

Essential Elements of a Successful Reliability Program

Abstract: Reliability is a strategic issue. Maintenance is a tactical issue. Effective reliability programs prevent failures and the risk of failures by attacking the high \$ issues first. This requires empowering and enabling the entire work force from top to bottom to prevent failures rather than only fixing failures.

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What Is Reliability?

- **Reliability** is concerned with **avoiding failures** of equipment and **processes**. The process is of greater importance than the equipment as it generates cash!
- Avoid failures by **proper design** and **careful operation** of equipment by **trained personnel** in a **specified environment** for a **given time interval**! That's how you get a **failure free** environment and reliability.

What Is Reliability?-more

- Reliability is mainly a **strategic issue!**
Maintenance is mainly a **tactical issue**
- Consider this as a reliability policy:
We will build an economical and failure free process that will operate for 5 years between planned turnarounds.
- So, what does your reliability policy say?
- Want an example of a grand strategy?

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Allies WW II European Strategy*

- The **political** aim was unconditional defeat of the enemy and return to a world of peace and order.
- The **strategy** was to take the war to the enemy by all available means: aerial, land-based, naval, economic, and diplomatic
- This required **decisive successes at the operation** level...first the Allies had to gain command of the Atlantic waters from U-boats.
- Remember when WW II started, the USA had the worlds 13th largest army—behind Romania.
(Romania is smaller than the state of Oregon!)

*Paul Kennedy, **Engineers Of Victory**, 2013, page 14, ISBN 978-1-4000-6761-9 ⁴

What Is Maintenance?

- Maintenance is concerned with quickly correcting failures often driven by a natural law of system entropy changes. Often failures are driven by **MTBSE*** rather than entropy deterioration.
- The aim of maintenance is **minimizing maintenance costs and downtime.**
- Maintenance is mainly a **tactical** issue—not a strategic issue.

* **MTBSE = Mean Time Between Stupid Events**

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What Is Maintenance?--More

- At the start of a reliability program you will need about 10 maintenance engineers for every 1 reliability engineer.
- With time and reliability successes the ratio declines from **~10:1** to **~3:1** as repairs decline.
- Job descriptions* are different for maintenance and **reliability engineers**, i.e., repair failures vs **prevent failures.**

* <http://www.barringer1.com/jobdescriptions.htm>

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Where Do Failures Originate

- Mature Nuclear Power Production Failures
 - People →38%
 - Procedures + Processes →34%
 - Equipment →28%
- } **72% of all failures**
- 10 Year ASME Boiler Test Code Equipment*
 - 23,338 Accidents →83% human oversight or lack of knowledge
 - 720 injuries →69% human oversight or lack of knowledge
 - 127 deaths →60% human oversight or lack of knowledge
 - **Engineers--can you really reduce problems working only on the hardware?**

* Source: ASME National Board Bulletin, Summer 2002, Volume 57, Number 2, Page 10, "Ten Years Of Incident Reports Underscore Human Errors As Primary Cause Of Accidents", <http://nationalboard.org/SiteDocuments/Bulletins/SU02.pdf>

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FAA Top 5 Failures In 10 Years**

- Large turbofan/turbojet/turboprop aircraft
 1. Controlled flight into terrain, 2. Loss of control inflight, 3. Acts of aggression,
 4. Takeoff procedures, and 5. Unknown reasons
- Helicopters
 1. Lack of avoidance of objects, 2. Improper flight control, 3. Collisions with ground/water, 4. Low rotor RPM, and 5. **Engine/turbine failures**
- Small, fixed gear aircraft
 1. Visual flight rule problems with clouds, low visibility, and night flight, 2. Stalls,
 3. Judgment and low level operation contact with object, 4. Recklessness and acrobatic flight, and 5. Stalls involving reckless low altitude operations.
- **Again, engineers--can you really reduce failures working only on the hardware?**

**Source:

http://www.faa.gov/aircraft/air_cert/design_approvals/engine_prop/media/SAT_Report.pdf

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Reliability, Maintenance, and \$

- **Business is all about making money.**
This requires a balanced between avoiding failure, repairing failures, and keeping the process operating to make money.
- The ultimate aim of business is **satisfying customers** with on-time delivery of quality products while producing a long-term return for **satisfying stockholders**.
- In the end, **reliability and maintenance are all about money**.

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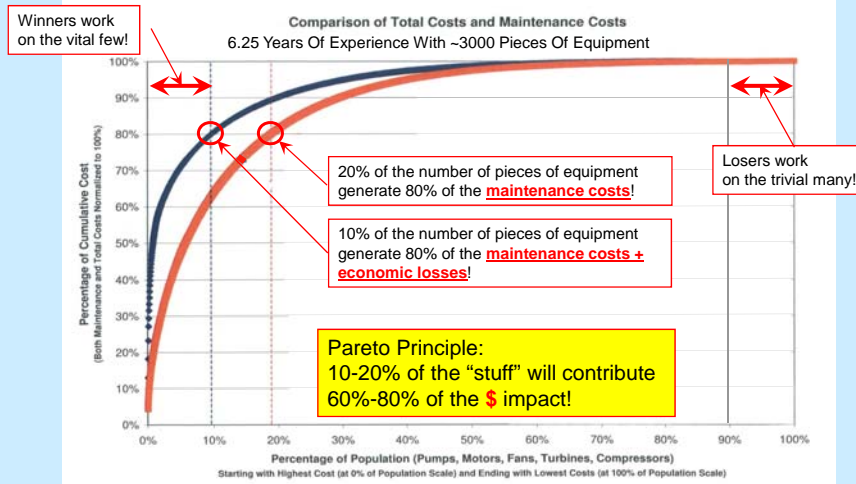
R, M, & \$--more

