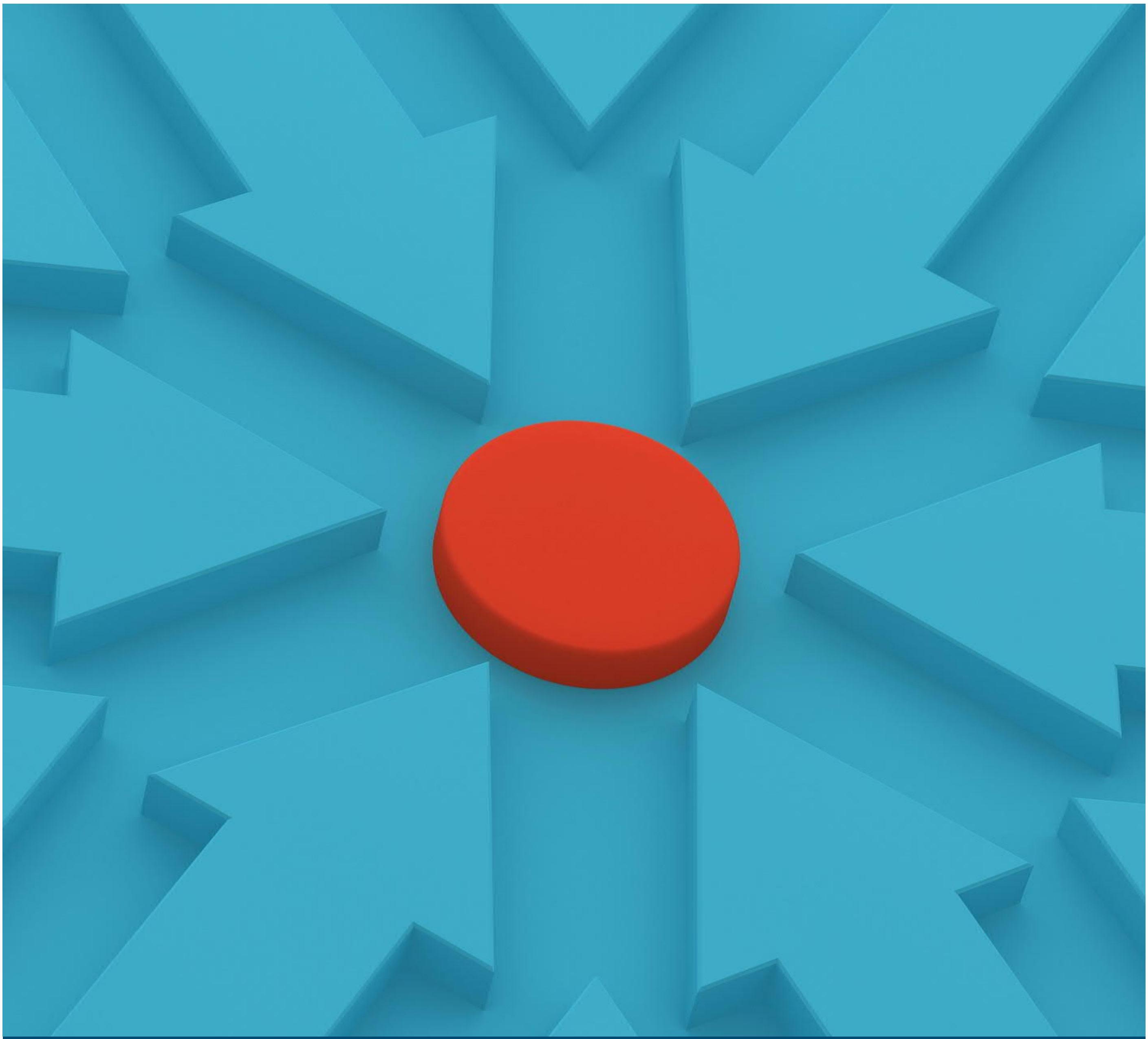

DYNAMIC. PERSPECTIVE. MAINTENANCE.

