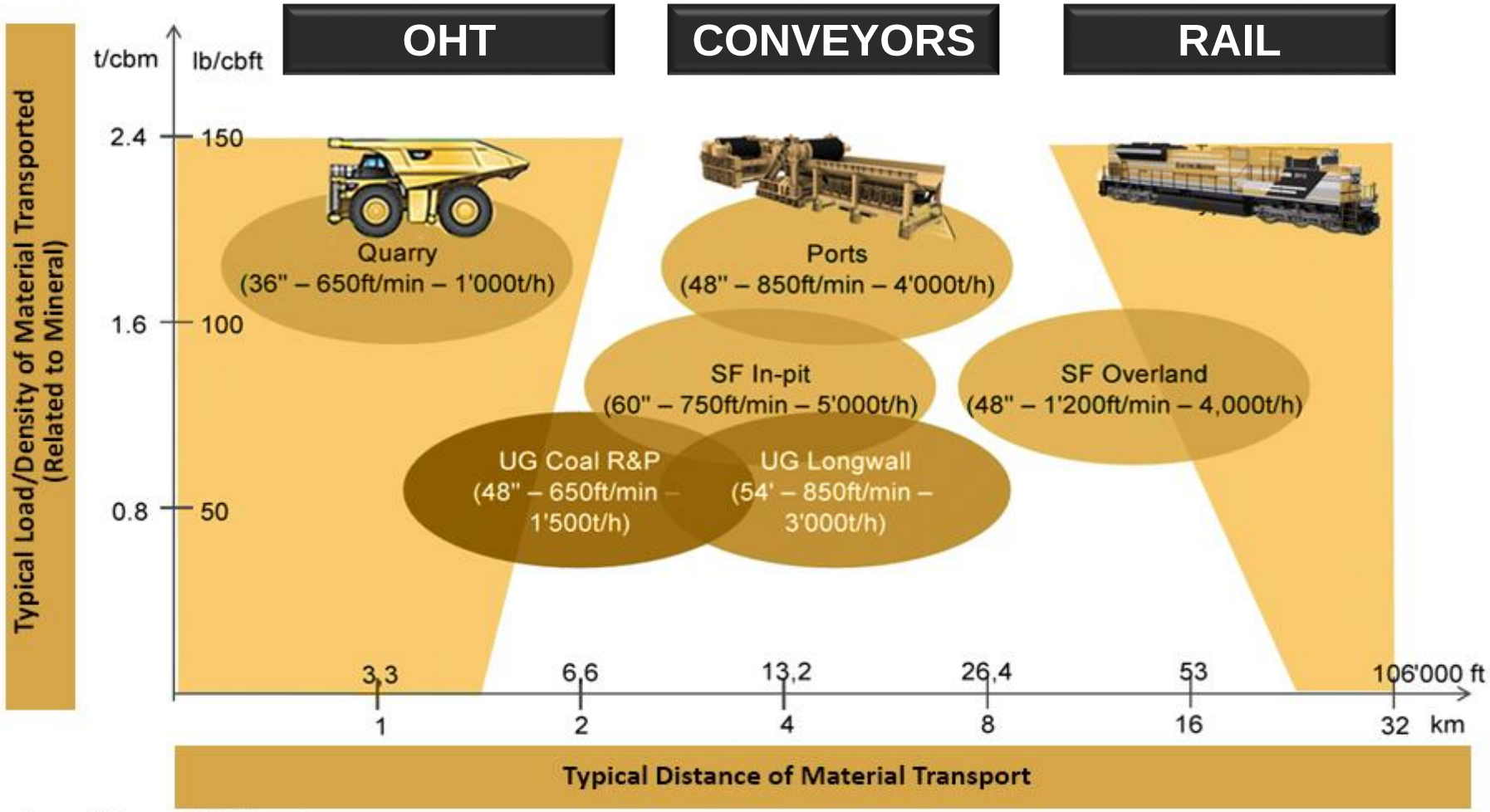
The importance of properly sizing a conveyor system in the early stages of site development

Tim Felts
Engineer, Cat® Conveyor Systems
February 16, 2015

Agenda

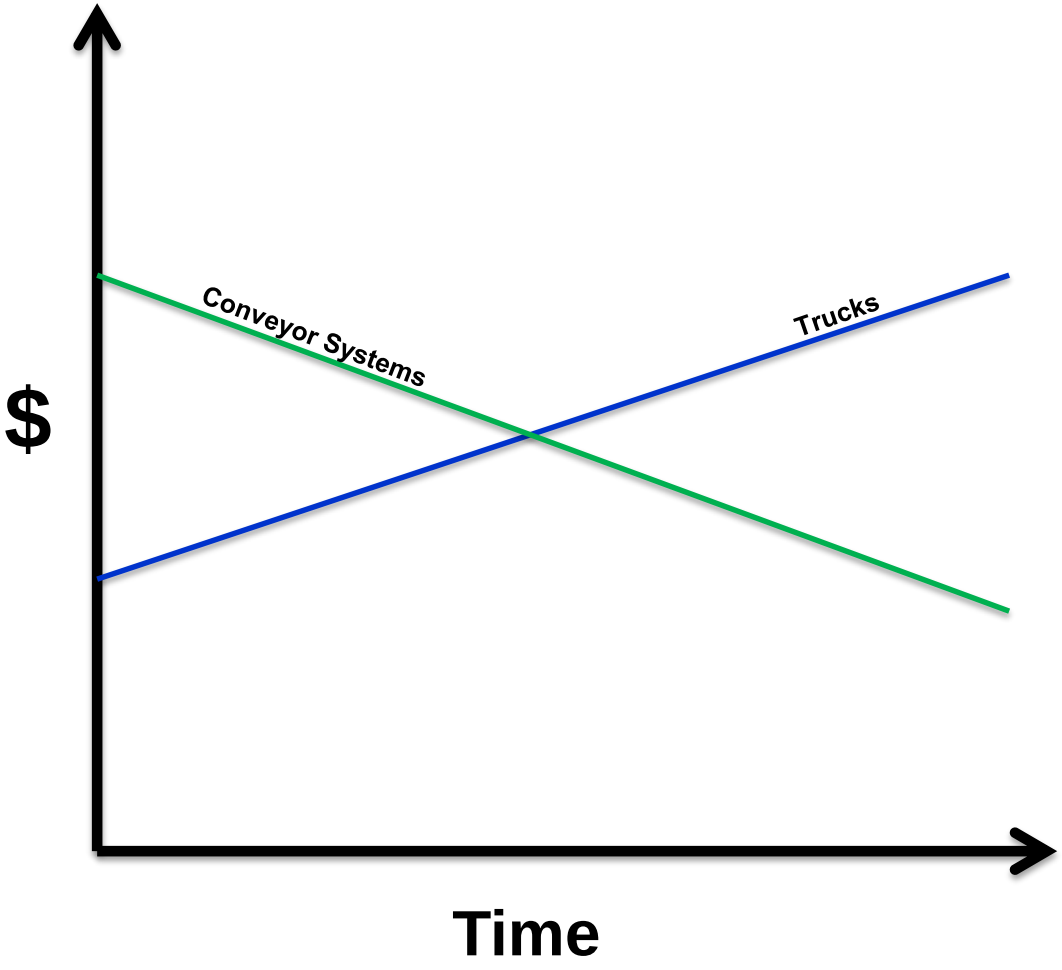
1) Current Industry Trends
2) Timing of Conveyor Sizing
3) Importance of Accurate Input Parameters
4) Cost Benefit Analysis
5) Streamline and Supply Chain
6) Optimization
7) Application Versus Cost
8) Case Studies
9) The Future of Conveyor Systems Sizing

Transportation Solutions



Source: CAT experts; KRIOS analysis

Conveyor System Typical Cost Considerations



Trucks

Conveyor Systems

Current Industry Trends

"We need a 250hp drive." = "We need a car."

