# RELIABLE EQUIPMENT ASSET MANAGEMENT FOR A LEAN AND PROFITABLE BUSINESS

By Drew D. Troyer of Sigma Reliability

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## INTRODUCTION

Whether you make paper, generate power, process chemicals, produce food and beverages or manufacture steel, aluminum, tires or other products, if you depend upon equipment assets to deliver value to your shareholders and other stakeholders, the reliability of that equipment must be on your top-five executive priority list. Here, we'll discuss how reliability system deployment (RSD) enables effective equipment asset management (EAM), which in turn enables Lean manufacturing and business strategies. Most important, we'll link RSD, EAM and Lean manufacturing to creating a healthy income statement, a lean balance sheet and managed risk, which in turn drives maximized return on net assets (RONA) and, eventually, share price. We'll discuss the benefits and the framework you need for achieving reliable equipment asset management.

*Reliable and Lean – Effects on Your Income Statement, Balance Sheet and Share Price*

A majority of manufacturing and process industry companies are at some level implementing Lean business strategies, which is an adaptation of the famed Toyota Production System (TPS). Lean has many tentacles – some are simple and some are complex – but at its core, Lean has the following objectives:

- Maximize Availability – Expressed as a percentage, availability is the number of hours the plant or the machines are operating divided by the number of available hours. If a manufacturing line runs 7000 hours in a year – and there are 8760 hours in the year, the availability factor is 79.9%.
- Maximize Yield – Also expressed as a percentage, yield is the average production rate divided by the design best demonstrated production rate. So, if the manufacturing line is running at 800 widgets per hour and it's designed to make 1000 per hour, the yield factor is 80%.
- Maximize Quality – Also expressed as a percentage, quality is the percentage of production that's first-pass "A" quality, meaning it can be sold at list price without any rework or scrap. It's measured simply as the number of first-pass "A" quality production divided by total production. So if, on average, 750 of the 800 items produced per hour are "A" quality, the quality factor is 93.8%.
- Minimize Inventory – Inventory is one method to mitigate the risks associated with unreliable operations and supply chain. However, inventory is wasteful and costly. Whether the inventory is raw material, work in process (WIP), finished goods, maintenance & repair parts, critical spares, or redundant systems inventory carry costs range from 20% to 30% of inventory value per year. Carrying costs include cost of capital, coast of space, cost of handling, cost of insurance, cost of degradation, cost of pilferage, cost of obsolescence, etc – it really adds up. It's usually much less expensive and more desirable to improve the inherent reliability of a manufacturing process than it is to use inventory as a risk countermeasure to poor reliability.
- Minimize Transfer and Conveyance – Transfer and conveyance fail to add any value to production but can add a lot of cost in the form of manpower requirements, increased likelihood of mistakes, time WIP, paperwork and overhead, etc. However, if your processes aren't reliable, continuous flow operation is risky business. Transfer and conveyance points are natural places where we insert slack in the form of buffer inventory, which is employed to mitigate the risks of an inherently unreliable process. If you want the benefits of continuous flow operations, which you should, you better get serious about equipment asset reliability management.

An important metric in lean manufacturing is overall equipment effectiveness (OEE), which is the product of Availability X Yield X Quality. Simply stated, OEE represents our performance compared to perfection. So if our availability factor is 79.9%, our yield factor is 80% and our quality factor is 93.8%, our OEE = 60%. This means that we're running at 60% of perfection. While no organization actually achieves 100% OEE, our goal is to close the gap between our current and desired performance level – at least insofar as doing so adds value in the form of profit, RONA, share price and other measures of organizational performance.

So, what's it worth it to you to increase the OEE of your manufacturing or process plant? And, what's reliability got to do with it? The answer to these questions is simple – A LOT! The Aberdeen Group, a research think tank, completed a benchmark study about EAM practices. They benchmarked lower quartile, average and upper quartile performers on equipment asset availability, yield and maintenance costs as a percentage of sales. They found that leading companies enjoyed an 8.5% increase in production availability, 6.3% increase in production yield and a 26.8% reduction in maintenance costs as a percentage of sales compared to lagging companies - their results are summarized in figure 1. Quality data wasn't reported in the Aberdeen study. Measures of quality are harder to compare from industry to industry. And while reliable EAM influences quality, it's the main driver of availability and a major factor in yield. However, you should factor quality into your internal analysis, as it's vital to the success of the firm.

