



THE 21ST INTERNATIONAL
OPERATIONS & MAINTENANCE
CONFERENCE IN THE ARAB COUNTRIES

THE IMPORTANCE AND TYPES OF MAINTENANCE EDUCATION AND TRAINING TO MEET THE FUTURE NEEDS

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Outline

- Introduction
- Issues of Maintenance
- Maintenance Training Programs
- Return on Investment in Maintenance Training
- Maintenance Future Needs



Introduction

Maintenance is a key function in sustaining **long-term profitability** for organizations.



With the rapid advancement of technology and its integration into facilities, and with the continuously increasing levels of occupant requirements, and with organizations' demand for profitable business with less consumptions,

Deloitte is forecasting a shortage of 2.1 million skilled workers by 2030 in the manufacturing sector.

New set of training courses is deadly needed to upskill and prepare maintenance staff to meet future needs.





Introduction

Every organization has the challenge of inadequate maintenance training within their maintenance teams.



Introduction

Reducing Downtime

How training ensures faster identification and resolution of maintenance issues

Improving Safety

Highlighting the role of training in creating a safer work environment

Increasing Equipment Lifespan

Exploring how well-trained maintenance professionals can extend the lifespan of equipment



Issues of Maintenance



Unplanned downtime:

- It is the unexpected and unscheduled interruptions or stoppages of equipment or systems due to failures, breakdowns, or unforeseen issues.
- It is the period during which equipment or systems are unable to perform their intended functions, resulting in loss of productivity, revenue, and potential damages.



Issues of Maintenance

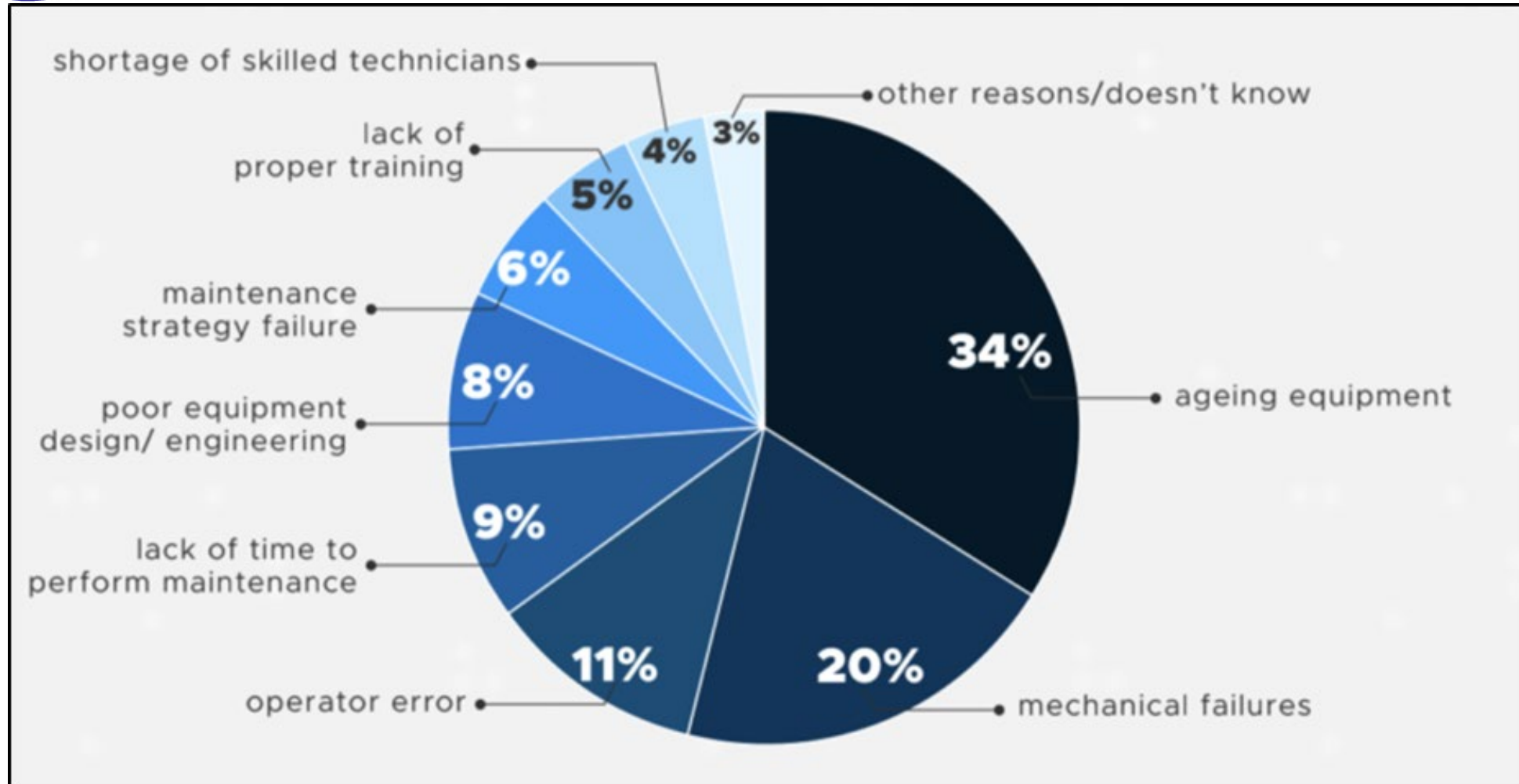


Unplanned downtime:

- According to Aberdeen Group, **60% of unplanned downtime** events are caused by the **lack of preventive maintenance planning**.
- Inadequate training or shortage of skilled maintenance personnel can also contribute to maintenance failures.
- According to ARC Advisory Group: **50% of asset failures** are due to **aging equipment**.