ARTICLE SERIES - 1

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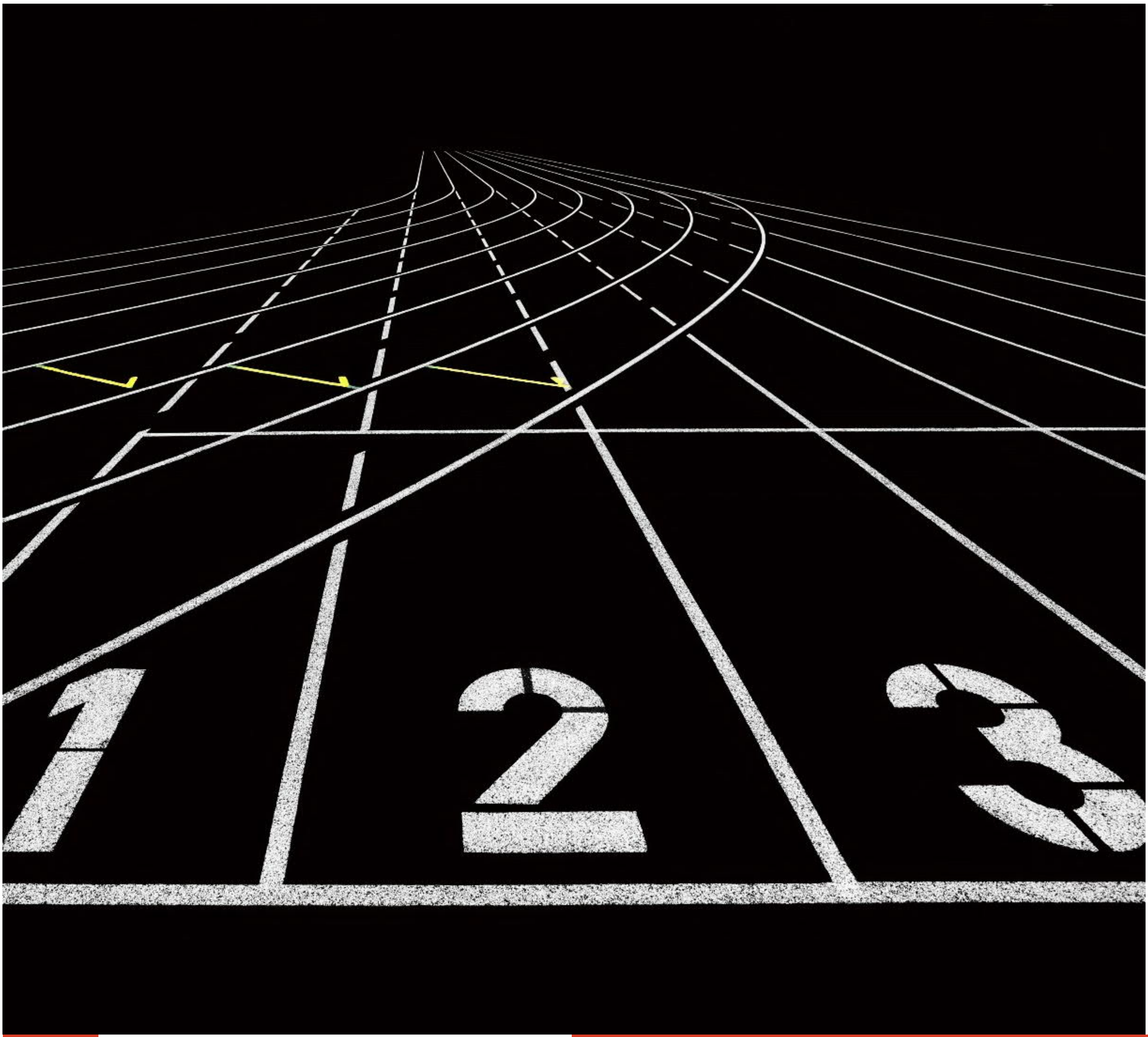


ARTICLE 1.1: CONVENTIONAL MAINTENANCE

LEVEL: BASIC

Dynamic Perspective Maintenance (D.P.M.) is a philosophy that guides transformation from conventional maintenance and embrace digitalization.

To understand D.P.M., series of articles have been published, catering Basic, Intermediate, and Advanced levels of knowledge sharing. Concept is briefly described. Emphasis is actual implementation & field / plant usage with best results. Conventional maintenance article describes the various practices applied at operating plants & organizations.

LET’S COMMENCE WITH THE IMPORTANCE OF “DATA ANALYTICS & MAINTENANCE “

Data analytics based decision-process has revolutionized Maintenance concept. Future failures are forecasted. Restoration is planned well in advance. Breakdown can be eliminated, and no need to perform routine tasks that has no value. Finally implementation of “Just-in-time” (JIT) maintenance could be a reality.
“Dynamic prescriptive maintenance (D.P.M.)” is a methodology that can transform traditional maintenance-model into empowered strategy to focus on maximizing return-on-investment.

ARTICLE 1.1

AIM: FAMILIARIZE CURRENT STRATEGIES.