Conveyor systems are a critical piece of capital equipment

Often times conveyors are the life line for the operation with multiple repercussions due to downtime

End users may not know the type of information to provide

This approach is not the best solution for long term cost and performance

Current Industry Trends

Conveyor systems sizing is often times an afterthought in today's industry

"Best Guess Scenario"

Exposes the *customer* to:
- Downtime
- Production loss
- Maintenance concerns
- Revenue / Profitability Loss

Exposes the *manufacture* to:
- Warranty
- Liability

"Best Guess" can equate to RISK

Timing of Conveyor Sizing - Current Challenges

Current Challenges: Last minute, rushed, with information gaps

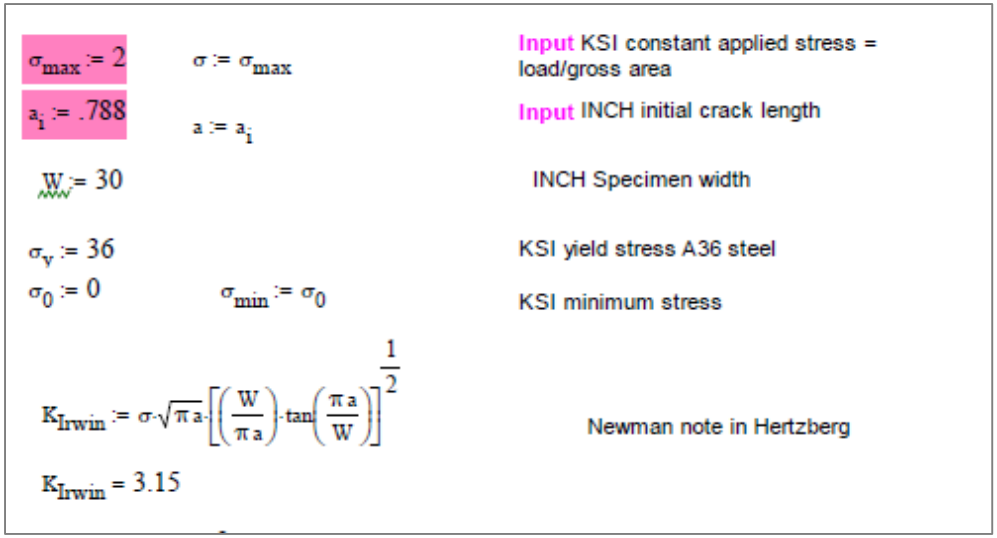
- Time for information acquisition is limited
- “Garbage in Garbage out”
- Not enough information *versus* the correct information

Step 1 Conceptual	Step 2 Budgetary	Step 3 Quote
Correctly sized conveyors have a direct impact on success of the site. Therefore emphasizing early planning of a conveyor system can equate to cost savings and reduced risk.	Having a correctly sized conveyor systems does not always mean a higher upfront cost. Compare initial startup cost to longevity of the operation.	Optimal pricing scenario is given based on the information provided upfront. Working to identify pertinent information results in an accurate quote.

Importance of Accurate Input Parameters

Understanding conveyor sizing requirements

- Lower initial costs are not always the most cost efficient solution
- Purchasing decisions benefit from expert design knowledge
- Capabilities and performance can be enhanced through training and education



Pulley Life Calculation

Value add for customers when working with design experts

Source: Klingerman Stress - Stress Intensity Factor

Importance of Accurate Input Parameters

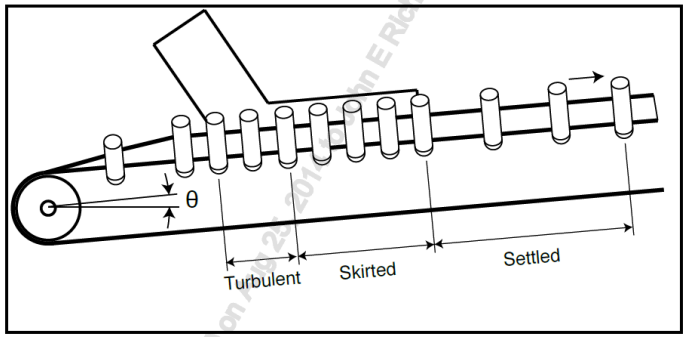


Figure 4.4
Cross sectional area profiles

The conveyed bulk material cross sectional area, A, can be calculated from the design inputs for tonnage, Q, belt speed, V, bulk density, γ_m, and $\Theta = 0$ degrees.

$$A = \frac{Q}{V \times \gamma_m}$$

Equation 4.5
A, cross sectional area of bulk material based on design inputs

Where:

A = Conveyed cross sectional area of the bulk material normal to the belt velocity direction [$ft^2 (m^2)$]

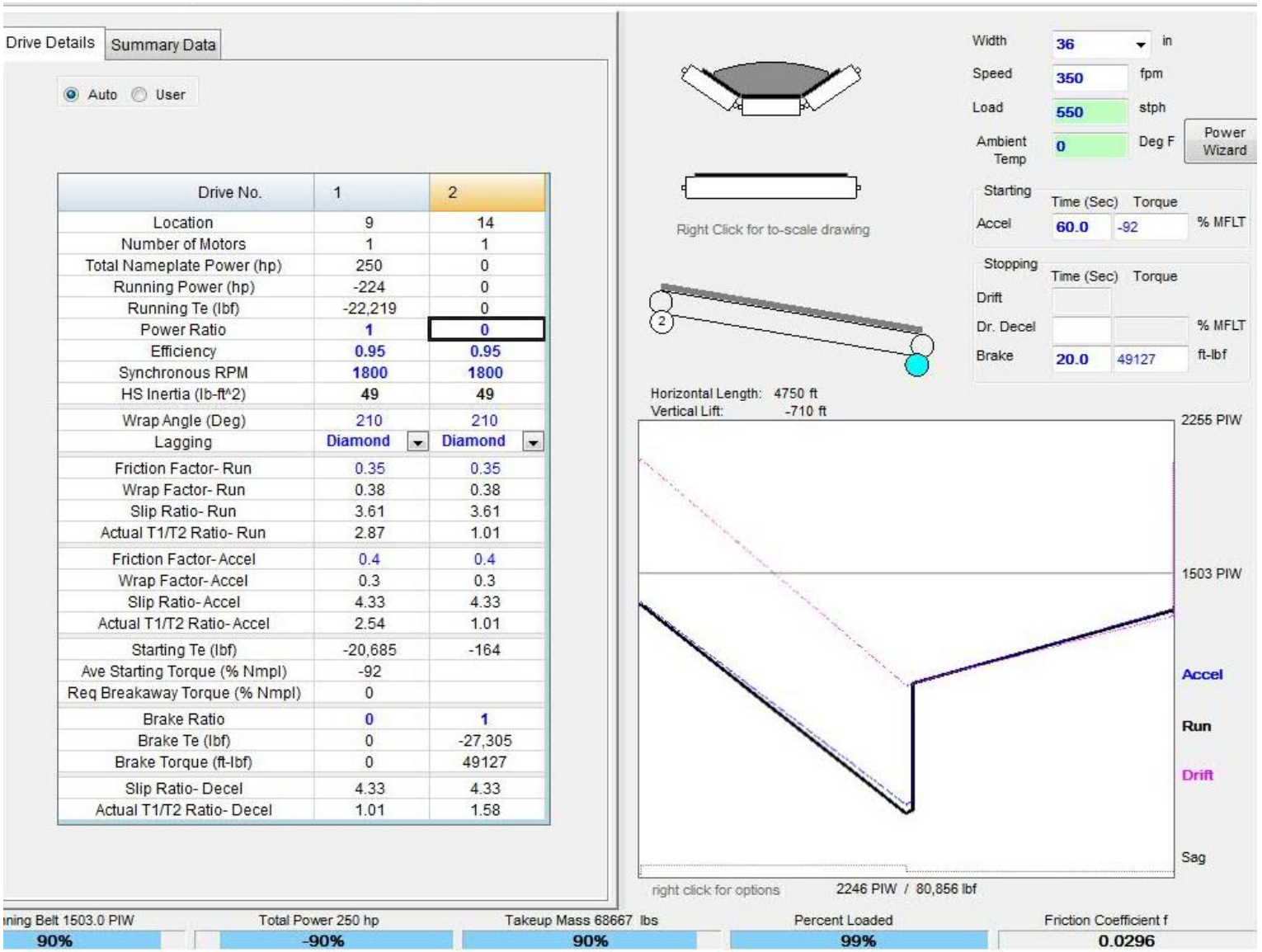
γ_m = Conveyed bulk density of the bulk material as defined in CEMA 550, Classification and Definitions of Bulk Materials