Intrigued by the Aberdeen Group's data, I wondered what might happen to the firm's income statement if a lower (25th) percentile performer adopted the practices of an average or upper percentile (75th) performer. The results are stark. By catapulting from the lower quartile to the average, sales increases by about 10%, but profit increases by 72%. By adopting the upper quartile performers' business practices sales increase by 15%, but profit increase by 151% (figure 1)! That's the profit impact from more effectively leveraging a heavily fixed equipment asset dependent firm – **that's the impact of Lean and Reliable Operations!**

| Results from Aberdeen Group Benchmark Study | Lower Quartile Performers | Average Performers | Upper Quartile Performers |
|---|---|---|---|
| Availability | 81.80% | 87.20% | 88.80% |
| Yield | 79.20% | 81.90% | 84.20% |
| Maintenance Costs/Sales | 23.50% | 20.80% | 17.20% |
| | | | |
| **Results from Sigma Relaibility "What If" Analysis** | | | |
| **Sales** | $1,000,000,000 | $1,102,356,079 | $1,154,108,320 |
| **Costs** | | | |
| Cost of Goods Sold (assume 60%) | $600,000,000 | $661,413,647 | $692,464,992 |
| Maintenance Costs | $235,000,000 | $229,290,064 | $198,506,631 |
| Fixed Costs | $100,000,000 | $100,000,000 | $100,000,000 |
| **Total Costs** | $935,000,000 | $990,703,712 | $990,971,623 |
| | | | |
| **EBITDA** | **$65,000,000** | **$111,652,367** | **$163,136,697** |
| | | | |
| **EBITDA as a Percent of the Lower Quartile Performers** | **100%** | **172%** | **251%** |

*Figure 1 Income statement comparison of lower quartile, average and upper quartile EAM performers.*

So how does reliability factor into the equation? It's really very simple, if the equipment assets aren't reliable, availability suffers. Also, when the equipment assets aren't reliable, we tend to be forced to run them at slower speeds, reducing throughput, or yield. And, as you might imagine, if the equipment assets aren't running and producing, they're down getting repaired – so we're spending more on maintenance labor and parts. Focusing on the proactive aspects of equipment asset reliability management unleashes the production potential of our equipment assets and simultaneously reduces maintenance costs – a winning combination on the income statement!

The income statement looks good, but what about the balance sheet and other indicators of success? Lean operators run a Lean balance sheet. It's tough to maintain a Lean balance sheet when the equipment assets aren't reliable. A major tenet of Lean manufacturing is "just-in-time" (JIT) inventory, where inventory arrives just as it's required. When the equipment assets are unreliable, we see a swelling of "just-in-case" inventory. We maintain large stocks of raw material, work in process (WIP), finished goods, maintenance and repair parts, critical spares and redundant systems "just in case" something goes wrong. This practice, which is a by-product of poorly managing the inherent reliability of our manufacturing equipment assets and processes, leads to a swelling of the balance sheet, which negatively affects RONA. While not measured directly in the Aberdeen study, we can make a few assumptions regarding the net operating asset in place (NOAP), which is the sum of the plant's replacement asset value (RAV), inventory and cash. For our purposes, we've assumed that the average performer requires five-percent less NOAP than the lower quartile performer. Likewise, we've assumed that the upper quartile performer requires 10% less NOAP than the lower quartile performer. Based upon these the

upper quartile performer in our scenario has a RONA that's nearly three times higher than that of the lower quartile performer! Since RONA – sometimes called "management effectiveness" is the primary driver in attracting investors to the firm's stock and is typically utilized to calculate economic value add (EVA), which is commonly employed for determining payout in executive bonus and stock option schemes, this relationship should be very compelling. Moreover, research suggest that reliable equipment assets produce fewer adverse health, safety & environmental (HS&E) events. This stands to reason as adverse events that influence production or HS&E goals tend to share many of the same underlying root causes.

