MATERIAL HANDLERS & CONCRETE *FEATURE IN THIS ISSUE*

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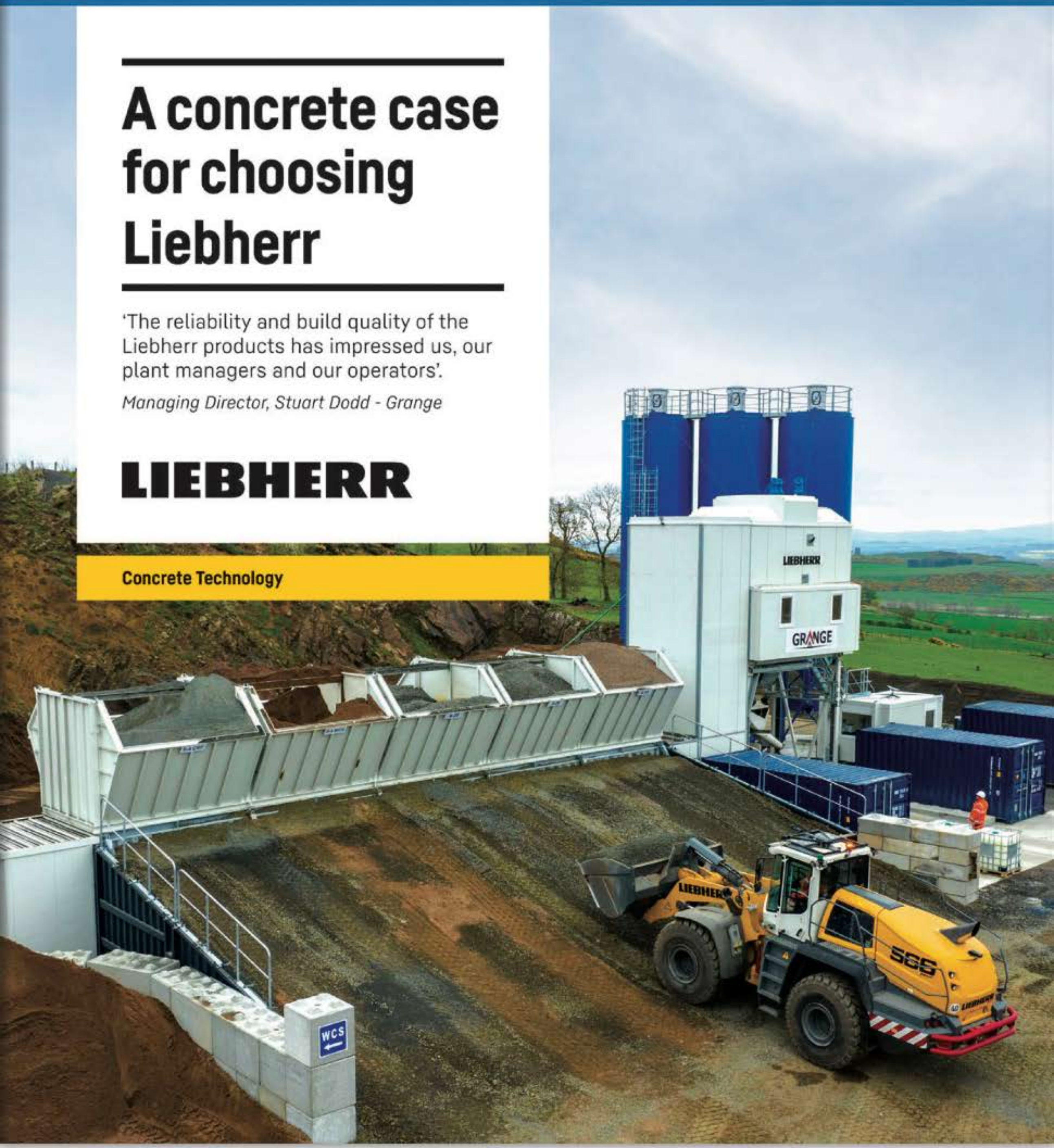

A concrete case for choosing Liebherr

'The reliability and build quality of the Liebherr products has impressed us, our plant managers and our operators'.