Q = Quantity of bulk material conveyed based on design requirements $\left[\text{tph}; \frac{2000\ \text{lbf}}{\text{h}} \left(\text{mtph}: \frac{1000\ \text{kgf}}{\text{h}}\right)\right]$

V = Belt speed $\left[\text{fpm}: \frac{\text{ft}}{\text{min}} \left(\text{m/s}: \frac{\text{m}}{\text{s}}\right)\right]$

Source: Conveyor Equipment Manufacturers Association

Importance of Accurate Input Parameters
Belt Analyst™



Importance of Accurate Input Parameters

Best solution ≠ initial lowest cost
Inadequate information ≠ the best solution

Why manufacturers and customers should be aware of differences in sizing components

Capital Vs. Operating Costs

"*Making capital decisions that increase the operating budget to meet approved capital spending limits is unfortunately a common practice that can have disastrous effects. Once production starts, there is never enough time or money to correct an under designed bulk material handling system. All efforts are focused on cleanup, unplugging chutes, unplanned maintenance, and just getting enough material into the process to keep it running. Critical components like the belt are often damaged and their life shortened, further increasing operating costs.*

While bulk material handling systems are often only a small percentage of the initial cost of an overall project, if not properly designed and maintained, they are often the main reason for delayed start up and under capacity performance. A well thought out and properly designed conveyor system, with consideration to future demands included in the original design, will always pay for any additional up-front capital cost vs. deferring necessary costs to further operating budgets."

Source: Conveyor Equipment Manufacturers Association

Optimization does not always mean higher cost

Financial Benefits

Capital cost savings as a result of:

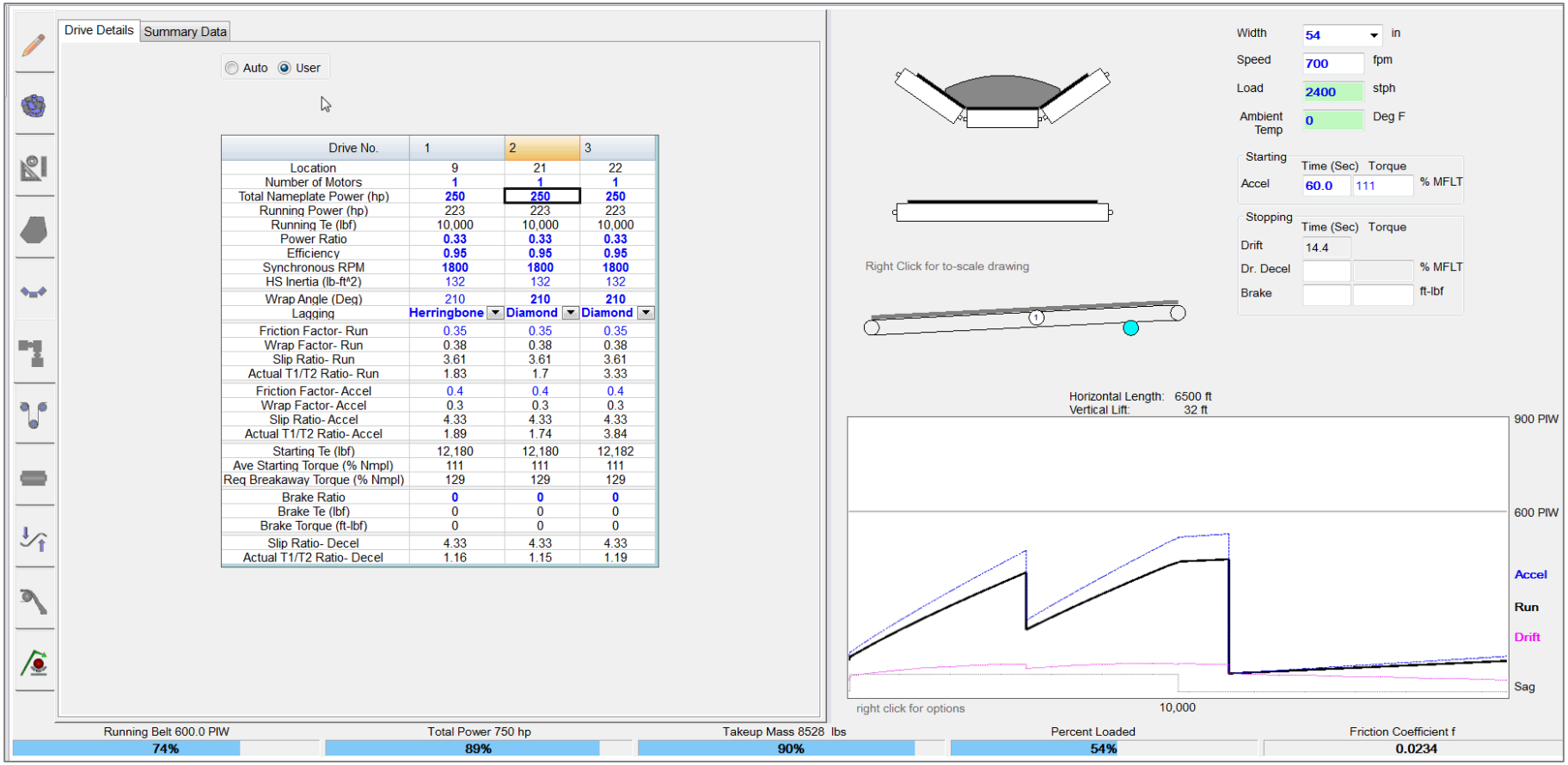
- Correctly sized equipment and systems
- Single source supplier
- Commonality of parts- capital and spare parts

Comparison

1) A correctly sized Conveyor *versus* 2) an oversized conveyor *versus* 3) an undersized conveyor