| | Lower Quartile Performers | Average Performers | Upper Quartile Performers |
|---|---|---|---|
| **EBITDA** | $65,000,000 | $111,652,367 | $163,136,697 |
| | | | |
| **Assumed Net Operating Asset in Place (NOAP)** | $1,200,000,000 | $1,140,000,000 | $1,080,000,000 |
| | | | |
| **NOAP as a Percent of Reactive Scenario** | 100% | 95% | 90% |
| | | | |
| **Return on Net Assets (RONA)** | 5.4% | 9.8% | 15.1% |
| | | | |
| **Shares Outstanding** | 25,000,000 | 25,000,000 | 25,000,000 |
| | | | |
| **Earnings Per Share** | $2.60 | $4.47 | $6.53 |
| | | | |
| **Price to Earnings Ratio** | 12 | 12.5 | 13 |
| | | | |
| **Share Price** | $31.20 | $55.83 | $84.83 |
| | | | |
| **Share Price Growth as Compared to the Lower Quartile Performer** | 0% | 79% | 172% |

*Figure 2 - Reliability also drives return on net assets (RONA) and share price.*

Ultimately, it all comes down to share price. Share price is a function of earnings per share (EPS) multiplied by the price to earnings ratio – the multiple of earnings that the market is willing to pay for a share of your company's stock. In our scenario, we've assumed 25 million shares outstanding. The lower quartile performer produces and EPS of $2.60, the average performer produces $4.47 per share and the upper quartile performer comes in at $6.53 per share. The price to earnings (P/E) ratio is assumed to be 12 for the lower quartile performer. Because the P/E ratio is driven predominantly by volatility, it's assumed in our analysis that the average

performer will be more predictable than the lower quartile performer and achieve a P/E of 12.5, while the upper quartile performer, which is the least volatile of all, reaches a P/E of 13. Based upon these assumptions, the stock price for the upper quartile performer computes out at $85 per share in our scenario, versus $31 per share for the lower quartile performer. Share price is where the rubber meets the road, and Lean, Reliable Equipment Asset Management really delivers.

The differences between the leaders and the laggards in terms of production availability and yield, and maintenance cost as a percent of sales are researched and well established and clearly a function of the reliability of your equipment assets and production processes. In this exercise, I've illustrated how adopting best in class equipment asset reliability management practices can influence the things that are really important to you – profit, the balance sheet, RONA and share price. However, this is simply an illustrative exercise. I challenge you to factor your OEE, maintenance costs, energy costs, inventory costs, etc into an interactive version of your income statement and balance sheet. Then ask yourself "if we functioned as a top-tier Lean and Reliable operator, how would it impact our income statement and balance sheet? In turn, how would that impact RONA and our share price?" If you take the time to analyze your opportunity, I think you may be surprised by the results.

Now that we have a clear focus on the value proposition, let's look at the practices that will enable you to achieve upper quartile performance.

*Equipment Asset Reliability Management Best Practices*

Overall Equipment Effectiveness (OEE) elegantly measures the equipment asset dependent firm's performance relative to perfection. But how do we achieve the gains that separate the leaders from the laggards? Lean Equipment Asset Reliability Management isn't a short-term, cost cutting proposition – rather, it must be managed over the life-cycle of your equipment assets and manufacturing processes. In general terms, that life includes design, manufacturing, installation, commission, operations, maintenance and disposal. We're going to focus on design, operations and maintenance. To help illustrate the point, we'll draw a parallel between managing the health of equipment assets to managing the health of our own bodies –something with which we're all familiar!

- Design for Reliability – The inherent reliability, operability, maintainability, cleanability, flexibility and all the other "abilities" of an equipment asset are effectively defined during the design, manufacture, installation and commissioning stages of the life cycle. It's the "DNA" of the machine. In the case of a human, DNA largely determines native intelligence, how fast you can run, how tall you'll be, your susceptibility to certain diseases and, ultimately, how long you'll live. Sure, lifestyle management and the quality of health care provided are important, but DNA is the major influencing factor in determining quantity and quality of life. We must design, manufacture, install and commission equipment to maximize value creation over the life-cycle of the asset. It's easy to fall into the trap of "saving a buck" during this phase of the life cycle, but we wind up spending multiples of what we saved in the form of increased maintenance and operations cost. Don't fall into the trap of stepping over operations & maintenance dollars to pick up upfront pennies during design, manufacturing, installation and commission. The apparent savings usually represent a false economy.

