



THE INTRODUCTION OF THE

S-D-I-P-F SAFETY RELIABILITY CURVE

Terrence O'Hanlon

The S-D-I-P-F Safety Reliability Curve Begins With the 1979 Birth of the P to F Interval

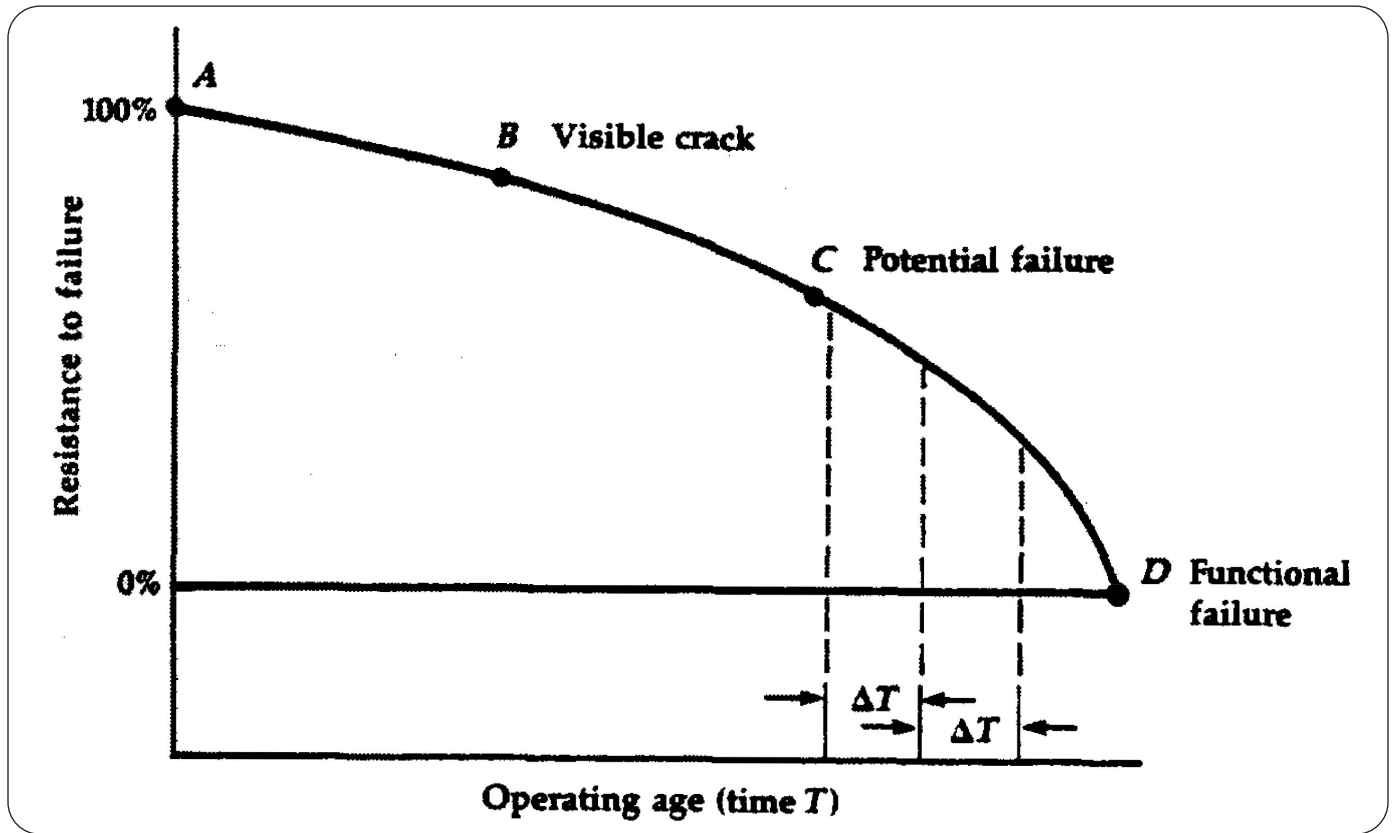


Figure 1: Original P to F curve (Reliability-Centered Maintenance report by Nowlan and Heap)

“Determining the interval for on-condition inspection of an item subject to metal fatigue. Once the rate of decline in failure resistance has been determined, an inspection interval “AT” is established that provides ample opportunity to detect a potential [P] failure before a functional [F] failure can occur.”