Financial Benefits

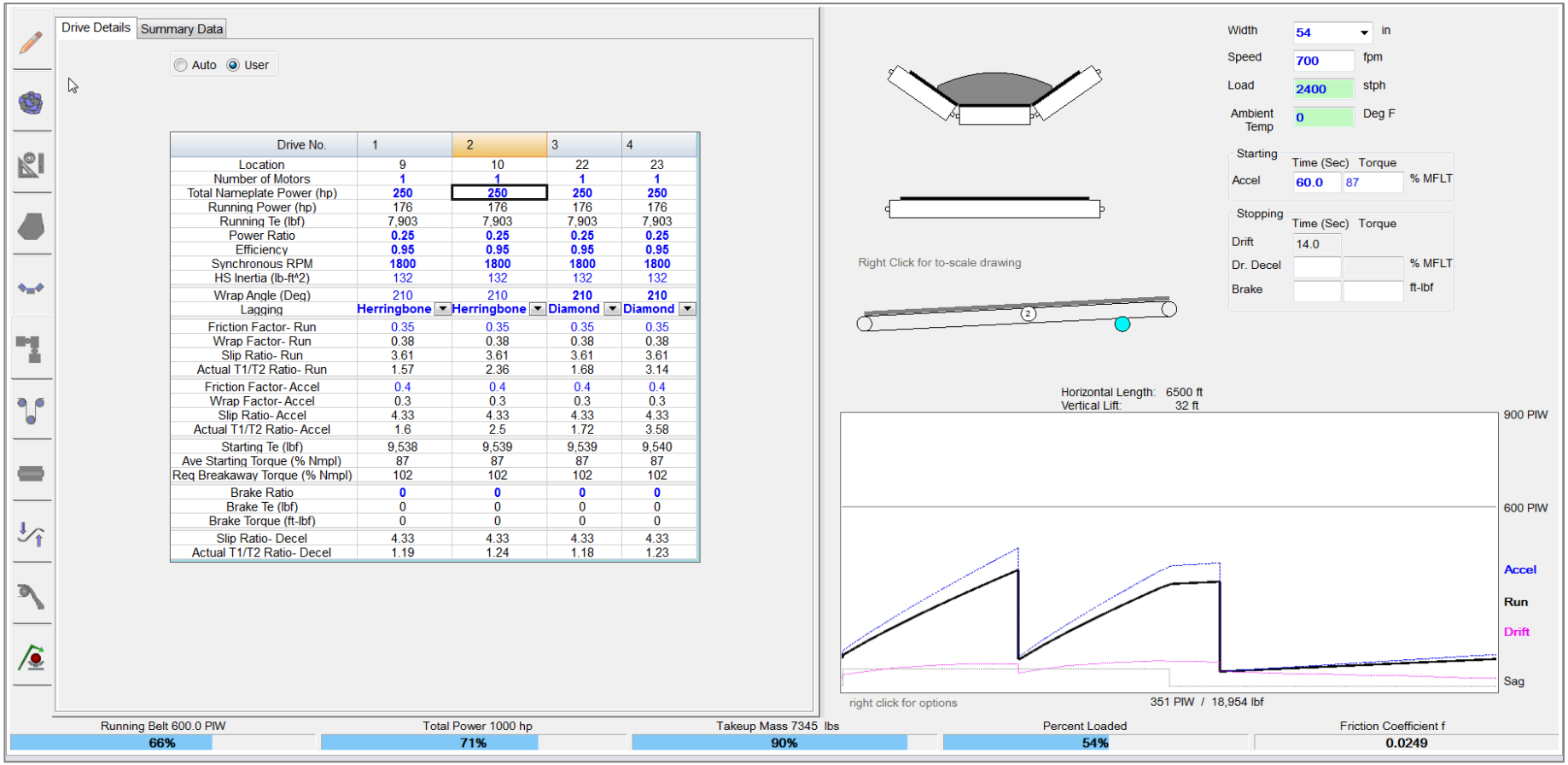
Correctly Sized Conveyor System



Source: Belt Analyst™

Financial Benefits

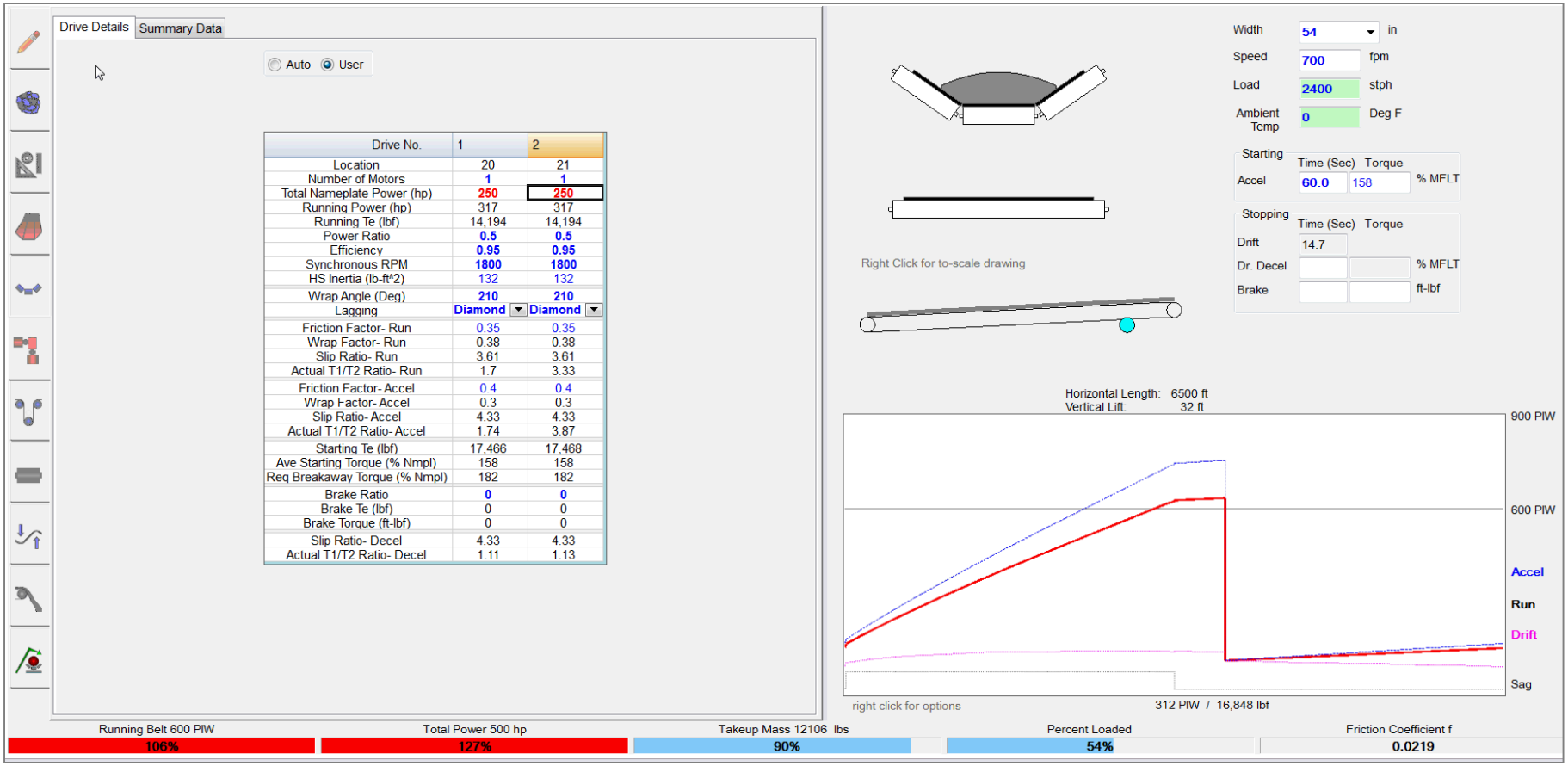
Oversized Conveyor System



Source: Belt Analyst™

Financial Benefits

Undersized Conveyor System



Source: Belt Analyst™

Financial Benefits

Cost of a correctly sized system *versus* cost of downtime

- Reduction in maintenance
  - Failures
  - Mishandling
  - Spillage
- Personnel / Productivity
- Reliable production rate

Cost benefit of a higher initial capital cost *versus* the life of the conveyor in comparison to a lower initial capital cost *versus* life

Multiple Belt Line Inventory

Optimization of Inventory Across Multiple Belt Lines

- At a specific location i.e. a specific customer location
- Across multiple site locations
- Optimization allows for an increased predictability of inventory and product forecasting

Inventory is cost. Smart Inventory. Inventory is not evil.


