General notes:

- Textbook: Maintenance, Replacement, and Reliability (2nd Edition)
    - Will be needed, course will follow textbook

EMEC-0538-WB: Maintenance Decision Analysis

- Course outline has already been emailed out
- First 5 weeks; tutorial class to be used as a lecture
- Group presentation (groups of 4-5), in-class presentation and report required.
    - Report is no longer required, just need to submit PowerPoint slides (last time this class is being offered)

Chapter 1: Introduction

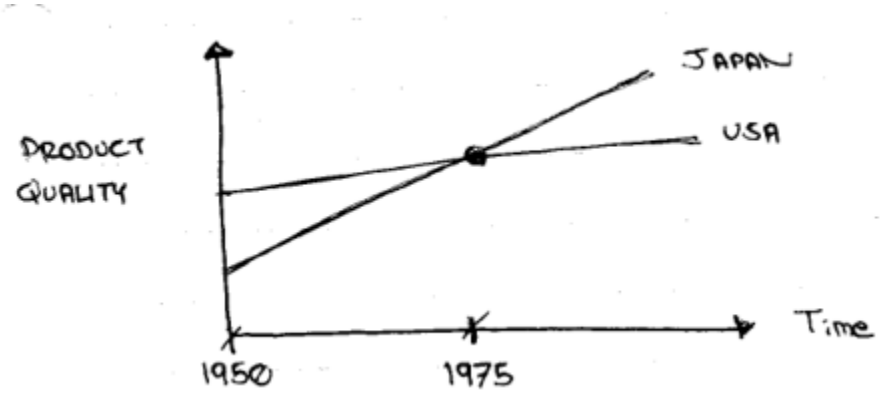
Definition: A formal definition of maintenance is that a function of manufacturing management that is concerned with day-to-day problems of keeping the physical plant in good operating condition.

But maintenance is not limited to manufacturing, so, there are many definitions:
"all actions necessary for retaining an item, or restoring it, a serviceable condition, including, servicing, repair, modification, overhaul, inspection and condition verification."

Maintenance and reliability
" The objective of maintenance and reliability is to maintain the capability of the system while controlling costs."

"Maintenance is all activities involved in keeping a systems equipment in working order."

"Reliability is the probability that a machine will function properly for a specified amount of time."



Consider:

- Kaizen improvement
- Decline of US auto
- Steady improvement of Japanese automakers

"Maintenance is the combination of all technical, administrative, and management actions during the life cycle of an item intended to retain it in, or restore it to, a state in which it may perform the required function" (CEN 2001). CEN stands for European Committee for Standardization.

Maintenance Engineering and Maintenance
US Department of defence sees maintenance engineering as a discipline that assists in acquisition of resources in performing or accomplishing maintenance.

In contrast, maintenance activities are viewed as those that use resources in physically performing those actions and tasks attendant on the equipment maintenance function for test, servicing, repair, calibration, overhaul, modification, and so on.

Maintenance engineering is an analytical function as well as it is deliberate and methodical.

In contrast, maintenance is a function that must be performed under normally adverse circumstances and stress, and its main objective is to rapidly restore the equipment to its operational readiness state using available resources.

Objectives of maintenance engineering:

- Improves maintenance operations
- Reduce the frequency and amount of maintenance
- Reduce the effect of complexity
- Reduce the maintenance skills required
- Establish optimum frequency and extent of preventative maintenance to be carried out.
- Improve and ensure maximum utilization of maintenance facilities.
- Improve maintenance organization.

The scope of modern maintenance management covers every stage in the life cycle of technical systems (plant, machinery, equipment and facilities):

- Specification
- Acquisition
- Planning
- Operating
- Performance evaluation
- Improvement
- Disposed

When perceived in this wider context, the maintenance function is also known as Physical Asset Management (PAM). The performance demanded of PAM has become more challenging as a result of four developments these days.

1. <u>Emerging Trends of Operation Strategies</u>

- The concept of economy of scale is losing scale
- An increasing number of organizations have switched to lean manufacturing, just-in-time production, and six-sigma operations.
- Shift of emphasis from volume to quick response, elimination of waste, reduced stock holding, and defect prevention.
- Installation of the right equipment and facilities optimization of maintenance of these assets, and the effective deployment of staff to perform maintenance activities are crucial factors to support these operation strategies.

2. <u>Toughening Societal Expectations</u>

- Widespread acceptance, at least in the developed countries
- Of the need to preserve essential services
- Protect the environment
- Safeguard people's safety and health

So,

- Wide range of regulations have been enacted in these countries to control industrial pollution and prevent accidents in the workplace.

Scrap, defects, and inefficient use of materials and energy are source of pollution.

- They are often the result of operating plant and facilities under less than optimal conditions.

Keeping facilities in optimal condition and preventing critical failures are effective means of managing the risks of service interruptions, pollution, and industrial accidents.

3. Technological Changes

With technology changing at a breathtaking rate, the condition of equipment can be monitored continuously or intermittently while it is in operation.

This has given birth to condition-based maintenance (CBM), an alternative to the classis preventative maintenance.

The development of new technologies is instrumental to enhancing system availability, improving cost-effectiveness, and delivering better or innovative services to customers.

4. Increased emphasis on sustainability

Sustainability demands all developments to "meet the needs of present without compromising the ability of future generations to meet their own needs."

Total cost of ownership, life cycle performance, energy consumption, and safety are the parameters that can be effectively optimized by the application of appropriate methodologies of and tools for PAM.

