# ASQ Edmonton Section

Dinner Meeting
November 13 2014

***"Introduction to Reliability Engineering (in an Operating Environment)"***

The Global Voice of Quality™

# Agenda

- Safety Moment
- Welcome
- November is World Quality Month
- What is ASQ?
- Mission Statement for our section
- Initiatives for our section
- Renewals
- Word from the ASQ Mining Interest Group
- Presentation by **Andre Ferrari and Brad Jones**

# Safety

- Exit's
- Muster Point
- Washrooms

*Safety Moment being covered in the presentation.*

# Welcome

Warm welcome to ASQ members and non-members

- Anyone attending for the first time?

- Any new ASQ members?
- Any new ASQ certified members attending?

- How many of you have viewed our section's:
  - Website - asqedmonton.org
  - Linked-in profile Group

# November is World Quality Month

**November is World Quality Month, which provides a platform for acknowledging the efforts and accomplishments of quality and all who work to make it happen.**


**This is a time to celebrate — a time to showcase the advancements and valuable quality contributions in businesses, communities, and institutions.**

**Together — through our collective passion for improvement — we will raise the voice of quality worldwide. For more information, check the ASQ website** http://asq.org/world-quality-month/

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ASQ

# What is ASQ?

- ASQ provides the quality community with training, professional certifications, and knowledge to a vast network of members of the global quality community.

- **ASQ Membership**
- **Networking - COP**
- **Certifications – 17**
- **ASQ Learning Institute**
- **World Conference and Events**
- **World Quality Month**
- **Knowledge Center**
- **Standards – ISO**
- **Quality Press**
- **Research**
- **Social Networking**
- **Social Responsibility**
- **Quality for Life™**
- **Advocacy**

# Mission Statement

ASQ Canada Edmonton Section adds value to ASQ membership and promotes quality in the Northern Alberta through:

- facilitating local access to information
- education on quality principles practices and experience
- and by providing opportunities to share ideas and learning.

# Initiatives for our section

- Study groups for popular certifications started
- Mentorship Program
- New member welcome package
- Member Leader Training – PAR Nov 15

Need our members input:

- What can your section do to provide value to you:
  - Charity participation
  - A topic that will interest you
  - A field trip to local industry

# Renewals

- Keep yourself updated with the latest in Quality field by renewing your memberships

- Re-certifications – do not forget to submit your recertification journals for your ASQ certifications – every 3 years (you do get 6 months to submit as long as the re-certification units fall within the 3 year period

# Last event jointly with AACE

- Over 40 participants



# Next Event

December 4th – same venue

**Your Section Annual General Meeting**

- Announce new member leaders
- Opportunities to volunteer with your local section
- Your section performance
- Plan for 2015

**Certification Panel discussion**

- Meet the certified members
- Sharing of their experiences
- Opportunity to ask questions