TOP CO


TOP CO

Choosing Conveyors for the Application Not the Cost

Capital cost is always a concern

- Longevity and project life
  - Size conveyor systems for the applications life rather than the short term benefits of a lower start-up cost
- Main conveyor components
  - Should not be viewed as a commodity
  - Different from a roll or a failure part
  - Look at applications with the best solution for the project in mind rather than a lowest cost option

Surface Copper Mine

Underground Coal Mine

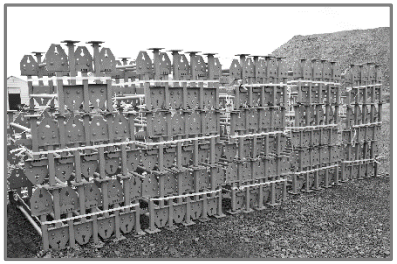
Surface Tunnel Project

Streamline and Supply Chain

Risk Reduction

- Cost
- Productivity
- Reliability

Partnering as Applications Experts *versus* Parts Supplier



Optimization

Discrete Element Modeling (DEM) and Finite Element Analysis (FEA)

- Conveyor Systems manufactures work to optimize equipment
- Optimization results are increased with timely project details upfront
- Application of common industry trends
- Optimal solutions requires critical details to size equipment for the application
- Allows conveyor manufacturer to lower cost by not using excess material
- Benefits the customer by providing best solution at best cost

FEA Analysis

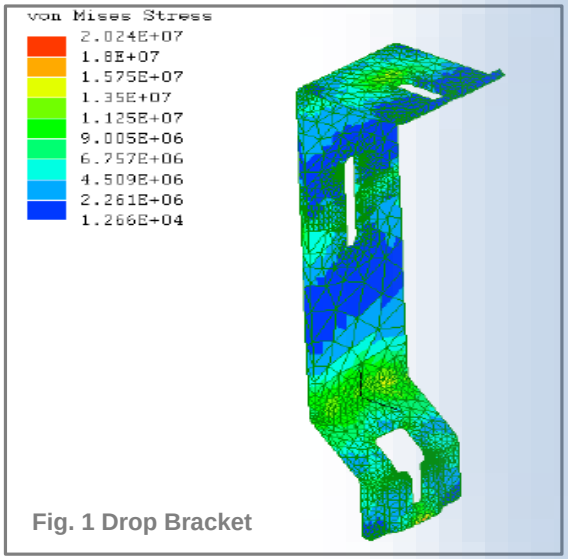


Fig. 1 Drop Bracket

FEA Analysis
(Figures 1-4)

