Manufacturing Reliability – What Is It and Why Should I Care

Aron Brall, CRE
SRS Technologies
Tutorial Outline – Manufacturing Reliability

- Introduction
- Why Manufacturing Reliability?
- Background
- Specification of Manufacturing Reliability
- Methodologies
- Reliability Improvement/Growth
Introduction

- Manufacturing Reliability is still in its youth
  - Initial efforts in 1987
  - Broad based Industry effort started in 1993-94
Methodologies and results are mixed

Desired performance does not generally meet actual performance

- In some cases, actual performance is 50% of desired performance or worse
- Good Problem Identification, Root Cause Analysis, and Effective Corrective Action is a necessity
Why Manufacturing Reliability?

- Product Quality and Reliability are impacted by the performance of manufacturing equipment
  - Failed machinery may hide failures until significant defective or scrap material is produced
  - Machines blocked or starved by down machines may need significant warm-up time until capable of producing quality parts
- Production Costs are significantly affected by Machinery unreliability
  - Unless adequate “float” is provided in production line, 1 minute of downtime in each machine is one minute of lost production for the entire line
Specification of Manufacturing Reliability

- MTBF/MTTR
- % Uptime
- Availability
  - Inherent
  - Operational
  - Equipment
  - Technical
MTBF/MTTR

- Not well understood by Manufacturing Personnel
- MTBF thought to be “Minimum” time between failures
  - Actually Mean Time Between Failures
- MTTR thought to be “Maximum” time to restore
  - Actually Mean Time to Restore
- Inappropriate for manufacturing equipment
  - Failure rate of machinery not exponential
  - Two disparate distributions make up failure rate
    - Operational events – chip collecting, misloads, etc.
      - High failure rate, low restore times
    - Hardware failures
      - Low failure rate, long restore times
% Uptime - 1

- Concept is understood by most manufacturing personnel
- Describes reliability performance as desired outcome
- Generally unambiguous
  - Administrative time may be an issue
    - Administrative time includes meeting time, lunch and break time
- Deals with disparate failure and repair distributions
  - Uptime is a direct measure of manufacturing time and is distribution independent
Issues with defining:

- Scheduled time
- Unscheduled time
- Preventive maintenance time
- Uptime
- Downtime

Ambiguous or non-consensus definitions lead to conflict, confusion, and wasted efforts
Production Availability Time - AMT

TOTAL TIME (A)
- PLANT SHUT-DOWN (B)
- PLANT OPERATING TIME (C)
  - SCHEDULED DOWNTIME (D)
  - SCHEDULED OPERATING TIME (E)
- DELAY TIME (F)
  - REPAIR TIME (H)
  - NOT IN-CYCLE PROCESS TIME (I)
- PRODUCTION TIME (I)
  - IN-CYCLE TIME (K)
  - POTENTIAL PRODUCTION TIME (G)
Availability

- **Inherent Availability**
  - Not well understood by Manufacturing personnel
  - excludes all delay time & non-hardware failures
  - Inappropriate to manufacturing
    - Manufacturing has large numbers of “Events”
  - Academic exercise
    - Not a practical measure
  - \( A_i = \frac{MTBF}{MTBF + MTTR} \)
  - Non-exponential MTBF results in availability dependent on operating time
Operational Availability

- Should be identical with % Uptime
- Difficulties in interpretation of scheduled time, unscheduled time, administrative time, etc.

\[ A_o = \frac{Uptime}{Scheduled\ Time} \]
Equipment Availability

- Specified definitions for all time categories by AMT Guideline
- When all parties agree to use, reduces disagreements and confusion

\[
\text{Equipment \_ Availability} = \frac{\text{Scheduled \_ Operating \_ Time} - \text{Repair \_ Time} - \text{Delay \_ Time}}{\text{Total \_ Time} - \text{Shut \_ Down} - \text{Scheduled \_ Downtime} - \text{Delay \_ Time}}
\]
Availability - 4

- Technical Availability
  - Specified by some European companies
  - Somewhere between inherent and operational
  - Has ambiguities
Reliability Improvement/Growth

- Unless significant changes in Design and/or Process are implemented, Reliability Improvement in manufacturing equipment is due to removal of defective components, infant mortality, training inadequacies, and workmanship errors
  - Incremental reductions in downtime (10% to 5%)
- Major process and/or design changes can dramatically effect reliability
  - Tenfold reduction in downtime (10% to 1%)
Keys to High Manufacturing Reliability

- Understand the Process
  - Over 90% of Downtime can be due to process issues
- Simplify the Design
  - Fewer parts provide fewer items to fail
  - Replace wear items with software
- Derate
  - Robust designs with large margins have significantly lower failure rates
- Make it Maintainable
  - Easy maintenance can significantly reduce downtime
- Use Preventive and Predictive Maintenance
  - Planned Maintenance is less costly and more time effective than unscheduled corrective maintenance
Summary

- Manufacturing reliability is still in development
- Manufacturing Reliability addresses lost time in production
- The absence of rigorous guidelines produces conflicts and confusion
- Simplicity in methods and terminology provides the entry to improving manufacturing Reliability
- Robust designs, understanding processes, and planned maintenance provide increased reliability