Excerpt from: F.S. Nowlan, “Reliability-Centered Maintenance,” 1979

Over 40 years later, many of the benefits from Stanley Nowlan’s and Howard Heap’s *Reliability-Centered Maintenance* report are still setting the standard for achieving asset reliability.

Setting inspection periodicities based on failure mechanisms and failure modes is a basic maintenance building block for high reliability organizations. The approach described in the P-F curve is proven and forms the center of what many refer to as predictive maintenance, however, the Uptime® Elements A Reliability Framework and Asset Management System™ refers to it as asset condition management (ACM). As solid as the original P to F curve is, it is applied in the final stages of an asset’s lifecycle and does not attempt a *whole life* asset view.

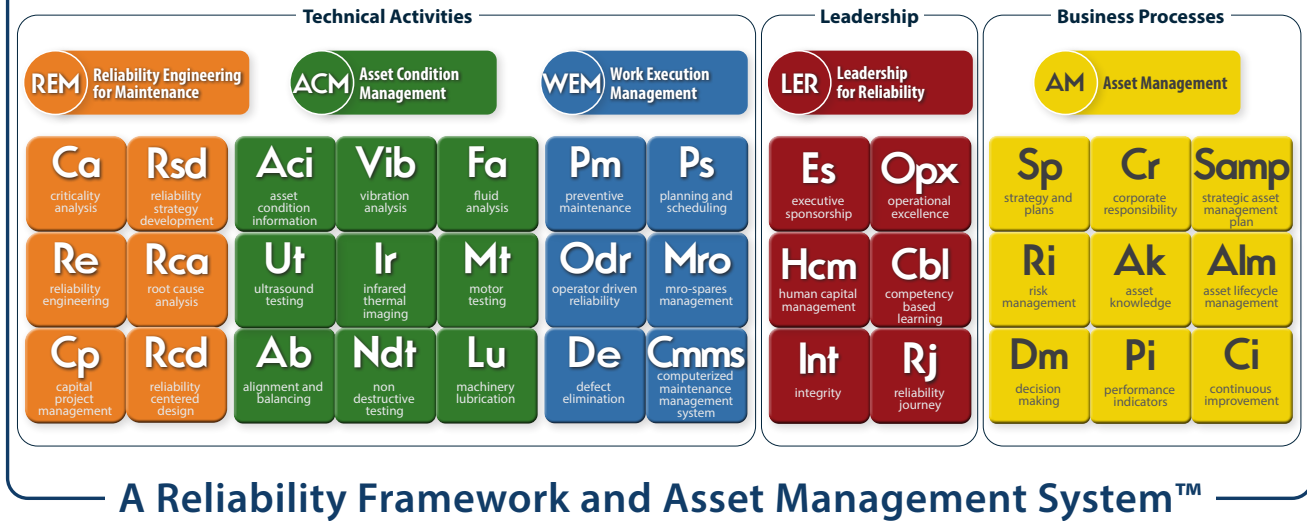
Various stakeholders, who can obtain value from assets at various stages of their life and their roles in the organization, typically work in silos. A critical success factor for assuring value from assets is to better understand the dynamic connections

between reliability strategy development and asset criticality and risk management and decision-making and asset condition management and preventive maintenance and work execution management and asset knowledge and asset management across the assets’ lifecycles and based in policy, strategy and plan to align intentional thought, effective action and efficient effort toward creating value from assets aligned toward achievement of organizational objectives.

That alignment and energy must be intentional for a group to achieve a new future that was not going to happen anyway.

Asset management, as described by the Uptime Elements A Reliability Framework and Asset Management System, creates an intentional management system or, more specifically, an asset management system to ensure opportunity and risk are managed or treated at the asset level that is appropriate for achieving organizational objectives as set by top management through value generated by the assets.

Uptime® Elements



A Reliability Framework and Asset Management System™

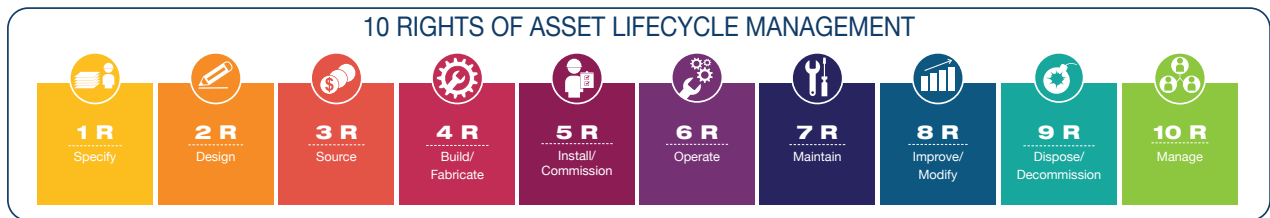


Figure 2: The Uptime Elements A Reliability Framework and Asset Management System (Terrence O’Hanlon, Reliabilityweb.com)