Managing Director, Stuart Dodd - Grange

LIEBHERR

Concrete Technology

Justifying Conveyor Upgrades Part 1: Making the Case

R. Todd Swinderman, P.E. / President Emeritus / Martin Engineering

From mining to biomass, industries that handle bulk materials depend on intelligent, hardworking individuals who can be trained and promoted to positions from which they go on to make experience-based decisions. Using their expertise, they are often tasked with identifying conveyor system issues and proposing critical changes to improve production, safety and efficiency. These projects typically require capital investments, and convincing management to earmark budgets for improvements requires supporting data, solid ROI projections, thoughtful persuasion and good timing.

This two-part series is intended to help supervisors and managers in charge of writing proposals for upgrading conveyor equipment create persuasive arguments and set real-world expectations for the capital expenditure. Part two will cover implementation and reporting, so that the expense is properly tracked and justified, building trust among stakeholders which makes the process easier when future projects are proposed.

Conveyor spillage like that pictured here seems insurmountable, but service partners can help put scope and cost into perspective. ©Martin Engineering 2023

"As technical people who work with the equipment day in and day out, perhaps the most difficult part of this process is having to justify or 'sell' it to management," said Dan Marshall, Process Engineer at Martin Engineering. "To do this, operators need a good narrative, solid data, reasonable cost projections and a convincing ROI (return on investment)."

A Good Narrative Loosens Purse Strings

> **Direct and Indirect Costs**
>
> Direct costs can include labor, but generally also cover replacement equipment, contractor costs, production losses and injuries. Indirect costs are investigations and settlements as a result of injuries or accidents, increased energy usage, increases in insurance premiums, MSHA or OSHA fines and qualitative costs like poor morale, etc.

It's the way of the universe. Stakeholders that hold the purse strings will typically visit the area on the rare occasion when the system is working well, so photos and video bolster the narrative and help with visualization. More is better, and quality matters. Graphs are also invaluable for visualization, so plan Key Performance Indicators (KPIs) with a clear X & Y axis that will reveal evident "differences over time" or "costs per unit," etc.

ROI is extremely important in any equipment purchase but calculating it can be tricky. That is why all direct and indirect costs need to be applied. The goal for many smaller projects such as belt cleaner upgrades is to get the payback period to 1 year or less. [Fig.1] Categorize all possible causes of increased costs and then figure out the costs associated with each category.

ROI Conversions

ROI	Payback Years	Payback Months
10%	10.0	120.0
20%	5.0	60.0
30%	3.3	40.0
40%	2.5	30.0
50%	2.0	24.0
60%	1.7	20.0
70%	1.4	17.1
80%	1.3	15.0
90%	1.1	13.3
100%	1.0	12.0

Figure 1 – ROI payback over the specified time.[1]

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For example, calculating ROI to upgrade belt cleaners starts first with isolating a cleaner, then identifying the challenges associated with it. Likely one category will be spillage from carryback. Some of the common costs associated with spillage are cleanup time/labor, low air quality, safety (lockout/tagout, PPE, etc.), replacement parts (fouled rollers and machinery) and unscheduled downtime. [Fig.2]

Data Used in ROI Calculations

Data	Units
Administrative/Operating	
Cost of compliance: record keeping and reporting	currency
Health and liability insurance premiums increase	currency
Reduced life of equipment	currency
Safety/environmental fines	currency
Legal costs	currency
Energy costs	currency
Waste disposal costs	currency
Production	
Throughput: per hour, day, week, or month	tons (st)
Production time	hours
Cost per ton of bulk material	currency/ton (st)
Cost of down time	currency/hour
Cleanup manual (1 ton per hour is average)	labor cost/hour
Cleanup machine (5 tons per hour is average)	labor and machine cost/hour
Lost product due to dust and spillage	0,5% to 3% of production rate is typical
Safety *(Reference 31.2)*	
Cost of recordable incident	currency
Cost of lost-time incident	currency
Maintenance	
New installation: *Estimated cost for labor and materials*	currency
Adjustment: *Estimated labor cost per adjustment*	currency
Replacement Parts: *Cost of parts and labor*	currency
Equipment Wear: *Cost of belt and wear-resistant materials*	currency

Figure 2 – ROI categories for a belt cleaner replacement.[1] >

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Although ROI is a focus for management, Return on Prevention (ROP) is arguably just as important. Staying with the example above, lower quality equipment may offer a quicker ROI but might only clean 80% of material from the belt and deliver a shorter service life before unscheduled downtime starts all over again due to dust and spillage. Higher quality equipment with proven performance may be a higher cost with a slightly extended ROI, but the cost is generally justified over the long term. Reviewing equipment specs, examining the construction and evaluating case studies from similar applications can help determine ROP.

