
Manufacturing Reliability – What Is It and Why Should I Care

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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
 - NCMS/SAE R&M Guideline for Manufacturing Equipment published 1994, Second Edition published 1999
 - AMT Production Availability Guideline published in 1995, Second Edition published 2000



Introduction - 2

- 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

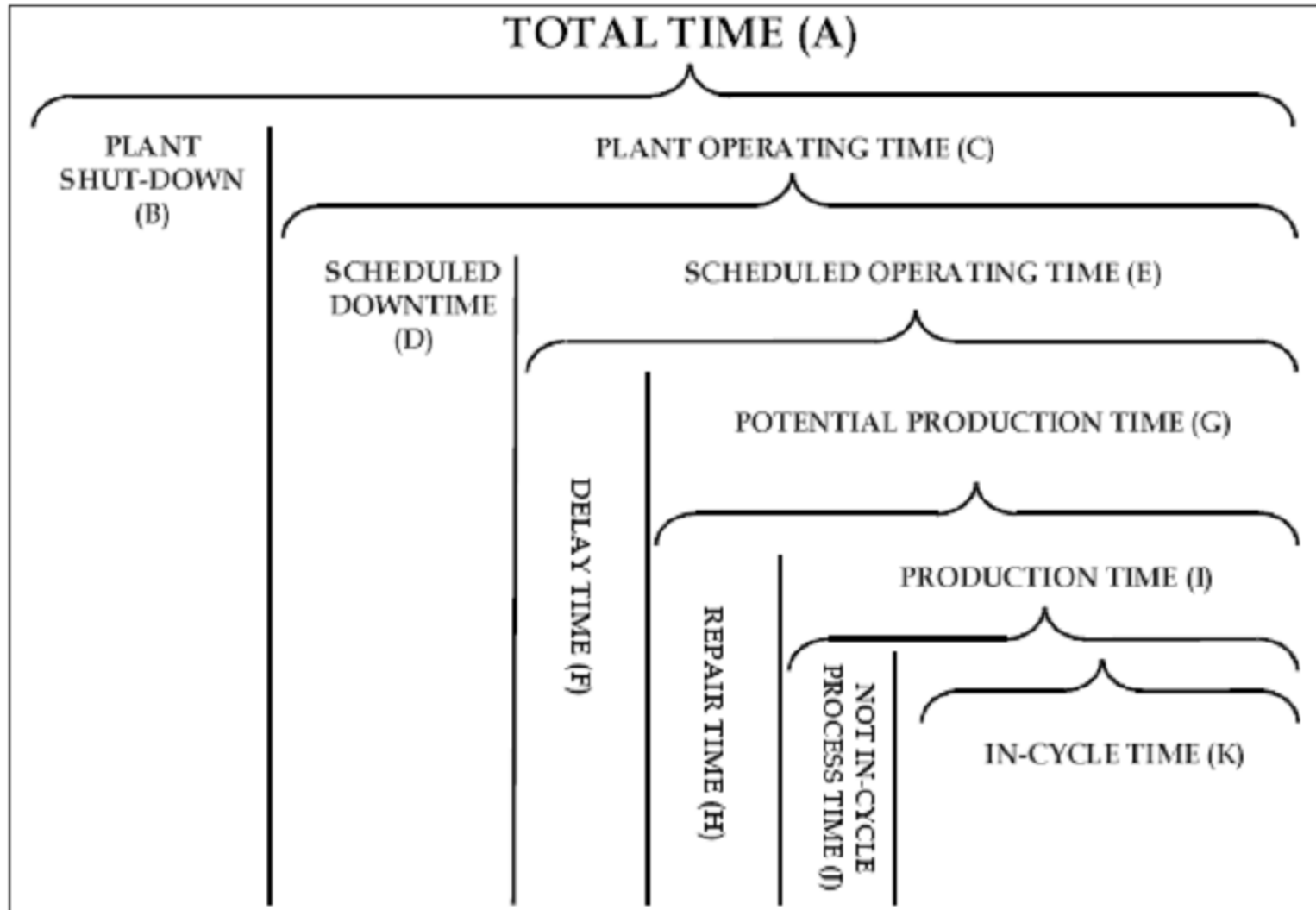


% Uptime - 2

- 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



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



Availability - 2

■ Operational Availability

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

- $$A_o = \frac{Uptime}{Scheduled_Time}$$



Availability - 3

■ 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