A COMPLETE UNDERSTANDING OF CONVENTIONAL MAINTENANCE IS FUNDAMENTAL BEFORE CONSIDERING DIGITAL TRANSFORMATION.

OBJECTIVE: WE INTEND TO UNDESTAND -

- the migration from conventional maintenance to digital world of excellence;
- the journey of maintenance from “being necessary evil” to profit-center;
- how static strategy can be transformed to dynamic decision making process; and
- application of artificial intelligence-based data analytics on historical & near-real-time database.

Note

The fundamentals, basic understanding and implementation methodologies have been explained in structured format. It starts with description of simplified concepts, and complexity grows gradually. For the digital transformation, step-wise application protocol has been developed, that can be applied without external assistance. The coding has been open-sourced, for developing in-house program. D.P.M tool software tool is also available, along with user manual, training & technical support, and can interface with client server (either on cloud, or desktop version). Rule engine libraries are available with software, with provision of upgraded version releases and Subject matter domain Inputs.

ARTICLE-1.1: CONVENTIONAL MAINTENANCE

Maintenance is a process of up-keeping an asset, condition, or state, to ensure full functional capabilities over its life-cycle, by cost-effective utilization of resources.

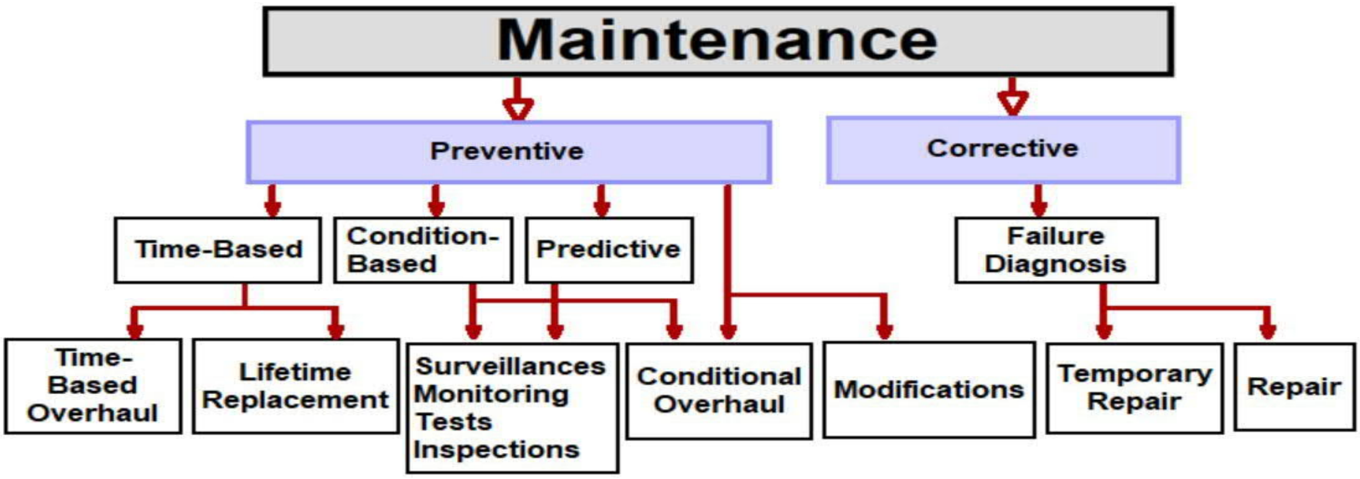
In a Process industry, the equipment and facilities perform specific functions. These are usually complex machineries and assets. Specialized supports are required to maintain, replace, or overhaul. Ineffective maintenance causes failures. And failure leads to significant financial loss & safety consequences.

Conventional Maintenance Practices:

Maintenance process is generally categorized into

1. Unplanned Maintenance -
   - 1.1 Reactive – Principle: Repair when failed
2. Planned Maintenance -
   - 2.1 Preventive – Principle: Perform time-based defined tasks; and
   - 2.2 Predictive – Principle: Analyze, predict & perform task, when necessary

Maintenance strategies can also be expressed as
1. Preventive; and
2. Corrective



1. Reactive maintenance—

Characterized by practices such as
- run to fail, breakdown, and emergency maintenance.
- unplanned and urgent.