Successful proposals generally offer a direct line to a solution and the next steps for implementation. Make sure the intent of the project is clear and the bottom line is as close to the real outcome as possible. Also consider all project variables: downtime, labor, installation obstacles, special equipment such as cranes and any associated safety regulations or certifications.

To ensure that projects meet government-mandated safety standards, insist on factory-trained technicians with government certifications and other industry-recognized organizations. Many equipment suppliers contract their installation and service functions to outside firms, which often represent dozens of different product lines. Personnel trained by the equipment manufacturer and dedicated solely to its proper care will have greater knowledge and experience, ultimately delivering superior results over the long term.

Determining the Investment Strength

One of the most anxiety-inducing aspects of this process is determining how to make the best financial decision on equipment. Luckily, there are the general calculations of net present value (NPV) and internal rate of return (IRR) to help with this endeavor. These are financial tools that can be used to compare investment options, including safety investments.

NPV is a financial measurement of life cycle costing where two or more options are evaluated based on initial price, annual costs and expected life as expressed in terms of today's currency. Generally, the option with the highest NPV would be the wisest choice. IRR shows the annual compounded rate of return on an investment and is defined as the interest (or discount) rate that makes the NPV equal to zero.

NPV and IRR are calculated in Figure 3. The calculations are linked to:

- Cash Flow = the expected savings for a specific year minus the costs of operating and maintaining the project in that year.
- I = The total number of periods (usually years) used in the analysis.
- Initial Investment = the initial purchase, delivery and installation costs of the project.
- R = the weighted cost of money for the company from all sources: borrowing, selling stock, etc. Expressed as a decimal and often called the discount rate, this can also be thought of as the inflation rate.
- IRR = the discount rate that makes the NPV equal to zero.

$$\text{Net Present Value} = -\text{Initial Investment} + \sum_{i=1}^{I} \frac{\text{Annual Cash Flows}}{(1+R)^i}$$

$$\text{NPV} = -\text{Initial Investment} + \frac{\text{Cash Flow Year 1}}{(1+R)^1} + \frac{\text{Cash Flow Year 2}}{(1+R)^2} + \frac{\text{Cash Flow Year 3}}{(1+R)^3} \ldots$$

Internal Rate of Return = What Rate R will Make NPV = 0?

$$0 = -\text{Initial Investment} + \frac{\text{Cash Flow Year 1}}{(1+\text{IRR})^1} + \frac{\text{Cash Flow Year 2}}{(1+\text{IRR})^2} + \frac{\text{Cash Flow Year 3}}{(1+\text{IRR})^3} \ldots$$

Figure 3 – NPV and IRR are common industry-wide tools used to approximate investment strength.[2] ©Martin Engineering 2023

Half Measures Often Achieve Less Than Half Results

Purchasing decisions are often based more on price and what's in the budget than on achieving performance (ROP) and reducing costs. A common question is: "This is what I have in the budget, what can you do for that?" The correct answer is often, "Nothing." That's because taking half measures usually only temporarily treats the symptoms of conveying problems and doesn't address the root causes. To illustrate the point, a belt cleaning case study in Figure 4 analyzes using actual customer data and making some assumptions based on industry averages. [2][3]

The installation and maintenance costs consider that the conveyor is a reversing design and dual belt cleaners were installed at both ends. It is critical to specify equipment that is designed for safety and ease of service, rather than just seeking the lowest-cost options. These components may carry a slightly higher initial price, but they will pay off over the life of the equipment and ultimately result in lower life cycle costs.

Customer Data		Assumptions	
Material	Frac Sand	Initial Installation Cost	$20,000
Carryback Before	4,225 tons/y	Annual Maintenance Cost	$7,000
Carryback After	930 tons/y	Cost of Money	10%
Additional Sales	$400,000	Evaluation Time Frame	5 years
Downtime Reduced	$?	Cleanup Rate per Hour	0.5 t/h Shoveling
Cleanup Reduced	$?	Belt Cleaner Effectiveness	50% & 55%
Safety Savings	$?		

Figure 4 - Belt Cleaning Case Study Data ©Martin Engineering 2023

Belt Cleaning effectiveness is the % of material the cleaner removes from the belt and is measured by the grams per square meter (g/m2) that the cleaner removes from the dirty portion of the belt. Many manufacturers claim 98% or more cleaning efficiency without specifying 98% of what: 98% of 500 g/m2 or 98% of 100 g/m2 of carryback? The desired result is not cleaning efficiency, but the effectiveness in reducing carryback -- expressed in the tons of fugitive material that have to be cleaned up. In this study the carryback levels were measured by a technician using a standardized test method.