- Operate for Reliability – It may come as a surprise, but plants often operate equipment in ways that adversely affect its health and reliability – just as we often voluntarily mistreat our bodies. The risks associated with carrying excess weight, smoking, drinking too much, using dangerous drugs, etc., are very well-publicized. Nevertheless, we continue to get fatter and unhealthy lifestyle practices continue to persist. In the absence of knowledge, ignorance is an excuse. Here's your wake-up call: improper operation of equipment assets has a deleterious effect on their performance and life expectancy, just as the failure to ignore research and warnings about obesity, smoking, excessive drinking and a sedentary lifestyle deleteriously affect the performance and life expectancy of a human. Too often we choose operate equipment beyond its design capabilities, we erroneously start it up or shut it down incorrectly, utilize poor practices when changing over to a different grad or product, defer maintenance, etc – just as we choose to carry extra weight, smoke, abuse our bodies and fail to seek out proactive health care support. Whether it's your body or your machines, mis-operation proves costly.

- Maintain for Reliability – We depend upon physicians and other health care professionals to restore our bodies back to health when we're sick or injured just as we depend upon maintenance professionals to repair broken equipment. But there's more. We also depend upon health care professionals to detect diseases early to reduce their impact and assure a speedy recovery. For instance, lung cancer, if caught early, is very treatable. If caught late however, the risk of death increases substantially. In much the same way, we depend upon maintenance professionals to catch machine problems early, for the very same reasons. Early detection of problems saves money and reduces the impact on the organization. We also depend upon health care professionals to advise and help us maintain healthy cholesterol, blood pressure, weight, cardiovascular health and other conditions that, if left uncontrolled, increase the risk of disease. We depend upon maintenance professionals to do the same with our machines. If we pro-actively and precisely manage machine balance, alignment, tightness and lubrication with precision, the equipment enjoys a long, trouble-free life.

Reliability engineering and management systems provide a time-proven framework for managing the risk, reliability, availability, OEE and cost of operation of our machines and manufacturing processes over the life cycle. Conceived to assure safety and reliability in commercial and military aviation, nuclear power and other reliability-critical industries and applications, these systems are easily adapted and right-sized to fit the needs of the manufacturing and process industries – any business for that matter. Reliability System Deployment (RSD) enables you transition your organization to the upper quartile of EAM performance. There are many tools, analytical methods and strategic frameworks associated with RSD (see figure 3). Some will be applicable to your application, others will not. Details about the tools are beyond the scope of this paper, but suffice to say that if they keep airplanes flying safely, the tools are sufficiently robust to enable your objectives for a Lean & Reliable Operation.