# Quality in Mining Interest Group

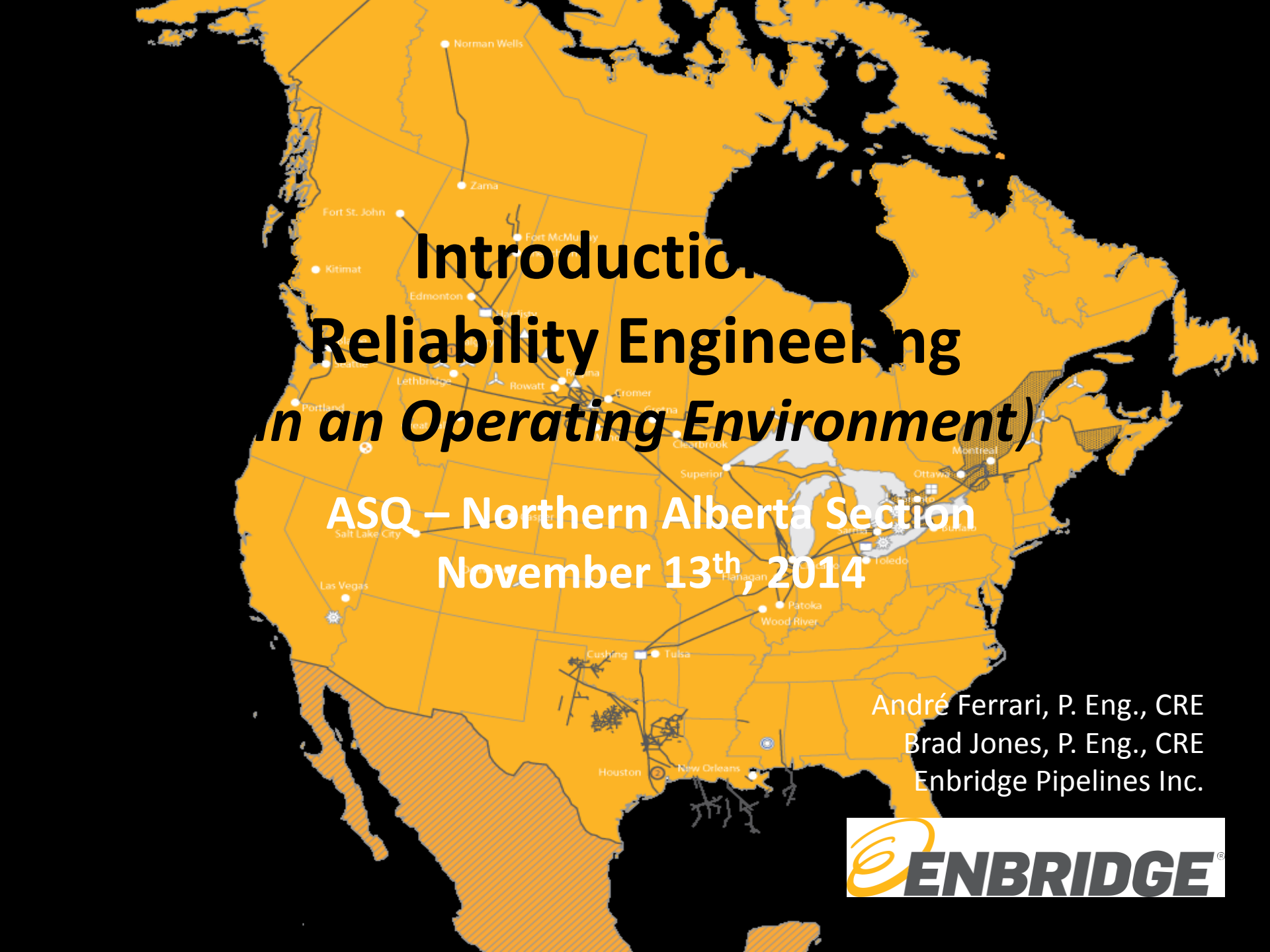
ASQ The Global Voice of Quality™

Leading the Way in Quality, Reliability,
and Continuous Improvement
in the Global Mining Industry

# Introducing……

## Andre Ferrari

## Brad Jones




# Introductio[illegible]
# Reliability Engineering
## *(In an Operating Environment)*

**ASQ – Northern Alberta Section**

**November 13th, 2014**

André Ferrari, P. Eng., CRE
Brad Jones, P. Eng., CRE
Enbridge Pipelines Inc.

ENBRIDGE®

# Safety Moment

- At the time one death/$Million Spent
- Forecast $35 Million, 35 Deaths
- Strauss insisted on higher standards
- Hard Hats, Antiglare Goggles etc.
- Most Importantly Safety Net Used

The nets saved the lives of 19 men. Sadly 11 men died, 10 when a section of scaffold fell through the safety net.

**Safety Improvement Takes Innovation, Courage and Desire**

# Presentation Contents

- Definition and Aspects of Reliability Engineering in an Operating Environment
- Reliability and Quality side by side
- Lots of Interactive Examples
- Reliability Process Flow
- A day in the life of a Reliability Engineer
- Reliability KPI's
- Reliability Engineering Tools

# Definition of Reliability

The “dry” academic definition:

- Reliability (R) is the probability a system will perform its intended function without failure within a specified mission time (T) and process conditions.


$$R(t) = 1 - F(t)$$

***(where F = Failure Probability)***

# Practical Uses of Reliability Concepts

- Will we get what we expect out of the asset over its life cycle
- Is the quality of one manufacturer better than another one
- How many failures will I get after one year of operation.
- When is it most likely to fail  over it's lifetime
- How do failures occur - early wear out, random, old age
- What performance can I expect over the short, medium, and long term
- How much testing do I need to do before I release it to the public
- How will all those sub-systems performed collectively

# Origins of Reliability Engineering


***Lessons Learned and Objectives:***

- *Proactively / explicitly identifying and designing out failures throughout all phases of a product or process lifecycle*
- *Promote a "learning" organization to Improve*
- *Take control of the asset rather than letting the asset take control*

# Example 1

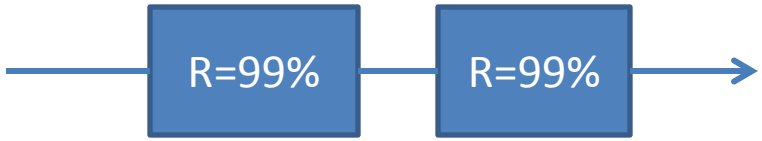
- Digital Camera cost 100$ at Trust-Me Electronics – Sales man offers extended warranty at 20$ “only”.
- Subaru Impreza at Ay-got-u Cars costs 25,000$ Sales man reduces price by 1,000$ and offers extended warranty at 2,000$ only.

***“What” would you do and “Why”?***

# Example 2

- What system arrangement should be used for improved Reliability? (A or B)? Why?

A)




R=0.99 x 0.99 = 0.98

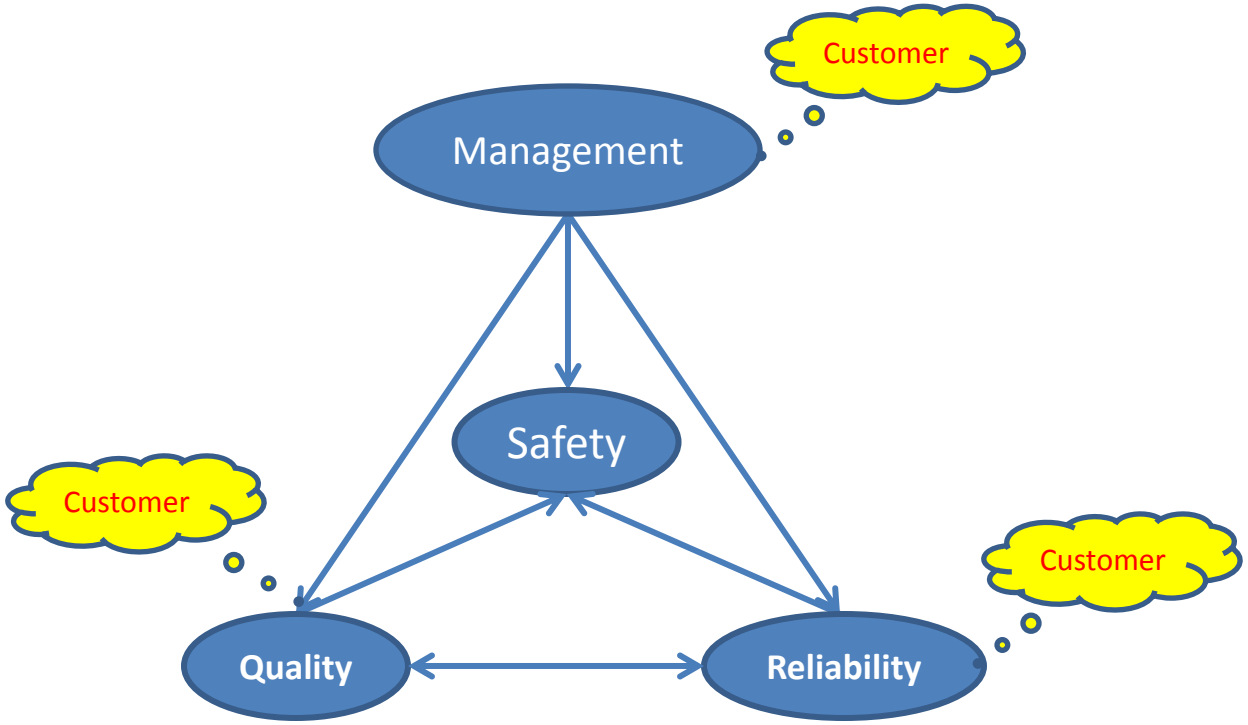
**98%**

B)


