LIFETIME LRS RELIABILITY SOLUTIONS
P +61 (0) 402 731 563 F +61 (8) 9457 8642 E info@lifetime-reliability.com

The Future of Production is Endless Risk-Free Operation

Abstract: The world needs plant and equipment that are reliable and fault-free for decades. Yet Maintenance can only keep machinery working by replacing broken and at risk parts. Even industrial asset management only aims to lower the cost of plant and equipment ownership. Neither methodology has the capability to deliver what mankind needs in future. Before the end of this century both disciplines will die-out because intelligent production machines will be made that are completely reliable and maintenance-free for their entire lifetimes.

Keywords: Reliability Engineering, risk elimination

By the start of the 22nd Century physical asset management and plant maintenance will no longer be required. Soon machines will be created that will not fail or stop during decades of use. This is certainly necessary if mankind is to visit and inhabit other worlds in lasting safety. The "machines" of the 22nd century maybe organic or metallic, or made of some as yet unknown compound, perhaps their construction may even be a mix of all these material types. But what is certain is that they will be amazingly reliable.

Operating Risk = Consequence of Failure x [Opportunity to Fail x (1 – Reliability)]

Consequence Reduction Strategies	Opportunity Reduction Strategies	Reliability Improvement Strategies
Strategies presume failure event occurs and act to minimise consequent losses	**Strategies prevent opportunities for the causes of a failure event to arise in the first place**	**Strategies reduce probability of failure initiation if opportunity is present**

• Preventive Maintenance
• Shutdown Maintenance
• Predictive Maintenance
  ○ Non-Destructive Testing
  ○ Vibration Analysis
  ○ Oil Analysis
  ○ Thermography
  ○ Motor Current Analysis
• Total Productive Maintenance
• Prognostic Analysis
• Emergency Management
• Computerised Maintenance Management System
• Key Performance Indicators
• Risk Based Inspection
• Operator Watch-keeping
• Financial Accounting
• Logistics, stores and warehouses
• Total Defect and Failure Costing
• Maintenance Engineering
	• Physics of Failure Reliability Analysis
	• Accuracy Controlled 3T SOPs
	• Design and Operations Cost Total Optimised Risk
	• Reliability Growth Cause Analysis
	• Engineering / Maintenance Standards
	• Statistical Process Control
	• Degradation Management
	• Lubrication Management
	• Risk Analysis
	• Hazard and Operability Study
	• Hazard Identification
	• Failure Design-out Maintenance
	• Failure Mode Effects Analysis
	• Root Cause Failure Analysis
	• Precision Maintenance
	• Precision Operation
	• Training and Up-skilling
	• Quality Management Systems
	• Planning and Scheduling
	• Continuous Improvement
	• Supply Chain Management
	• Reliability Engineering
		• Precision Maintenance
		• Training and Up-skilling
		• Oversize / De-rate Equipment
		• More Robust, Durable Materials
		• Segregation / Separation
		• Controlled Atmosphere Environment e.g. +ve /-ve pressures, explosion proof atmosphere

Done to reduce failure cost	**Done to reduce likelihood of failure**	

Table 1—Risk Management Options with the Three Factors

P +61 (0) 402 731 563 F +61 (8) 9457 8642 E info@lifetime-reliability.com

If the fate of maintenance is to end because plant and equipment never fail, then what understandings can we glean from the future for today's industrial world, where such equipment does not yet exist? What can we do now so that our machines may never stop?

The risk equation is eternal. It applies to every situation imaginable. In its full form it is written as:

Event Risk ($/yr) = Event Consequence ($/event) x [Opportunity (events/yr) x (1 – Reliability)]

Risk has three factors—consequence, opportunity and reliability. As a factor varies it changes the risk. If you want no bad risks whatsoever you must ensure that the consequence of a bad event is zero, or there is no opportunity for the event to happen, or, should the event happen, the items affected by the event can never fail. The risk equation advises what to do to eliminate risk—minimize consequences, prevent opportunities, maximize reliability. Many options used to manage risk in industry today, plus the new solutions in the Plant Wellness Way, are listed in Table 1.

Reliability Engineering is a late 20^{th} Century discovery that combines the physical sciences, risk elimination, and computer aided design with rapid scientific-method experimentation. It has given us great insights into how to maximize machinery component and system survival rates. Reliability Engineering now guides us in creating new industrial processes, designing new materials-of-construction, making highly durable products, and picking strategy to extend the time between failure of production plant. It is certain that in the coming years new Reliability Engineering inspired solutions will let us displace the need for plant maintenance and industrial asset management.

From the presence of reliability in the risk equation it's clear you don't need maintenance if the materials used to make your plant and equipment never fail. We don't yet have machines made of indestructible parts. Today we still have to control equipment risk by applying one or more of the risk factors. But research into components that cannot fail is already occurring in materials science labs and machinery design labs. Failure-free machines will be normal by the end of this century.

The future of production machinery is one where nothing goes wrong or fails. Not yet having that technology means the only way to get production success today is to drive operating risk out of all processes and assets impacting production costs. If the future of machines is designed-in, amazing reliability, then focusing on the same aims today—to have failure-free parts—using today's best solutions, will bring the greatest successes possible today.

The key production risk elimination lessons drawn from the future of maintenance and reliability to use today to design and build riskless life-cycle processes and operating equipment are:

1. **Have No Opportunity to Fail**

a) Create processes where variation that causes production failures cannot arise.
b) Control the decisions and actions within your processes so only ideal results occur.

2. **Create Sure Reliability**

a) Use materials-of-construction and parts designs that easily handle the stresses within them.
b) Keep your parts materials-of-construction atomic structures safe from all harm.

LIFETIME LRS RELIABILITY SOLUTIONS
P +61 (0) 402 731 563 **F** +61 (8) 9457 8642 **E** info@lifetime-reliability.com

Pending the day that our machines can safely run themselves unaided, we will need to design and make them in ways that minimize their chance of failure and to use and care for them in ways that maximize their reliability. That need validates the use of best practice physical asset management and maintenance until machines become totally reliable for their lifetime.

To get failure-free production today the only successful solution is to eliminate operating risk from throughout those processes used in your assets' life cycle. While we wait for the technological innovations that will give us the utterly reliable and safe machines that the future of mankind will need, we must still rely on the equipment risk elimination solutions in Table 1.

All the very best to you,

Mike Sondalini
Director
www.lifetime-reliability.com