Reactive maintenance levels for typical plant is 50%+, while the benchmark plants have <10%.
- Reactive maintenance at levels beyond about 20% to 30% should normally be considered a practice to avoid in most plants, or a “worst practice”.
  - Reactive maintenance tends to cost more (routinely twice as much as planned maintenance) and leads to longer periods of downtime.
  - Reactive maintenance practices for general rotating machinery cost some 30% more than preventive maintenance practices, and 100% more than predictive maintenance practices

2. Preventive maintenance (time based)—

Characterized by practices that are

- periodic and prescribed.
  - Examples: annual / quarterly / monthly / weekly tasks.

A program dominated by a PM, or time-based, maintenance strategy is not likely to provide for world-class maintenance performance

Check sheet: Determine PM Necessity

Critically analyze your PMs in each category, or for a particular machine or equipment. The fundamental question that must be asked—Is the PM task necessary?

Sl.No.	Description of Question	Y/N
1	Does it help me detect onset of failure so that I can manage a developing problem (e.g., inspections, predictive maintenance, process condition monitoring, etc.)?	
2	Does it help me avoid premature failure or extend equipment life (e.g., oil and filter changes, lubrication, cleaning, tightening, simple care, etc.)?	
3	Is it related to a known, consistent, wear- or age-related failure mode (e.g., brushes on a DC motor failing every 10 months, periodic corrosion, etc.)?	
4	Is it a statutory requirement that I must do (e.g., boiler inspections, pressure vessel inspections, etc.)?	
5	Is it driven by some other mandatory requirement?	

Check sheet: Analyze Your PMs

Sl.No.	Description of Question	Y/N
1	How often do I need to do this PM and why? Is it based on an equipment failure/history analysis? A known failure rate? My best judgment? Regulatory requirements?	
2	For inspections and condition monitoring, what is your current "hit rate"—number of inspections resulting in detecting a problem requiring action? Is that sufficient?	
3	Should the PM frequency be extended or reduced? Based on histories, "hit rate," trends, Pareto/cost analysis, experience?	
4	What is the consequence of failure? For example, more serious or costly consequences dictate more frequent inspections, greater design and operational attention to detail, or other actions.	
5	Could the need for certain PMs be mitigated or validated using condition monitoring or inspections to verify their need?	
6	Could certain PMs be consolidated? Could several PMs on one machine/process be done at the same time, vs. revisiting the machine/process frequently for "single" PMs?	
7	Do we need to take any proactive steps to avoid the PM, or failures, altogether, e.g., better design, procurement, installation, commissioning, startup, joint making, alignment and balancing, and so on, to support improved reliability or maintainability and extend equipment life? Define any actions needed, and next steps.	
8	Could certain PMs be done by operators to avoid or detect onset of failure? Define the process for this. Which issues or obstacles must be considered—safety, training, union, plant culture?	
9	Finally, are there other failures known where PM tasks need to be added to detect or avoid those failures?	

Reference: Moore, Ron "Making Common Sense Common Practice" *Elsevier Butterworth–Heinemann, 2004*

3. PREDICTIVE MAINTENANCE

- Condition based:

Characterized by practices that are
  - based on equipment condition.
    - Examples- changing a bearing long before it fails based on vibration analysis;
    - changing lubricant based on oil analysis showing excess wear particles;
    - replacing steam traps based on ultrasonic analysis;
    - cleaning a heat exchanger based on pressure-drop readings;
    - replacing a cutting tool based on deterioration in product quality, etc.

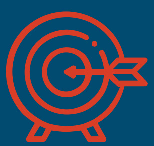
This is an essential part of a good reliability program. Knowing equipment and machinery condition, through the application of vibration, oil, infrared, ultrasonic, motor current, and perhaps most importantly, process trending technologies, drives world-class reliability practices, and ensures maximum reliability and uptime.

Predictive maintenance strategies when well-implemented are usually most cost-effective.

Case study-1: Rotating equipment – Compressor

Typical Predictive Maintenance routines-
1. Vibration levels in all frequency bands and at all fault frequencies – compare to ISO acceptable value.
2. Oil analysis parameters, e.g., viscosity, viscosity index, additives, water, and wear particles.
3. Motor current readings - in-rush current & normal operating current within normal limits on all phases.
4. Cross-phase impedance measurements on the motor to indicate inductive and resistive impedance within 5% and 3%, respectively, for all phases.
5. Infrared thermographer’s survey to indicate that the compressor had no unusual hot spots.
6. Ultrasonic leak detection to find leaks in the compressed air piping system.
7. Check operations logs:
   - Discharge pressures, temperatures, and flow rates – deviation from normal.
   - Moisture content in the instrument air.

At a glance



Reactive

run to fail, breakdown, and emergency maintenance, unplanned, urgent

Preventive

Periodic & prescribed

Predictive

Condition based