The Time Machine

One of the challenges with reliability is that its effects and causes are disconnected in time. Reliability decisions pay significant dividends, but they are paid slowly, over long periods of time. With management typically focused on short-term projects and goals, it is easy for organizations to depreciate reliability and realize a loss of consistent value generation from assets in a much more rapid fashion than it took to gain it.

The fallacy of improving reliability through maintenance has been chased for the past 40 years and like Sisyphus pushing his rock up the hill, a few dedicated teams of driven people make it to the top through a noble hero’s journey, but the rock inevitably rolls back down again within two to three years. The best practice maintenance expert advice sends the team to the *planned domain* where they develop systems to anticipate and deal with failures through efficient maintenance processes.

The only problem with this approach is that maintenance cannot influence all the causes of breakdowns. The planned domain is unstable and quickly becomes a *reactive-planned domain*, with an almost unescapable gravitational pull of failures caused by defects beyond the control or influence of the maintenance department to remove them or inspect and monitor to detect them.

The S-D-I-P-F Safety Reliability Curve is a visualization that attempts to graphically “bend time” to amplify the benefit of investing in and applying early reliability and sustainability efforts by showing a lifetime snapshot of the asset over time.

All due respect is given to Stanley Nowlan and Howard Heap, however, their excellent P-F curve work was intended strictly as an on-condition monitoring periodicity determinant. It is with high respect that their work is used in creating the S-D-I-P-F curve.



“There is nothing in a caterpillar that tells you it’s going to be a butterfly.” – Buckminster Fuller

“RELIABILITY IS DISCONNECTED FROM TODAY”

Figure 3: There is nothing in a caterpillar that tells you it’s going to be a butterfly - Buckminster Fuller (Terrence O’Hanlon, Reliabilityweb.com)