Improvement in PAM can be accompanied by:

- Having a clear strategy
- The right people and systems
- Appropriate tactics
- Controlled work through planning and scheduling, maintenance optimization, and process engineering.

A survey of maintenance budgets ranged from 2% to 90% of the total planned operating budget, with average being 20.8%.

Maintenance excellence is concerned with balancing:

- Performance
- Risks
- And resource impacts to achieve optimal solutions

Structured approach to achieving & maintaining excellence:

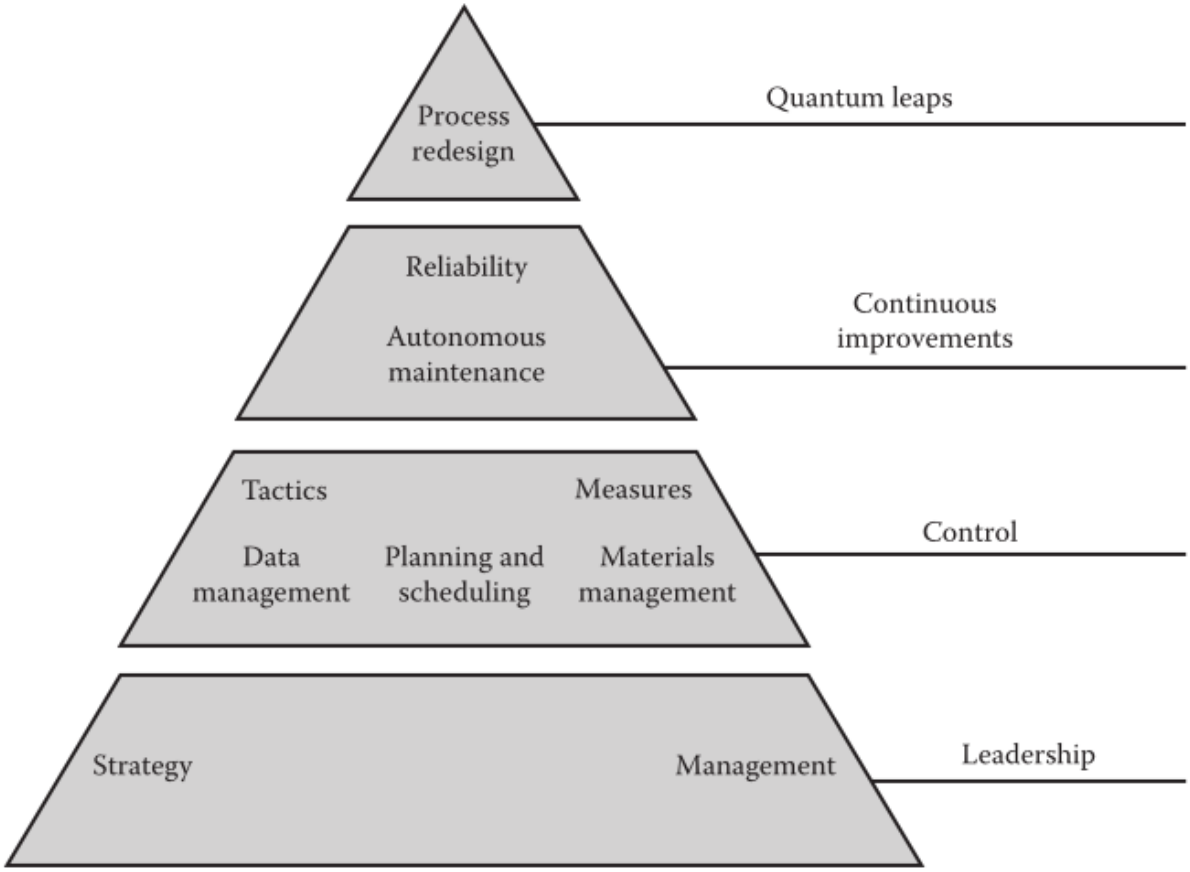


FIGURE 1.1 Structured approach to achieving maintenance excellence.

Tactical options:
- Time-based maintenance actions
- Time-based discord
- Condition-based monitoring (CBM)
- Run-to-failure
- Fault-finding tests

Continuous improvement:
- Two complementary methodologies to enhance the reliability (up time) of physical assets.
- Total productive management (TPM)
- Reliability centered management (RCM)
- TPM is people-centered
- RCM is asset-centered

PAS 5S: a framework for optimized management of physical assets.

PAS 5S is a publicly available specification, the status of which is between codes of standards and ISO standards.
It offers a framework for a holistic, systematic approach to optimize the management of physical assets.

PAS 5S-1 - Asset management Part I: Specification for the optimized management of physical assets.
PAS 5S-2 - Asset management Part II: Guidance for the application of PAS 5S-1.

PAS 5S is not sector specific. It is applicable to organizations with any type of distribution of physical assets and asset ownership structure.
Reliability through the operator: Total productive maintenance (TPM)

TPM is a people-centered methodology.

It has been proven to be effective for optimizing equipment effectiveness and eliminating breakdowns. It mobilizes the machine operators to play an active role in maintenance work by cultivating in these frontline workers a sense of ownership of facilities they operate, and enlarging their job facilities to include routine servicing and minor repair of these machines.

Through this type of operation participation in maintenance activities, TPM aims to eliminate the six big losses of equipment effectiveness:

- Breakdown
- Setup and adjustment
- Idling and minor stoppages
- Reduced speed
- Defects in process
- Reduced yield