- Focus your reliability program on money issues beginning with a **\$Pareto priority list**. The work list is made from **recent problems** and **the threat of failures**.
- Focus on the **10-20%** of the Pareto items containing **60-80%** of the money issues
- **Work on \$Pareto things first—not your love affairs!!**
- In the end, it's all about the money! Where's your focus: **R & M** or **R & M**? Contrast this to your safety program: **s & FA*** or **S & FA?**

* **S** = safety, **FA** = first aid, **R** = reliability, **M** = maintenance

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Pareto Discipline—VIP Status



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Management Essentials

- **Management:** Communicate reliability programs by a **policy statement**.
- **Management:** Establish discipline in the spirit of **train, direct, and mold** the organization for reliability.
- **Management:** Motivate the organization to work the **\$Pareto list of failures and threats** for the **lowest long-term cost of ownership**.

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Management Essentials-more

- **Management:** Organize your team results to achieve a failure-free environment you must hate failures!
- **Management:** Work for small discrepancies at every step of the process as helping hands take initiative, without individual direction, and without waiting for specific instructions. This requires empowerment and enablement of work force team work.

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Management: Empower & Enable The Workforce

- Empowerment means management authorizes individual initiative and experience to be used continuously in an effective and timely manner.
- **Management** must invest individuals in the organization with authority to take action.
- Empowerment and enablement is not minimum effort for lowest proficiency levels.

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Empower & Enable--more

- **Enablement** means the work force must be trained and drilled for proficiency using best practices for continuous improvement by feedback from the working teams.
- **Management:** Build a positive corrective action organization with a culture of confessing errors and correcting errors without punishment.

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Empowerment and Enablement Royal Navy 200 Years Ago

- England ruled the waves for 200+ years with an **empowered** and **enabled** navy.
- Officers gave up management prerogatives to **empowered** crews to achieve superior results in battle.
- Gun crews were **enabled** by carefully training and drilling to fire 2 to 3 times more shells in battle, with greater precision, and few commands during battle.

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Royal Navy*--more

- When needed, crew and officers both lent their hands to duties in battle without instructions **no US vs THEM conditions.**
- Seasoned officers were required to know and perform mundane details with great proficiency, e.g., **show me don't tell me.**

* **To Rule The Waves:** How the British Navy Shaped the Modern World, by Arthur Herman, 2004, ISBN: 0-06-053434-9.

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Modern Example: **Empower & Enable—USA Carrier Operations**

- You are drilled 24/7/365 good or bad weather.
- Your peers provide you public feedback to make a better, error free, operation.
- Aviators get graded on every carrier landing.
- You must publically confess your errors.
- Your inferior performance gets Skipper's help.
- The Air Boss, once a year, takes the aviation team step-by-step through all aviation details.

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Correct & Incorrect Priorities

Correct Priorities:

1. **Mission completion** is most important!
2. **Men & Women** your second concerns
3. **Me** is the last concern!!

Incorrect Priorities (how to fail in 3 steps):

1. **Me** first screws up the system!
2. **Men & Women**
3. **Mission**

US Navy 3-M priority in one slide!

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Failed Reliability Programs

- **Unsuccessful** reliability programs are **bottom-up** efforts to improve maintenance technical details without financial justifications.
- Bottom-up programs get **luke-warm management endorsement** with condescending management remarks such as “here we go again with another gear-head program”.

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Failed Program--more

- Management says yes **we're for reliability** now get that pump repaired faster.
- Emphasis of faster repairs rather than preventing repairs is also a kiss of death for a reliability program.
- Moving reliability programs up the organization is as effective as pushing a wet rope. Look for **successes of ~10-20%**.

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Failed Program-more

- Another kiss of death is installing a newer and more complex computerized maintenance system (**CMMS**) with loss of data from earlier systems.
- New CMMS systems show few immediate financial results except spending more \$'s.
- **Continuous improvement is greatly preferred over postponed perfection!**

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Summary: Successful Programs

- Make reliability programs **money driven--not technology driven**. Sell improvements as about time and money issues.
- Use reliability tools/technology to **reduce lost money issues**.
- Work the **\$Pareto list** based on actual failures **and** the \$risks of possible failures.
 $\$risk = (\text{probability of failure}) * (\$consequence)$
Keep \$risk within your authorized signature authority!

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Successes--more

- Discuss the top 10 \$Pareto items with management. **Progress is reducing \$losses in months--not years.**
- Forecast future \$failures for next 3-5 years using Crow-AMSAA reliability growth plots.
- Use **root cause analysis** to solve critical failure issues within the **top 10 \$items**—
 Why? **That's where the money loss occurs!**

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Successes--more

- Sell management that reliability programs are to their advantage for changing the site culture from \$failure accepting to **preventing \$failures with fact driven engineering effort with an empowered/enabled work force.**
- Encourage individual confessions of errors without punishment—look to the nuclear industry and the US Navy carriers as examples.

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Success--more

- **Empower** and **enable** your workforce (include hourly folks) for better performance.
- Describe improvements in **\$'s** not things.
- Make more **\$'s** for the company! Reduce failures! Make improvements! Do it **NOW!**



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Want More Reliability Info?

- Go to <http://www.barringer1.com> for:
 - Reliability engineering job descriptions
 - Military/NASA/NUREG reliability documents
 - Worked out examples of reliability issues
 - Historical Weibull reliability documents
 - Technical papers on reliability issues

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