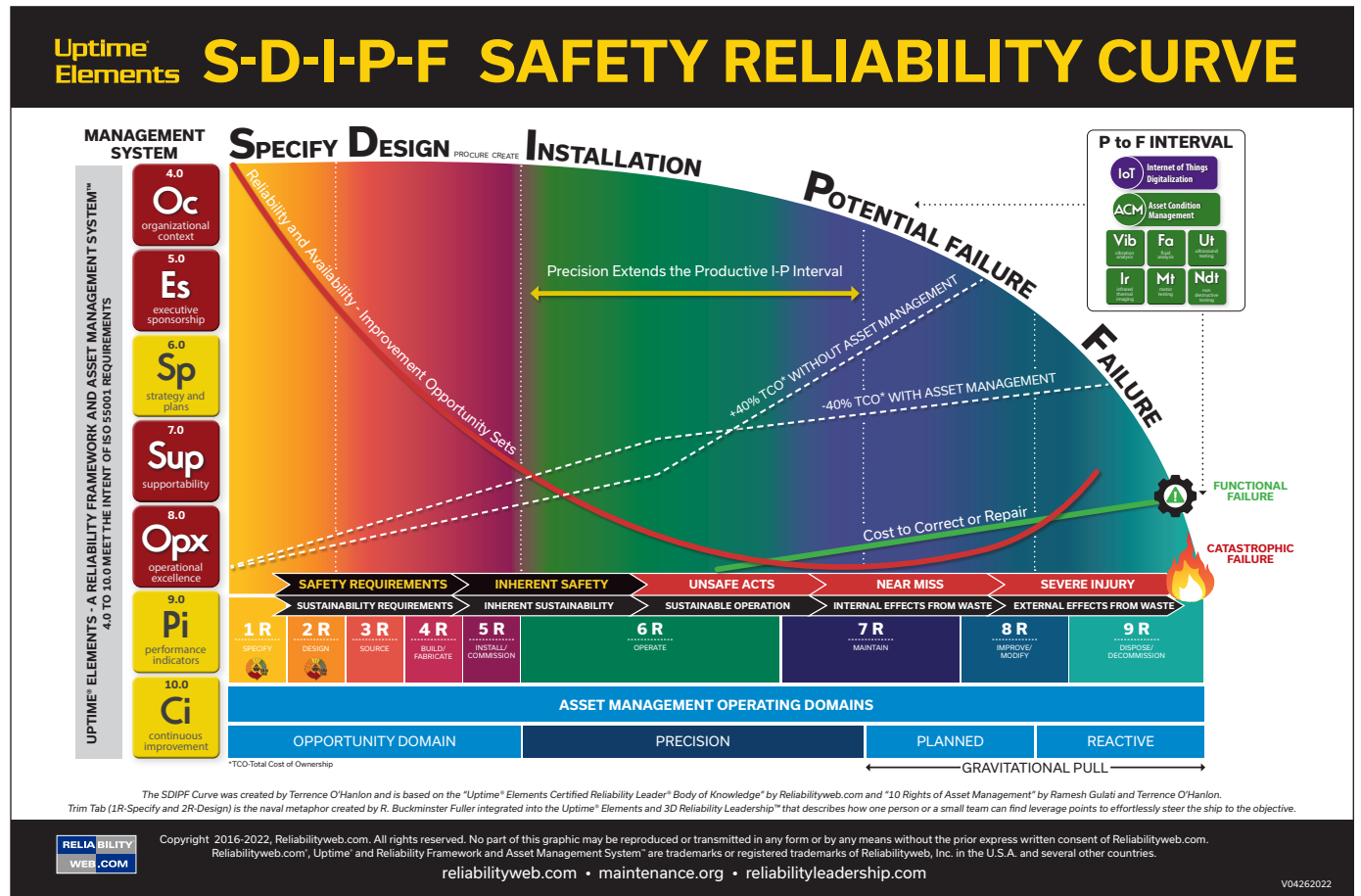
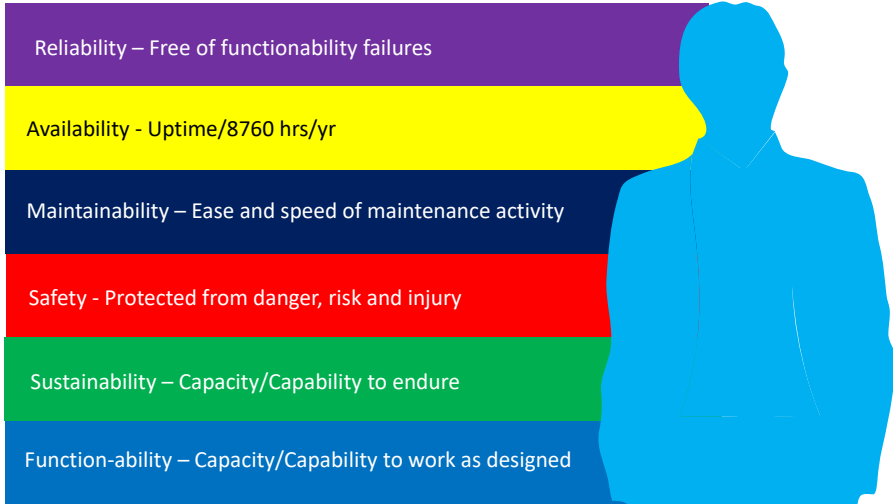


Figure 4: The S-D-I-P-F Safety Reliability Curve

WHAT IS RAMS²F

RAMS²F Determines Supportability Requirements

R
A
M
S
S
F



RAMS²F by Terrence O'Hanlon evolved from
RAMS2O developed by Ramesh Guleti

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Figure 5: What is RAMS²F by Terrence O'Hanlon

Some of the ideas expressed in the S-D-I-P-F curve:

- It visually expresses the full asset lifecycle phases from a "x for Reliability" lens.
- It visually expresses the *leverage* or *influence level* or *opportunity sets* for improving reliability and availability over the asset's lifecycle phases.
- It visually expresses total cost of ownership with and without formal asset management.
- It visually expresses the greatest opportunity sets for reliability, sustainability and maintainability to improve the asset itself early on in the asset's lifecycle phases.
- It expresses respect for the original intent of the P-F curve as a method to determine asset condition monitoring periodicity.
- It visually expresses operating maturity domains and encourages moving to the precision and expansive domains.
- It visually expresses the gravitational pull (p to f repeating cycle) of the reactive-planned domain, where systems have been put in place to anticipate and plan for asset failures, however, significant unplanned failures continue to surprise the team and consume resources.
- It shows the limited reliability and availability improvement opportunities in the operation and maintenance phases.