R=1-(1 - 0.9) x (1 - 0.9) = 0.99

**99%**

# Reliability, Quality and Safety




- Reliability supports Quality and Safety
- R+S+Q = Interconnected elements influenced by Management Direction
- Safety is the overarching value
- The customer is always the focus – who am I accountable to?

# Quality v/s Reliability



## Interrelationship of Safety, Quality, and Reliability (Cont'd)

| Quality: | Reliability: |
|---|---|
| The totality of characteristics of a product or a service that bear on its ability to satisfy stated or implied needs (needs may be translated into specified criteria).<br><br>Quality is sometimes referred to as:<br>1. "Fitness for use"<br>2. "Customer satisfaction"<br>3. "Conformance to requirements"<br><br>(Gee, 2005)[28] | 1. The duration or probability of failure-free performance under stated conditions.<br>2. The probability that an item can perform its intended function for a specified interval under stated conditions. (For non-redundant items this is equivalent to definition (1). For redundant items this is equivalent to definition of mission reliability).<br><br>(MIL-STD-721C, 1981)[60] |

Table 2.3 Comparison of Quality and Reliability Definitions

*Source: Certified Reliability Engineering Body of Knowledge*

# Quality v/s Reliability

II. RELIABILITY MANAGEMENT
STRATEGIC MGMT/INTERRELATIONSHIPS

BOK
I.A.2

## Interrelationship of Safety, Quality, and Reliability (Cont'd)

| Quality: | Reliability: |
| --- | --- |
| **Qualitative, Some Quantitative, Specifications, Attributes** | **Advanced Quantitative, Element of Time, Results Focused** |

Table 2.3 Comparison of Quality and Reliability Definitions

*Source: Certified Reliability Engineering Body of Knowledge*

# Example 3 – Fire Detection

Quality View – Attributes, Specifications

- Solid state photoelectric system with both smoke & heat sensor
- Sensor sensitivity dependent on rate-of-rise of heat & smoke
- Enhanced response to fast burning fires producing little smoke
- Sensitivity shall be factory set to an alarm threshold of 8%/meter.
- Design shall minimize effects of dust and dirt on performance.

Reliability View – Quantitative, Resultant Performance

- The system has a 99.999% probability of operating over one year between Preventative Maintenance tasks, when properly installed and tested inside residential dwelling.

# Benefits of Reliability Engineering

- Reducing Failures /Exposure to Failures Leading to Injuries or Loss of Life
- Assessing Life Cycle Patterns and Related Costs of Operation
- Minimizing Logistics Costs (e.g. Spare Parts)
- Matching the Capabilities of Product Design with Customer Application and Performance Expectations
- Optimizing the Cost to Performance Ratio Without “Over Engineering”
- Avoiding Unanticipated Products or Services Failures
- Applying Predictive and Preventive Maintenance Programs

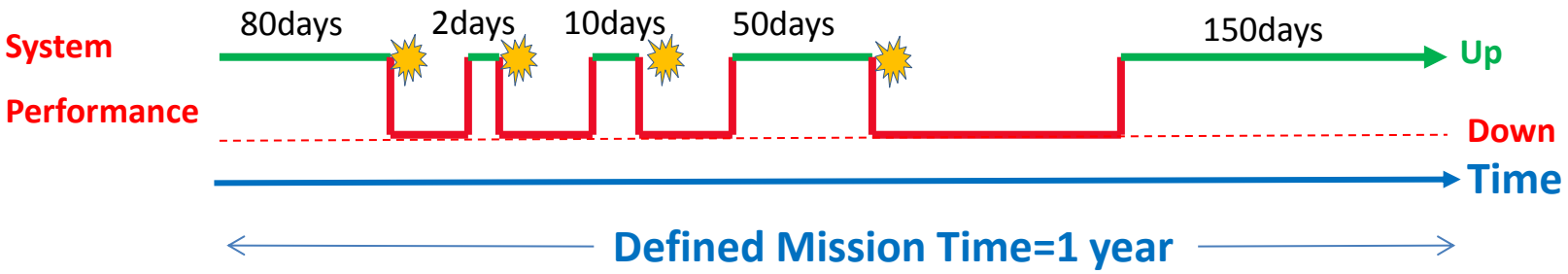
# Reliability ≠ Availability

- Reliability is the Probability of Success

- Availability is a ratio:

$$A = \frac{\text{Uptime}}{\text{Uptime + Downtime (or total time)}}$$

# Example 4




What is the Reliability of the System over 1 year?

*Answer: **0%** (will not survive 1 year without failure)*

What is the Availability of the System over 1 year?