Show stress and loads on different areas

Determines if design is structurally sound

Ensures systems will work in specific applications

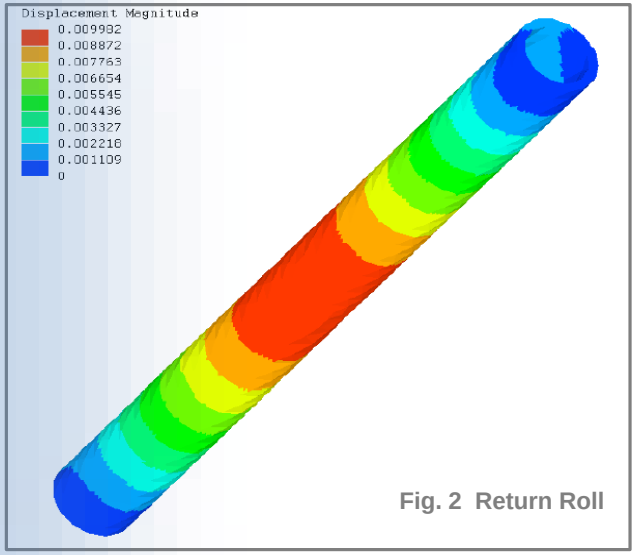


Fig. 2 Return Roll

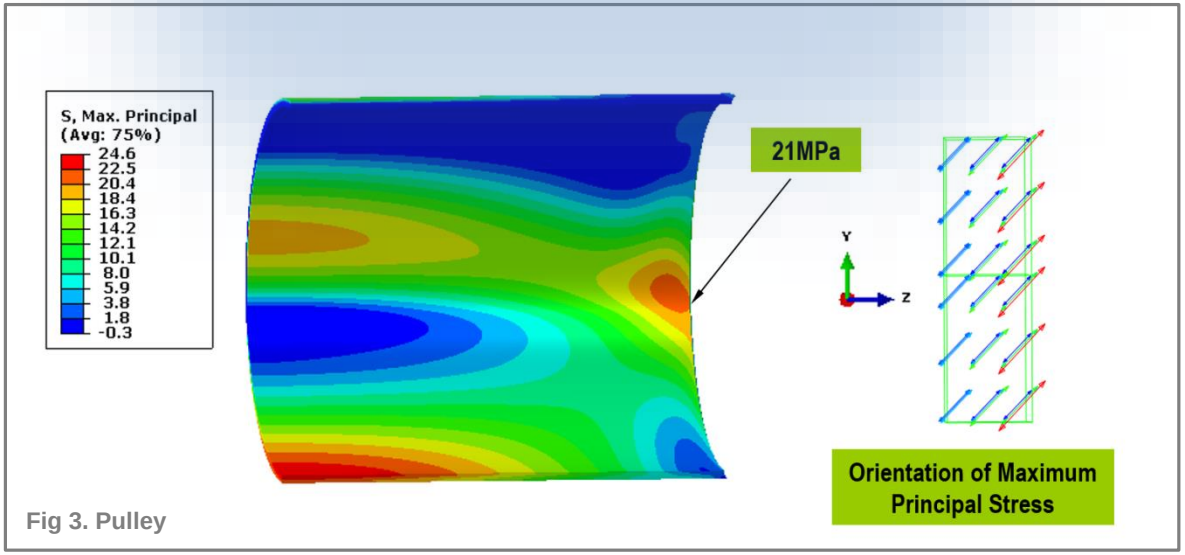
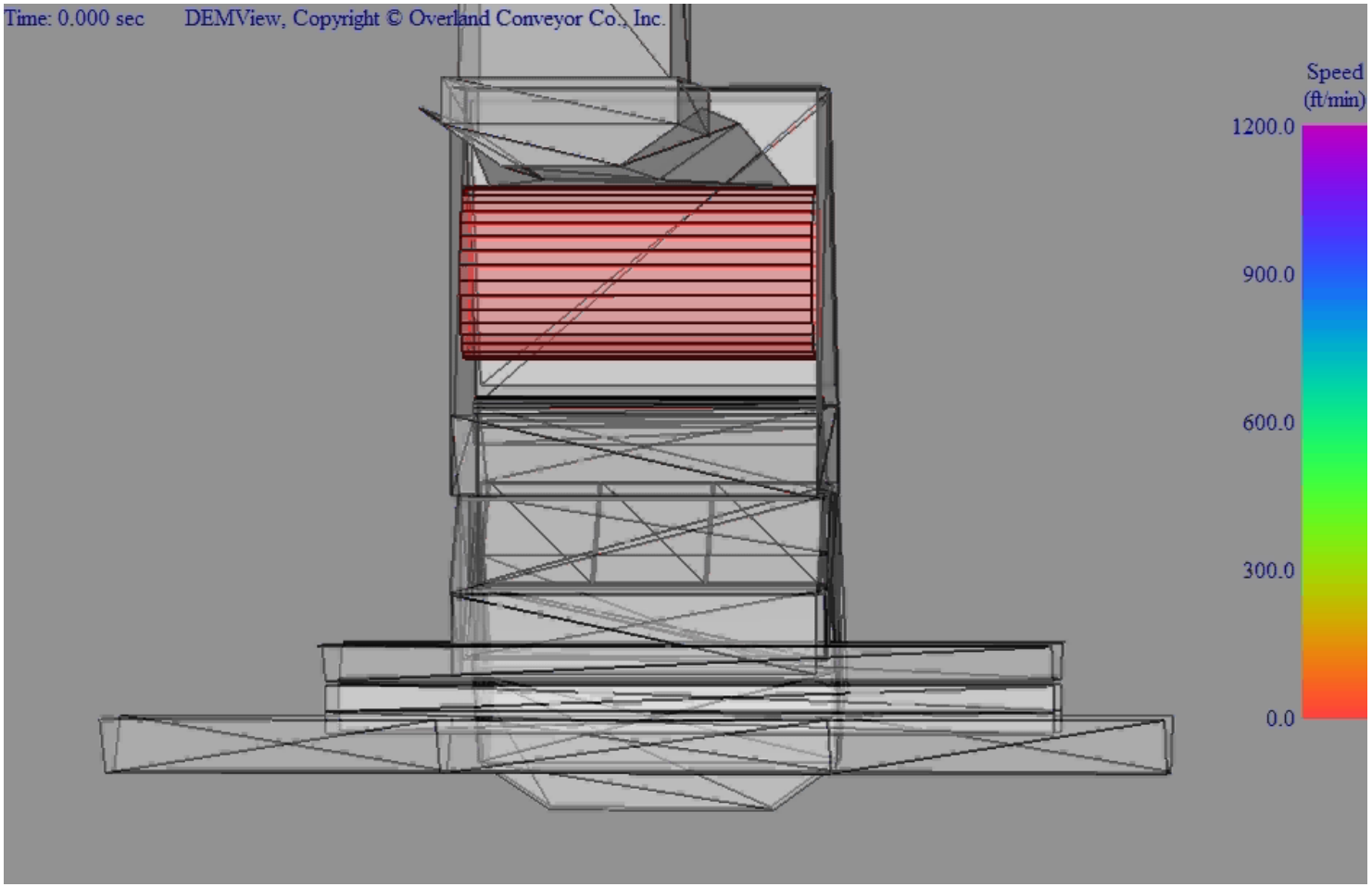
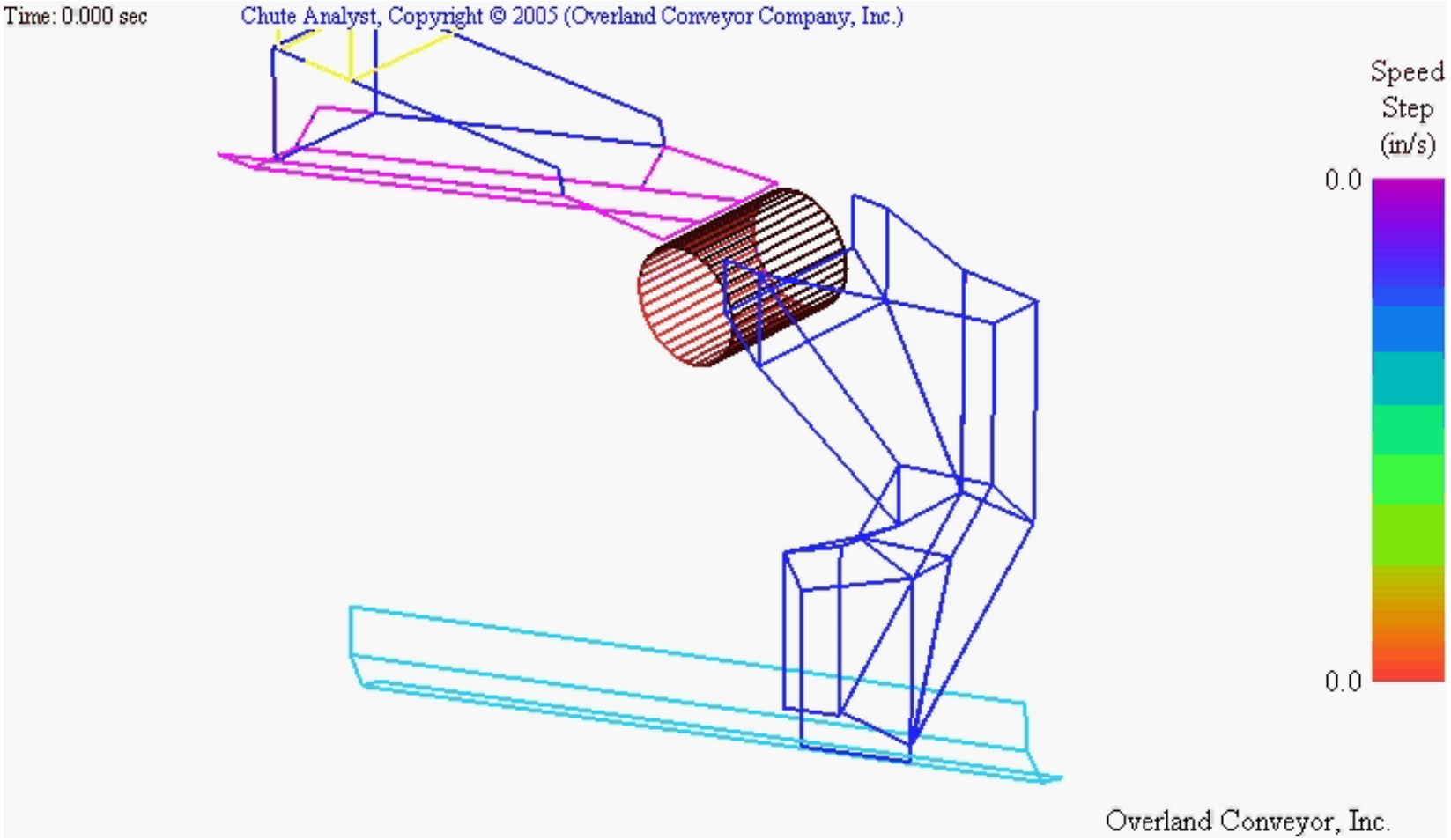


Fig 3. Pulley

DEM Sample Run 1



DEM Sample Run 2



Optimization

Standardization allows manufactures to increase production efficiencies, reduce costs, and provide the customer with best fit solutions.

Standardization

Commonality in items and models that allow for optimized solutions

- Reduces cost for manufacturer and end customer
- Ensures optimized manufacturing efficiency

CEMA Classification	Roll Diameter	Belt Width
B	101mm (4in)	457-1219mm (18-48in)
	127mm (5in)	457-1219mm (18-48in)
C	101mm (4in)	457-1524mm (18-60in)
	127mm (5in)	457-1524mm (18-60in)
	152mm (6in)	609-1524mm (24in-60in)
D	127mm (5in)	609-1828mm (24in-72in)
	152mm (6in)	609-1828mm (24in-72in)
E	152mm (6in)	914-2438mm (36in-96in)
	177mm (7in)	914-2438mm (36in-96in)
F	152mm (6in)	1524-2438 (60in-96in)
	177mm (7in)	1524-2438 (60in-96in)
	203mm (8in)	1524-2438 (60in-96in)