What ideas do you see? Note them here:

1. _____
2. _____
3. _____

Some RAMS²F Embedded in S-D-I-P-F Curve

Some of the more technical aspects of the RAMS²F asset lifecycle theory are embedded in the S-D-I-P-F curve:

AVAILABILITY is defined as the probability that the system is operating properly when it is requested for use.

RELIABILITY is the probability that a system or asset will operate in a satisfactory manner for a specified manner for a specified period of time when used under stated conditions.

Both reliability and availability can be specified, predicted and measured. The biggest opportunities to improve them exist during the early asset lifecycle phases of specification, design, procurement, build/create, and install/commission. Once in operation, the opportunity sets to improve the inherent reliability is limited.

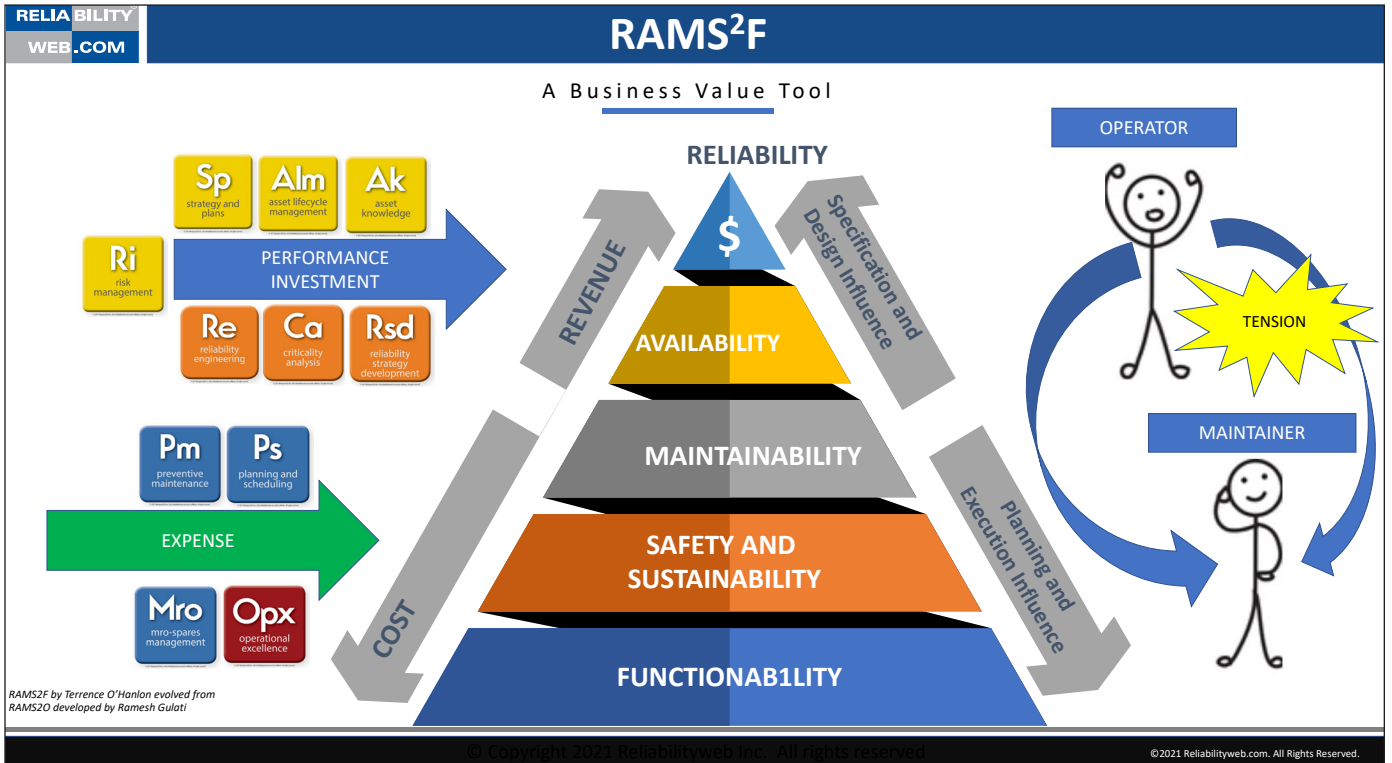


Figure 6: RAMS²F by Terrence O'Hanlon



Figure 7: Maintainability should be considered during design to leverage total cost of ownership