*Answer: **80%** (= [80 + 2 + 10 + 50 + 150] / 365)*

# Enbridge Reliability Functions

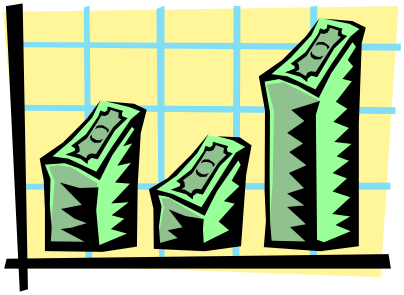
| New Designs | Existing Operations |
|---|---|
| Create Reliability Objectives | Collect/Analyze Performance Data |
| Convert Objectives to Design Requirements | Identify, Quantify and Prioritize |
| Analyze and Drive Design | Structured Problem Analysis |
| Partner with Vendors | Solutions Generation, Approval |
| Test and Verify Design | Solution Implementation |
| Test and Verify Construction | Check Solution Effectiveness |
| Monitor Resultant Performance | Put Control Plan In Place |

# Reliability Engineering Design Process

**Business Requirements**

*Throughput ,*
*Capital Costs*
*Operating Costs*
*Tolls, ROI*
*Contract Life*

**Define Reliability Requirements**



Targets/Goals *for*
*Throughput , Downtime,*
*Maintenance Costs,*
*Capital Spares etc.*
*Quantify Performance*
*Over Time*

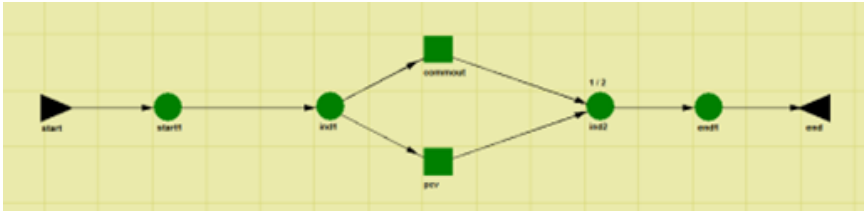
**Select Structured Analysis**

- *Reliability Modeling*
- *Fault Tree Analysis*
- *Failure Modes and Effects Analysis*

**Data Library**

**Complete Analysis**

*Example : Reliability, Availability, Maintainability Model*



- *Design In Requirements as opposed to let them happen*
- *Design Out Failures*
- *Design In Mitigation and or Redundancy*
- *Look at failures of Design, Operation and Maintenance*

*Results*

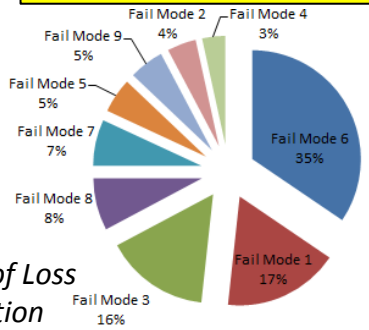
*Feedback to Business*

- *Design Capabilities and Tolerances*
- *Design Options for Capital Decisions*
- *Capital Sparing Vs Maintenance*
- *Defined Maintenance Strategy*
- *Uncover hidden business risk and mitigate*

# Reliability Engineering Improvement Process

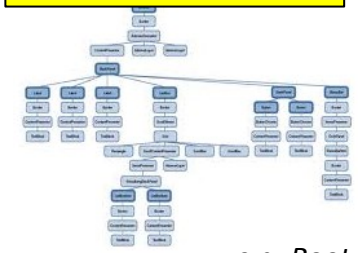
Data Library

Define/Quantify the Problem




*e.g. % of Loss Production*

Structured Analysis



*e.g. Root Cause Analysis*

NOT OK - NEEDS MORE WORK

OK - GO TO NEXT ISSUE

Check Effectiveness of Solution

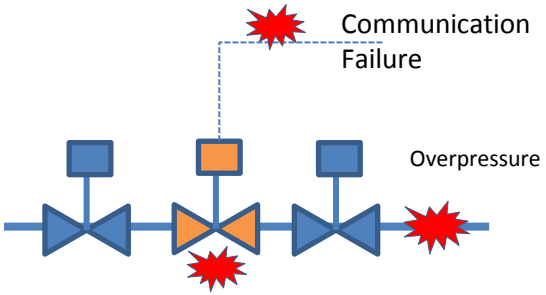

Define and Implement Effective Solution


- Fundamental Driver = Structured Problem Solving
  - KPI is often Defined by or with the customer

# A day in the Life of a Reliability Engineer


"I think we have a problem."

# A day in the Life of a Reliability Engineer

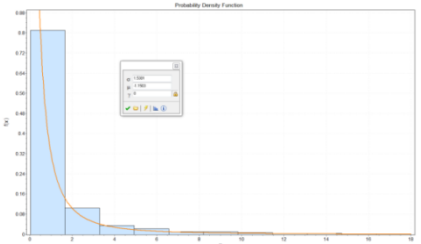



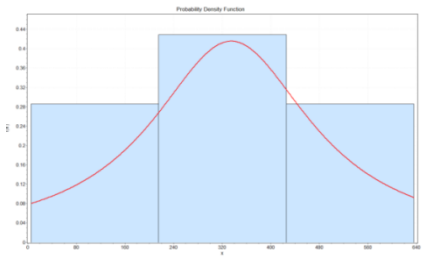

**Defining the System and failure modes**

**Retrieve Operational Data**

| GC CO all | LE CO all | NA CO all | WB CO all | MA CO all |
|---|---|---|---|---|
| 1.959085 | 2.32133 | 2.236267 | 2.206945 | 1.252461 |
| 0.496333 | 0.470277 | 0.48353 | 0.463737 | 0.515844 |
| 0.196098 | 0.163419 | 0.173219 | 0.168852 | 0.250061 |
| 0.063237 | 0.045464 | 0.049752 | 0.050148 | 0.098658 |
| 0.029688 | 0.019403 | 0.021647 | 0.022429 | 0.052047 |
| 0.016645 | 0.010126 | 0.011457 | 0.012148 | 0.03168 |
| 0.010373 | 0.005955 | 0.006813 | 0.00737 | 0.021034 |
| 0.002087 | 0.000989 | 0.001171 | 0.001364 | 0.005145 |
| 0.000343 | 0.000131 | 0.000162 | 0.000206 | 0.001024 |
| 0.000108 | 3.64E-05 | 4.57E-05 | 6.2E-05 | 0.000362 |
| 4.6E-05 | 1.4E-05 | 1.79E-05 | 2.53E-05 | 0.000166 |
| 2.31E-05 | 6.48E-06 | 8.38E-06 | 1.24E-05 | 8.84E-05 |
| 1.29E-05 | 3.4E-06 | 4.44E-06 | 6.77E-06 | 5.2E-05 |
| 7.83E-06 | 1.95E-06 | 2.57E-06 | 4.03E-06 | 3.28E-05 |
| 5.03E-06 | 1.19E-06 | 1.58E-06 | 2.55E-06 | 2.19E-05 |
| 3.38E-06 | 7.66E-07 | 1.03E-06 | 1.69E-06 | 1.52E-05 |
| 2.36E-06 | 5.14E-07 | 6.92E-07 | 1.16E-06 | 1.09E-05 |
| 1.7E-06 | 3.56E-07 | 4.82E-07 | 8.27E-07 | 8.05E-06 |