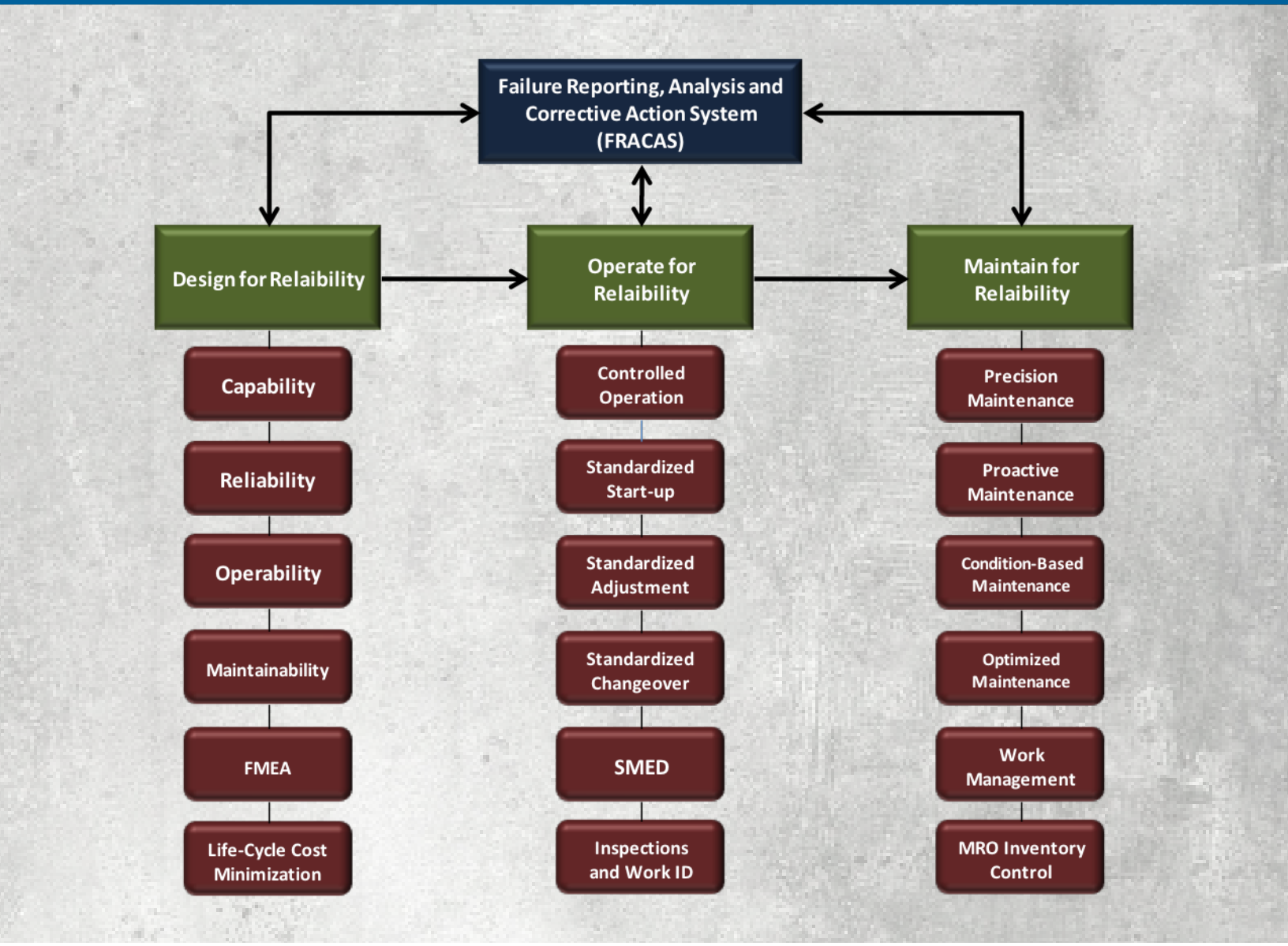


*Figure 3 - The tools of the trade for Lean & Reliable manufacturing. In all instances, data and its systematic analysis drive decisions and policy.*

## *CONCLUSIONS*

Lean & Reliable Equipment Asset Management can materially affect your income statement, balance sheet, return on net assets (RONA) and share price. The difference in performance on key performance indicators is, according to research, stark by contrast. When one considers the implications of moving from lower quartile to upper quartile performance on the financial performance of an equipment asset dependent manufacturing or process industry firm, management can't stand idly by. Even a small improvement on overall equipment effectiveness (OEE) can dramatically improve your profitability. Moreover, the improvements are gained by managing your current investment in plant more effectively utilizing proven risk and reliability management tools and techniques - so it's a very cost effective way to create distance between you and your competitors and satisfy the wants and requirements of your shareholders and other stakeholder.

**Drew D. Troyer** – is a pioneering thought leader, globally-known expert on Maintenance & Reliability engineering and management, award winning author, trusted advisor to Fortune 500 companies around the world and popular keynote speaker. Drew holds the Certified Reliability Engineer (CRE), Certified Maintenance & Reliability Professional (CMRP) and MBA qualifications to go along with more than 20 years in the trenches. He receives accolades for his easy style, clear communication and ability to get the point across to technical and non-technical people alike. Drew is the founding president of Sigma Reliability Solutions and the former co-founder and CEO of Noria Corporation. Drew currently holds staff advisory positions as a reliability engineer in several manufacturing and process industry firms around the world.

Contact Details:
*Drew.troyer@sigma-reliability.com*
*www.sigma-reliability.com*
*+1 918 576 6256 (office)*
*+1 918 691 1794 (USA Mobile)*
*+61 043 584 3644 (Australia Mobile)*