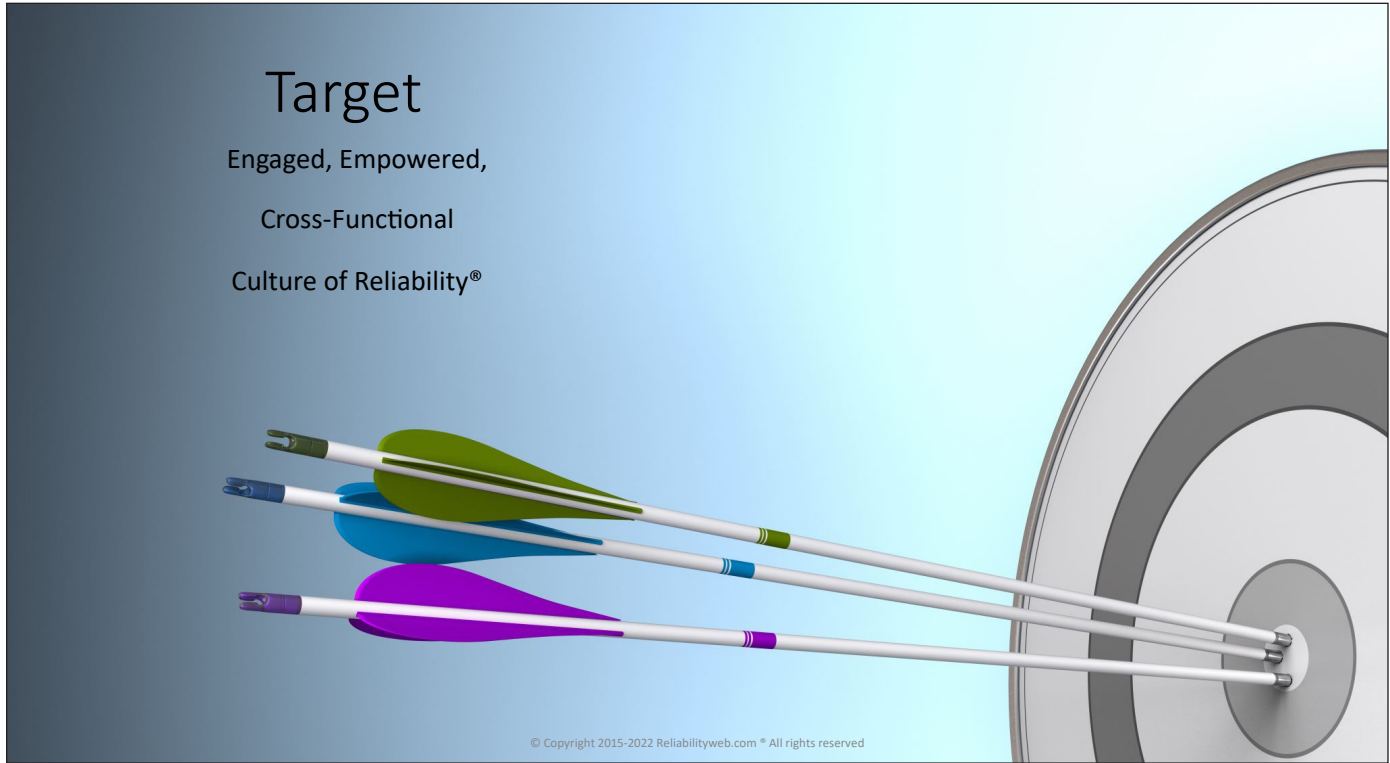


Figure 8: The target to achieve is an engaged, empowered, cross-functional culture of reliability

Uptime Elements

SOURCES OF DEFECTS

De
defect
elimination

CERTIFIED RELIABILITY LEADERS ENGAGE ACTION-ORIENTED, CROSS-FUNCTIONAL TEAMS TO ELIMINATE DEFECTS AND CREATE A CULTURE OF RELIABILITY

3 RULES OF DEFECT ELIMINATION:

- 1 Everyone should participate in at least 2 defect elimination projects per year.
- 2 Small cross-functional teams take action together to eliminate defects.
- 3 Defect elimination wins will be recorded, reported on and celebrated.


5

PRIMARY
SOURCES

WHAT IS A DEFECT? As it pertains to the world of business, a defect is anything that deviates from perfection and leads to customer dissatisfaction. Defects are anything that creates waste, erodes value, reduces production, compromises health, poses safety risks or negatively impacts the environment.