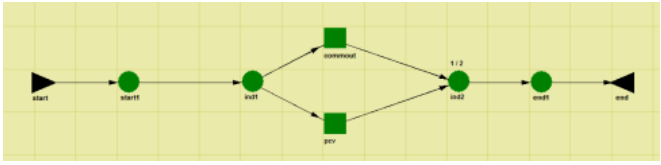
**Communication Historical Failure distribution**





**PCV Failure distribution**

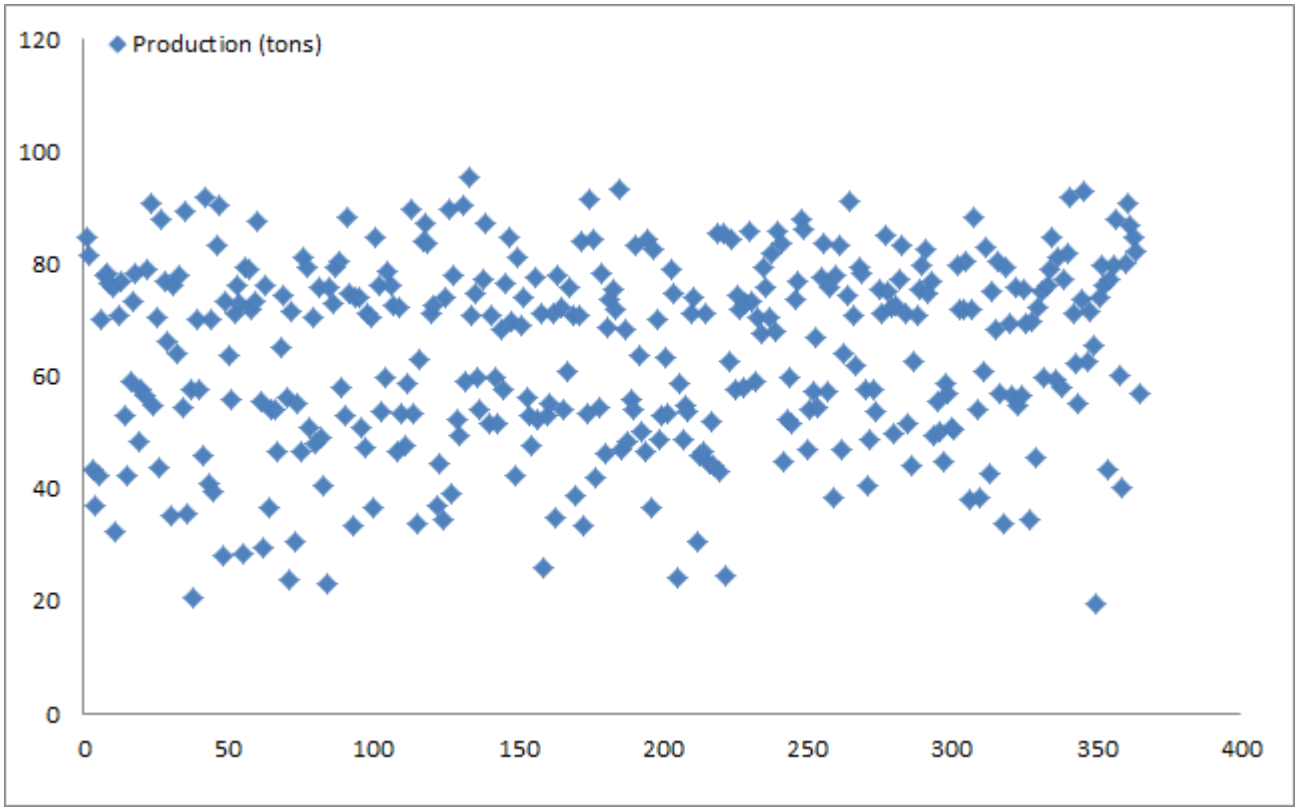
- **Probability of Failure Occurrence**
- **Expected Number of Failures**
- **Mean Time Between Failures**
- **Etc..**