Source: Conveyor Equipment Manufacturers Association

Case Studies- Improvement Opportunities

Case Study #1

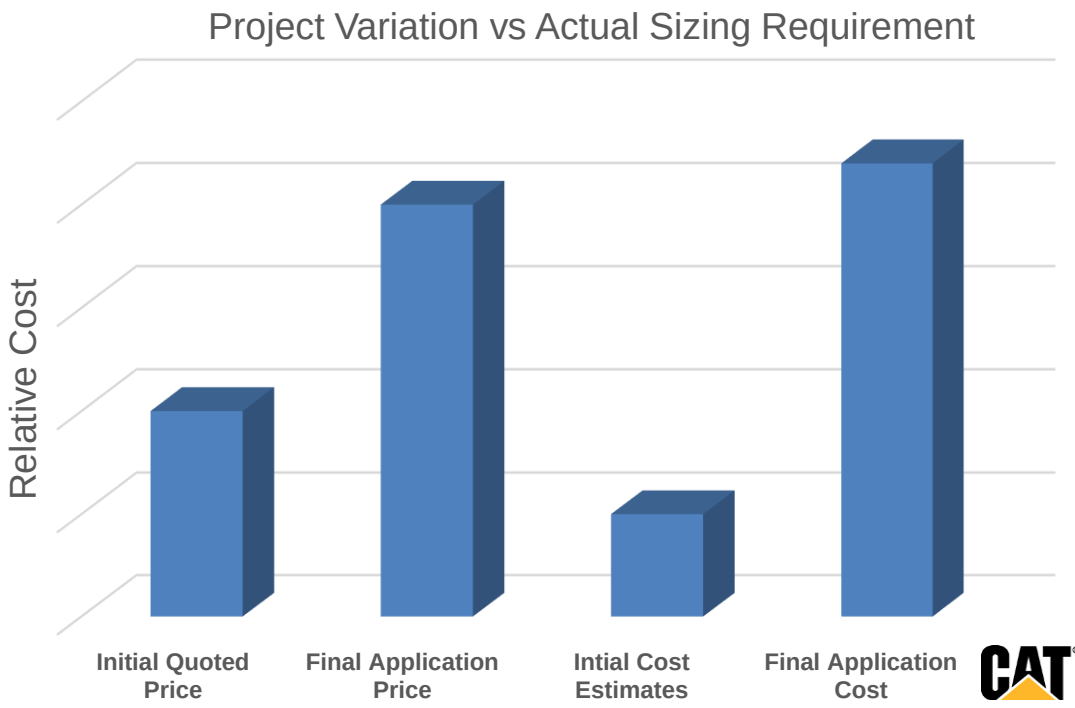
Customer project scope and application varied from sizing and quoting to installation

Background:

- Customer provided generic application details to which high-level sizing was made
- Customer ordered based upon these high level details and the final installation varied from the quote
- Critical specifications were not shared and were left out

Results:

- Conveyor Systems order was secured and supplied, but due to variation in the sizing performance issues arose.
- Loss of time and money for manufacturer (Engineering and labor hours)



Case Studies - Success Stories

Case Study #2

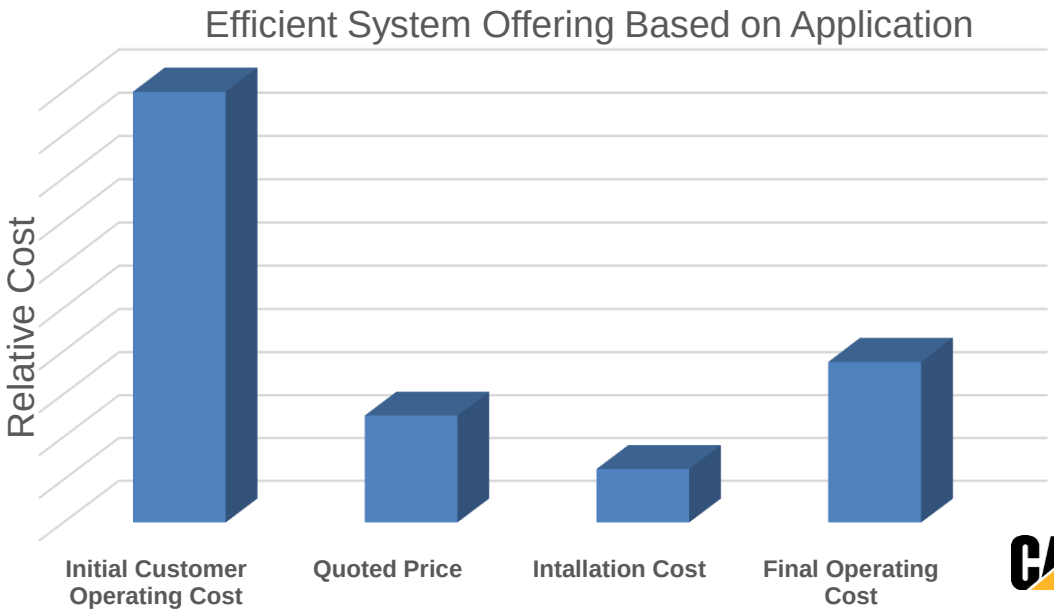
Presenting a more efficient system by consulting with the customer and recommending a solution based on their application

Background:

- Customer had a problem area in their belt line, forcing them to run an additional belt full time to catch scrapings
- One to two additional people were needed to work at this section for a full shift
- This cost the customer extra dollars in labor because the wrong initial solution was in place

Results:

- Manufacturer consulted with customer to provide a system solution for their application
- Eliminated loss labor time
- Increased Optimization
- Improved overall system performance



Case Studies - Success Stories

Case Study # 3

Undersized Conveyor system is caught prior to customer placing their order

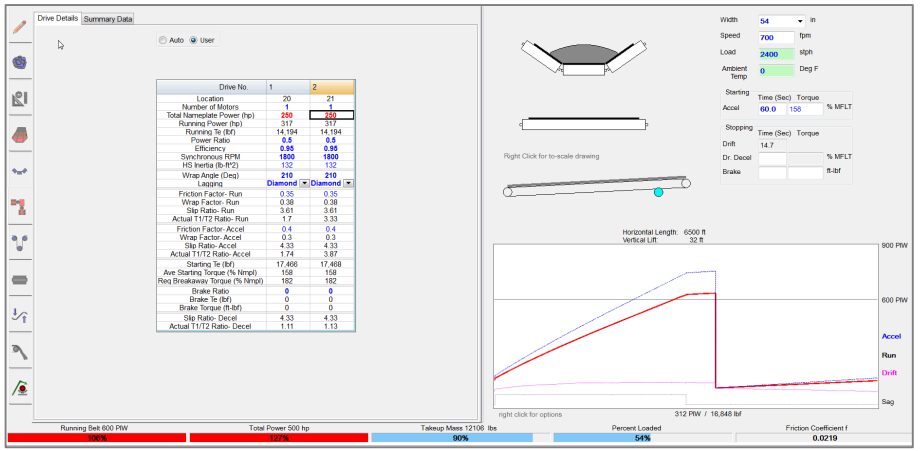
Background:

- An initial belt run was provided from a customer sized for a dual 250 hp system
- Working through the details of the application revealed the need for a triple 250 hp system.
- In reality the customer needed a triple 250 hp drive, or a tripper arrangement
- Customer could have been running at a maxed out motor situation

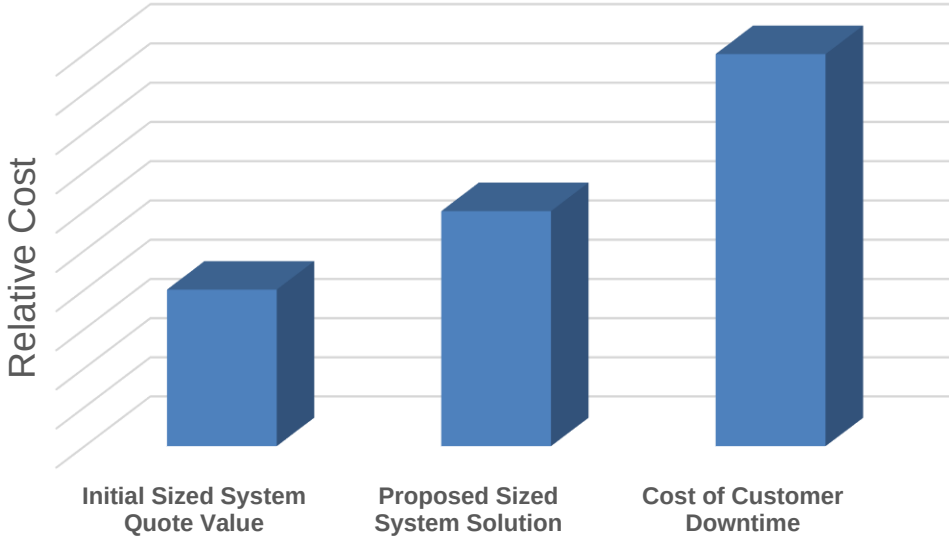
Results:

- The manufacturer having caught this error, bought credibility with the customer
- Presented opportunity for the manufacturer to stress the importance of input parameters
- In this situation the customer would have had a lower initial cost, but for longevity of the mine they would have Incurred higher costs, replacement parts issues, and maintenance concerns

Belt Analyst™ Run Oversized System



Undersized System Identified and Replaced

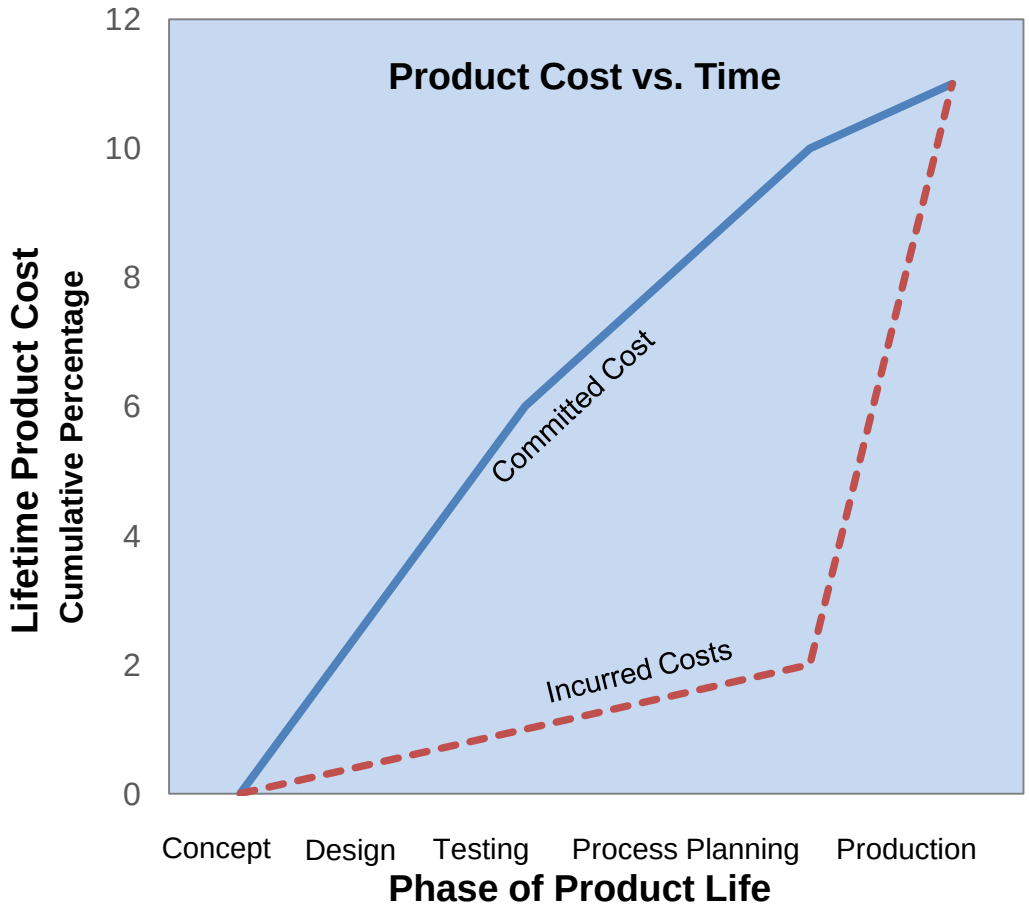


Future of Conveyor Systems Sizing

Achieving the Lowest Cost

When Costs are Committed

- By the time a product is designed; 80% of the cost has been determined
- When product goes into production; 95% of its cost is determined



Conclusion:
60% of a products accumulative lifetime cost is committed by the concept phase

Source: Design for Manufacturability, James Bralla

Future of Conveyor Systems Sizing

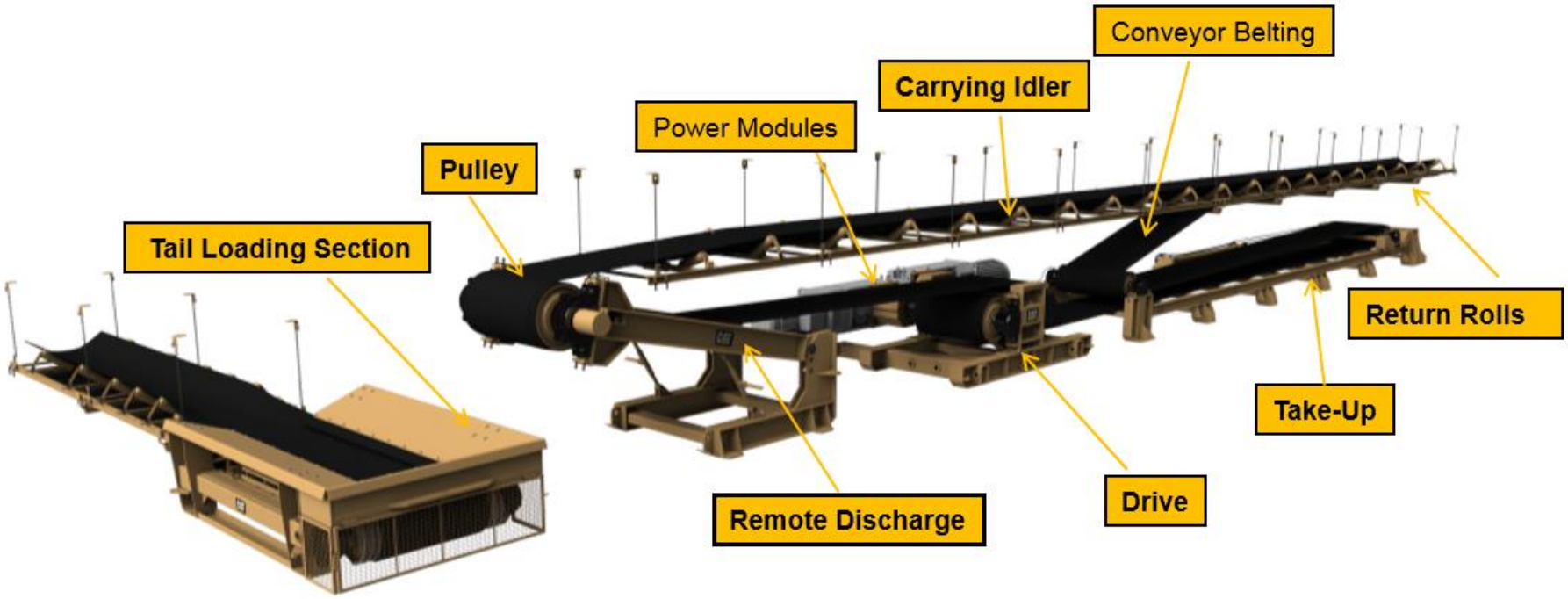
What is the correct timing?

Common feedback manufactures in the industry hear is “Why do we need this information?” “It is too difficult to provide the information.”

Demonstrate value in providing the detailed level of information upfront. Must change this perception.

- Educate users on the importance of obtaining detailed information.
- Early operation development/ planning, *versus* mid- operations, *versus* replacement components

Future of Conveyor Systems Sizing



Application Scope → Conceptual Sizing → Budgetary Sizing → Detailed Sizing → Scope Sizing Review → Final Sizing → Equipment Delivery

THANK YOU