WHAT IS ELIMINATION? To completely remove or get rid of (something).

RAW MATERIAL
AND PROCESS
INPUTS




Low quality raw material, highly contaminated, not meeting quality specifications, highly corrosive, hardness or material defects

OPERATIONAL
DISCIPLINE



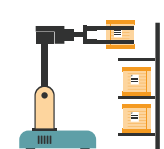
Over-speed, under-speed, overload, missing operator procedures, functions overridden, failure to report early indications of malfunction

MAINTENANCE
WORKMANSHIP




Missing work specifications, low skills, not using the right tools properly, rushed work, wrong work type

MAINTENANCE
MATERIAL AND
STORAGE




Low quality replacement parts and components, poor storage, counterfeit material, expired material, water ingress, contamination, poor distribution and handling

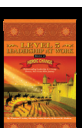
DESIGN, BUILD,
INSTALL



Not fit for purpose, not built to standard, not acceptance tested, not installed properly, poor access to maintain, poorly designed



Don't Just Fix It, Improve It
ISBN 978-0-9825-1631-7



Level 5 Leadership at Work
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THE 1% SOLUTION:

“1 out of 100 “fix-it” work orders should be a “don't just fix-it, improve it” work order.”

Winston Ledet, Creator, *The Manufacturing Game*®, TMG Frontline Solutions LLC

Attribution: The concepts of Defect Elimination, the 1% Solution and the 5 Sources of Defects were originally developed, practiced, shared and taught by Winston Ledet. Reliabilityweb.com and the entire industrial world owe Mr. Ledet an eternal debt of gratitude for providing one of the true keys to creating a reliability culture.

RELIA BILITY
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Figure 9: Sources of defects

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RIGHTS OF ASSET MANAGEMENT:

Achieve Reliability, Asset Performance and Operational Excellence



Ramesh Gulati and Terrence O'Hanlon



10 Rights of Asset Management

ISBN: 9781941872659

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Figure 10: The 10 Rights of Asset Management book was written by Ramesh Gulati and Terrence O'Hanlon

MAINTAINABILITY is defined as the probability that a failed system will be restored or repaired to a specified condition within a period of time when maintenance is performed in accordance with prescribed procedures.

Maintainability can be specified, predicted and measured. The biggest opportunities to improve it is through planning and execution.

Maintenance includes all scheduled and unscheduled actions necessary for retaining an item or restoring it to an operational condition. Maintenance includes repair, replace, remove, restore, renew, testing, modification, inspection, servicing calibration, overhaul, condition verification, and so on. Maintenance may or may not result in downtime. Maintenance is usually a major contributor to lifecycle cost.

Some Cultural Aspects Embedded in the S-D-I-P-F Curve

The target to achieve is the expansive opportunity domain through the precision domain by creating an engaged, empowered, cross-functional reliability leadership culture.

Traditionally, the maintenance team owns breakdowns or unreliability. They are the specialists with the know-how to react quickly to get the assets back online. They repair, replace, renew, restore and inspect.

Unfortunately, many organizations also default responsibility for reliability to the maintenance teams without providing all the controlling influences, setting up a cycle of

unplanned breakdowns that often lead to a safety, environmental, or economic catastrophe.

Engineering, Procurement, Operations, Quality, HR/HCM, Training, Safety, Stores, Capital Projects, IT, Sales, Marketing and top management are all stakeholders in reliability and make decisions that enable and disable reliability. A coordination effort, guided by policy, strategy and plan, is required to ensure intentional value.

Getting these stakeholders engaged is what the Uptime Elements A Reliability Framework and Asset Management System is all about. The S-D-I-P-F curve is designed to help you tell the story that you need to tell to engage those stakeholders who can enable your reliability journey! Please let the Reliabilityweb.com team know how they can support that.

The S-D-I-P-F curve is created as part of the Uptime Elements A Reliability Framework and Asset Management System by Terrence O'Hanlon. He is open to hearing your ideas around the S-D-I-P-F Safety Reliability Curve.



Terrence O'Hanlon, CMRP, and CEO of Reliabilityweb.com® and Publisher of Uptime® magazine, is an asset management leader, specializing in reliability and operational excellence. He is a popular keynote presenter and the coauthor of the book, 10 Rights of Asset Management: Achieve Reliability, Asset Performance and Operational Excellence. www.reliabilityweb.com