**System Operating Model**

# Example 5 – Process Reliability

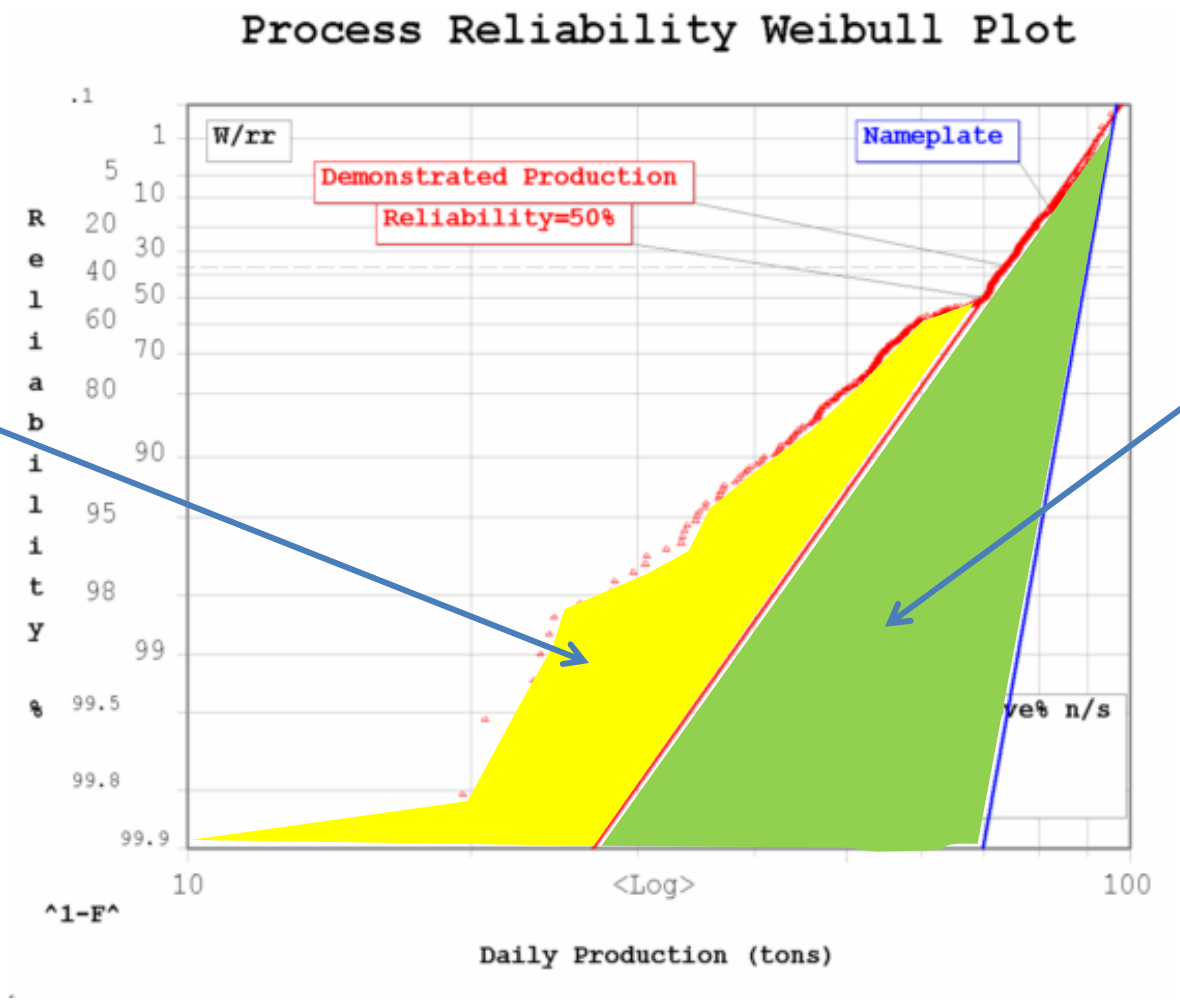
**Daily Production (Tons)**




**Time (Consecutive Days)**

Question: What do you see in this graph?

# Example 5 - Continued



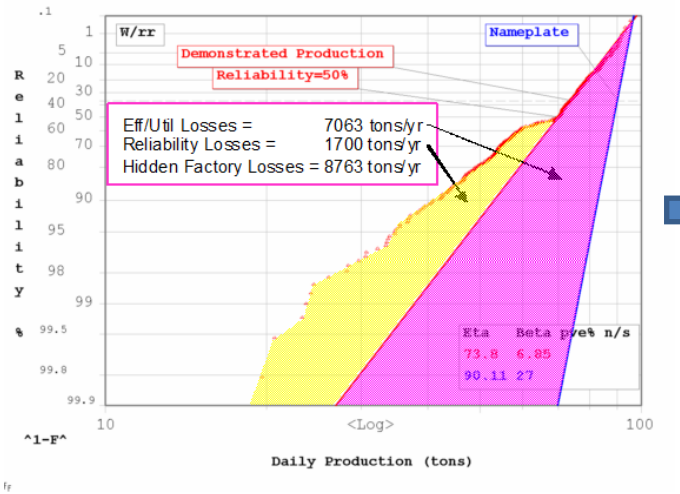

Reliability Losses (1,700 Ton/year)

Efficiency and Utilization Losses (7,063 Ton/year)

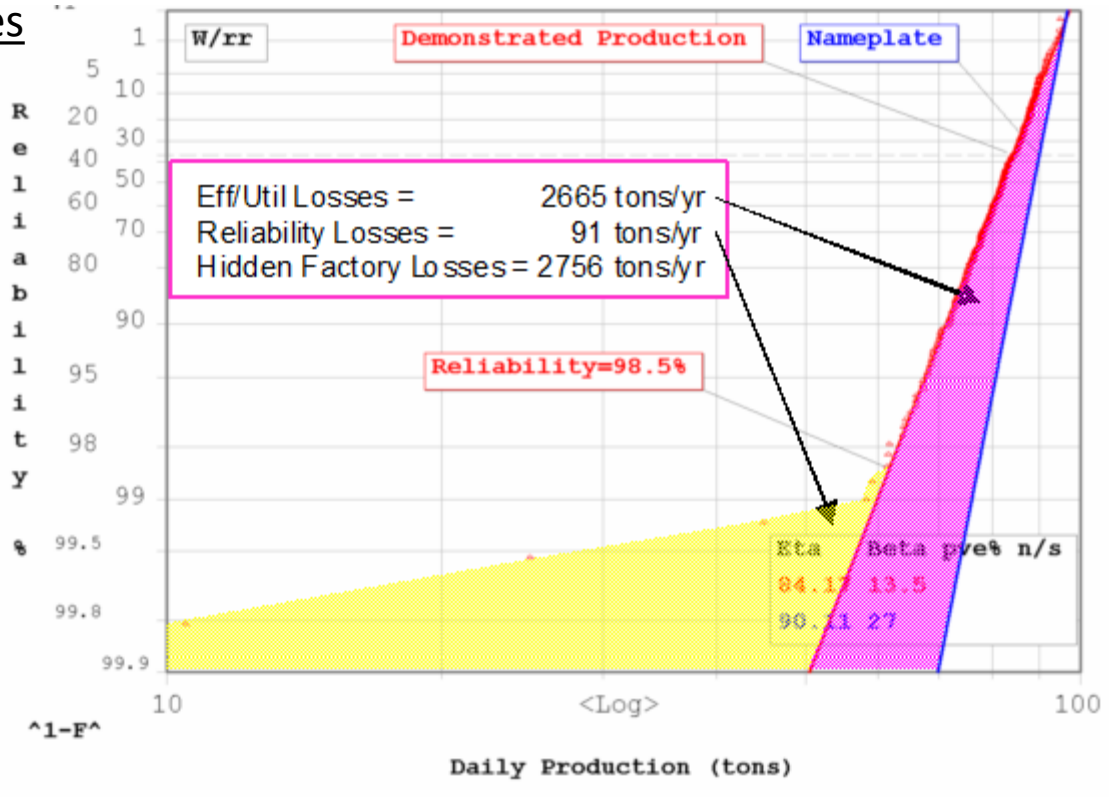
- Factory Report Card on one sheet of paper
- Concept of "Hidden Factory" (e.g. total loss of 1,700+7,063=8,763 Ton/year)