Equipment design and effective maintenance are keys to long term safety and cost control. Components that are engineered with these priorities will deliver longer service life and reduce maintenance costs while minimizing the risks inherent to bulk conveying. In this analysis, the effectiveness is assumed to be 50% for the precleaner and 55% for the secondary. It was assumed the cleanup was done manually by shoveling at a rate of ½ a ton per hour and labor cost is $25/hour. [Fig. 5]

The 5-year time frame was chosen as a reasonable life for this type of equipment. Doing nothing is costing $800,800 in discounted cash flow over 5 years. For spending an additional $10,000 up front on equipment and $5,000 a year in maintenance, the additional cash flow for the full solution (installing two cleaners on each end of the reversing conveyor) compared to the half solution is $201,700 on labor alone for the dual cleaning system vs. a single belt cleaner on each end of the conveyor and $578,000 compared to doing nothing.

If the one-year ROI on the initial investment for the full solution compared to the half solution is considered as savings divided by costs, it would be ($211,250 – 46,500) /

	Cleaner Effect.	Carryback Clean Up	Labor Cost/y @ 0.5 t/h Shoveling	Initial Installation	Annual Maint.	NPV: 5 years @ 10%
Before Upgrade	0%	4225 t/y	$211,250	$0	$0	$800,800
NPV of Cash Flows from Labor Savings						
Half Solution 2 Precleaners	50%	2113 t/y	$105,650	$10,000	$3,500	$377,300
Full Solution 2 Precleaners & 2 Secondaries	77.5%a	950 t/y	$46,500	$20,000	$7,000	$578,000
*Assume the dirty belt has 100 g/m2 of carryback. Effectiveness = 100 g/m2 x [(1-50%) x (1-55%)] = 22.5 g/m2 remaining on belt after cleaning or (100g/m2 - 22.5 g/m2)/100 g/m2 x 100% = 77.5% effective.						

Figure 5 - NPV of Cleanup Labor Savings for Half and Full Solutions ©Martin Engineering 2023

$20,000 = 1.76 or 176%, which is very good. But ROI doesn't tell the whole story, and that's why the NPV method should be used. One could also consider adding tertiary cleaners, but at some point there is a diminishing return, as it's not possible to clean a conveyor belt 100% consistently over time.

A company's cost of money may be different, or it may have a different labor rate. Once the NPV spreadsheet is set up, it's very easy to change assumptions, costs and savings to compare the results. If the cash flow from added sales and reduced accident exposure and other identifiable costs are included, it becomes even more clear that best financial, safety and production is the full solution. As is the case of most upgrades for the control of fugitive materials, the ROP is so great that the Internal Rate of Return is off the charts.

Prioritizing Safety Justifies the Cost

Often issues like excessive dust, mistracking, spillage, carryback, etc. are considered commonplace and "the cost of doing business." In reality, they are extremely unsafe, costly and easily remedied with modern equipment. A common injury for cleaning or maintenance personnel is a muscle strain. The OSHA Safety Pays Calculator [4] estimates the cost of a single lost time muscle strain injury at $32,023 in direct and $35,225 in indirect costs for a total of $67,248.

Conveyor guarding may seem like additional cost, but injury statistics make it an essential component. ©Martin Engineering 2023

If there is a history of safety incidents, improvements can often be justified on safety alone. Identifying that an issue exists is the first hurdle; another is asking for help collecting data and making sure it's recorded correctly. Keeping the project and equipment decisions simple and safety-focused is the best approach.

Make sure to read Part 2 for insight on how to prepare the project for success and justify the expense after installation.

References

[1] Swinderman, R. Todd; Marti, Andrew D.; Goldbeck, Larry J.; Marshall, Daniel; Strebel, Mark G.: Foundations; Fourth Edition; pg. 465, pg. 443; Martin Engineering; Worzalla Publishing Company; Stevens Point, Wisconsin 2009.

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[3] Swinderman, R. Todd; Marti, Andrew D.; Goldbeck, Larry J.; Marshall, Daniel; Strebel, Mark G.: Foundations for Conveyor Safety; First Edition; pg. 451; Martin Engineering; Worzalla Publishing Company; Stevens Point, Wisconsin 2009. https://foundations.martin-eng.com/foundations-4-book-download

[4] OSHA Safety Pays Calculator https://www.osha.gov/safetypays/estimator accessed 6/30/21

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