# Example 5 - Continued

Before Improvement to reduce losses



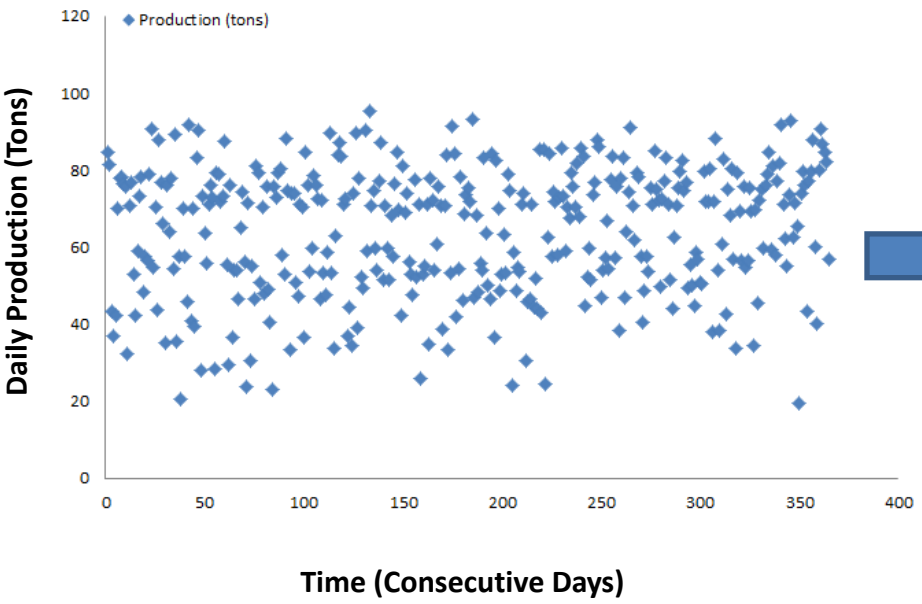

After Improvement to reduce losses




- Gain illustrated by reduction in Reliability and E&U losses
- Hidden Factory Gain of 6,007 Tons per year

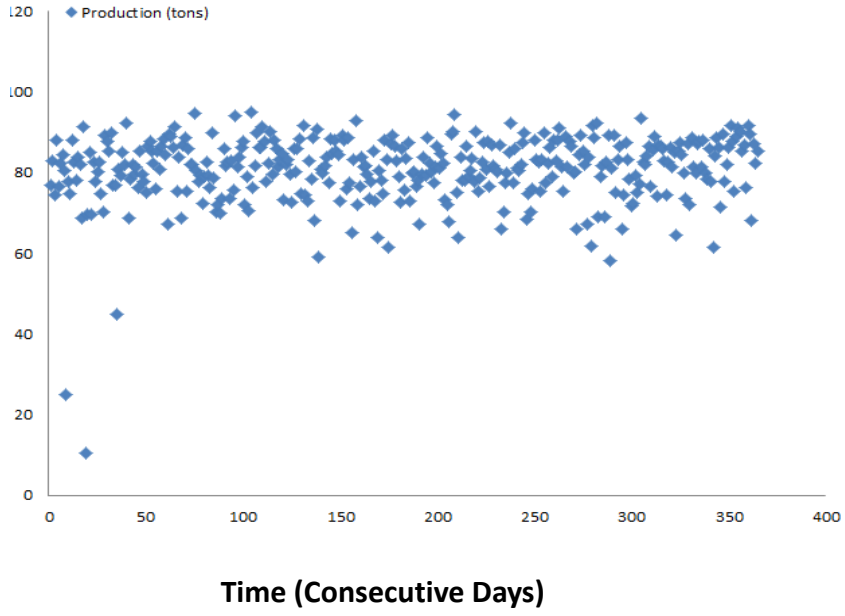
# Example 5- continued

Before Improvement to reduce losses



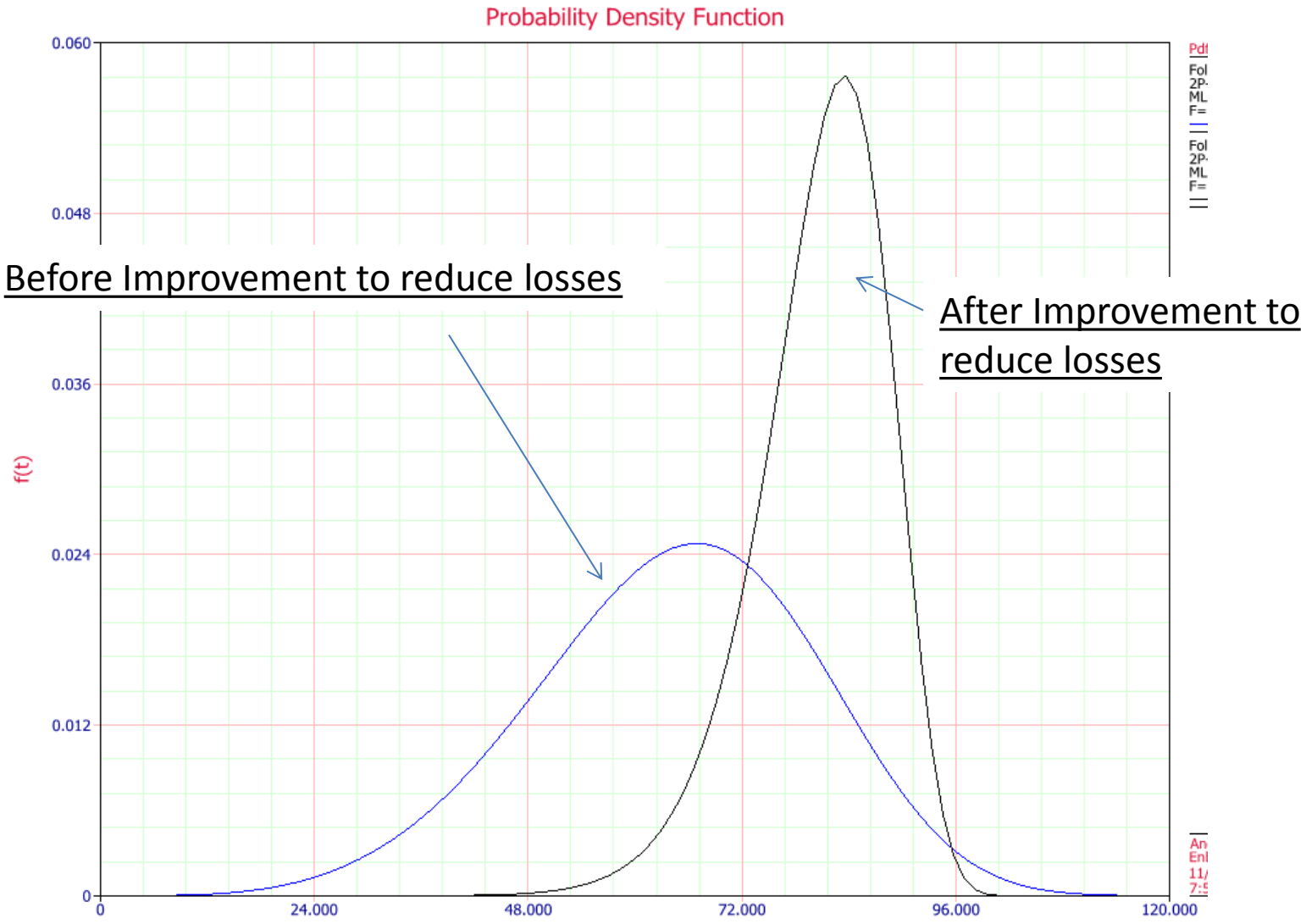

Characteristic Production Value = 74 Tons

After Improvement




Characteristic Production Value = 84 Tons
+ improved consistency in output

# Example 5 - continued



# Reliability KPIs (Examples)

- Probability of Success or Failure (with confidence bounds)
- Probability of Achieving Output Values
- Bad Actor Paretos
- % Utilization of Asset
- Failure Rate (Improving / Stable / Deteriorating)
- Mean Failures in Defined Period
- Number of Items to be Tested
- Estimated Life Cycle
- Inherent Availability
- Process Reliability

# Type of Data useful for a Reliability Analysis?

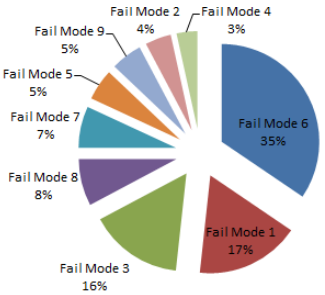
- Definition of the failure (What is the deviation from a Required Functionality? *aka Failure M*ode)
- Production Data (e.g. tons per day)
- Failure Data (What and When did it fail?)
- Maintenance Data (When was it maintained?)
- System Data (What is the system made up of?)

What is missing?

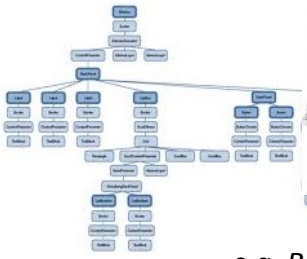
# Reliability Engineering Toolkit

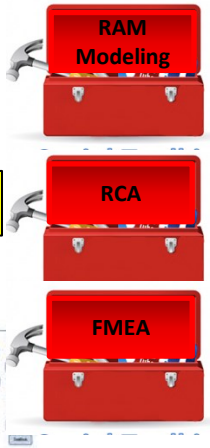

Data Library

Define/Quantify the Problem




Structured Analysis






*e.g. Root Cause Analysis*

NOT OK - NEEDS MORE WORK

OK - GO TO NEXT ISSUE

Check Effectiveness of Solution

Define and Implement Effective Solution




# Reliability Resources

- ASQ – Certified Reliability Engineer Program
- Conferences
  - Reliability and Maintainability conference (RAMS)
  - Applied Reliability Symposium (ARS)
- Webinars: www.thinkreliability.com
- General informational and tools: http://reliawiki.org/index.php/Main_Page
- Reliability WEB, source for lots of knowledge base information on Reliability http://www.reliabilityweb.com
  - Specifically 58 Tools by Paul Barringer http://www.reliabilityweb.com/art07/reliability_tools.htm
- ISO 55000-01 – Asset Management Standard (PAS 55 http://pas55.net/)

# The last word…

- Reliability is a journey, not achieved in one day
- Reliability (Like Quality and Safety) is everyone's business
- Data and Factual evidence a key to any good analysis
- The ultimate goal is to be in control of your asset rather than the other way round

# Thank-you for your time