Issues of Maintenance





Maintenance Training Programs

Failure/Errors	Training Programs						
	Equipment-Specific Training	RCM Training	Predictive Maintenance Training	Preventive Maintenance Training	CMMS Training	Adaptability Training	Time Management Training
Shortage of skilled technicians	×					×	
Lack of proper training	×						
Maintenance Strategy Failure		×	×	×	×		
Poor equipment design/engineering	×					×	
Lack of time to perform maintenance					×		×
Operator Error	×					×	
Mechanical Failure	×						
Ageing Equipment		×			×		



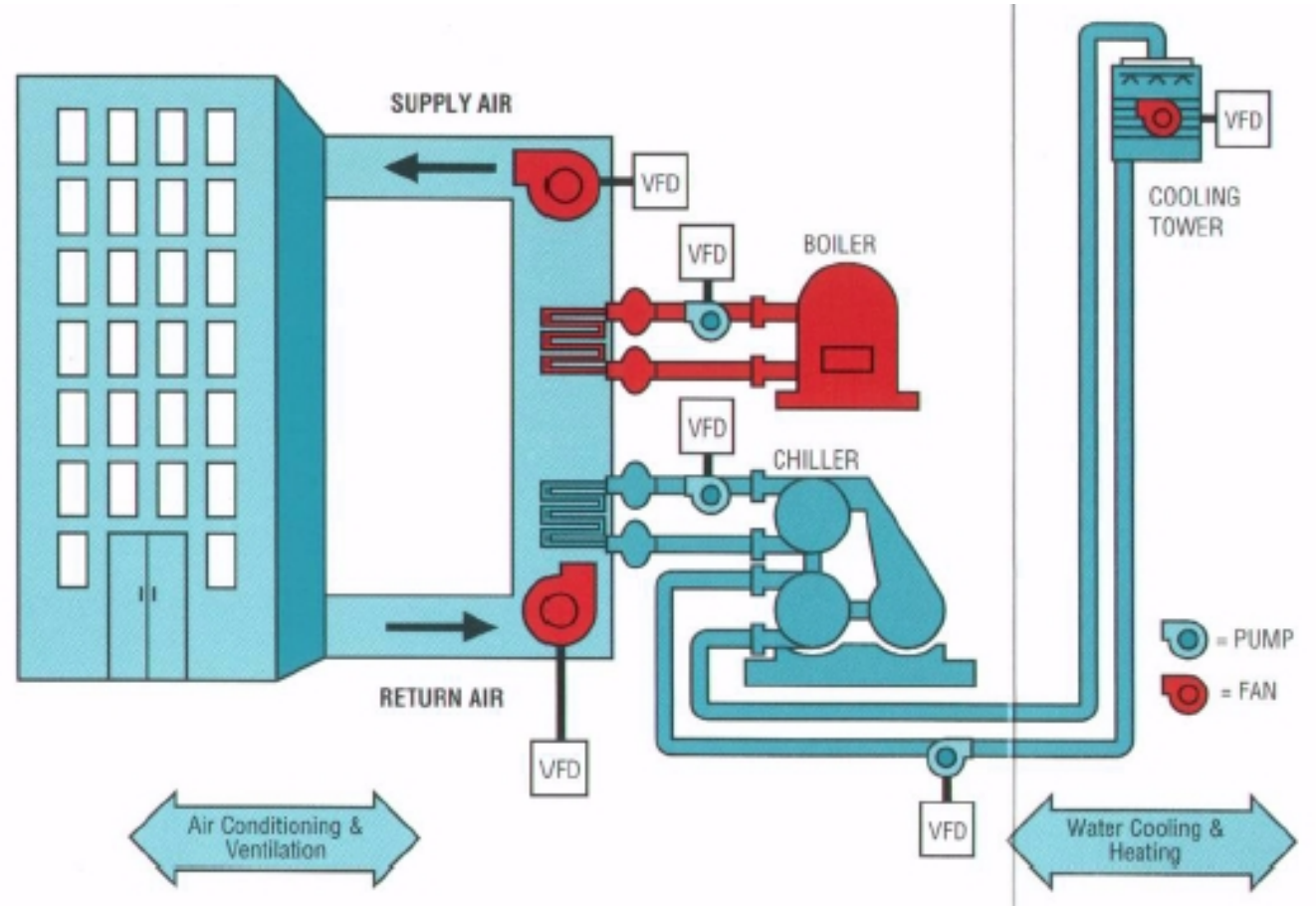
Maintenance Training Programs

1- Equipment-Specific Training:

This training focuses on teaching individuals how to operate, maintain, and troubleshoot specific types of machinery or equipment.

As per **Peerless Research Group (PRG)**, 2018, what FM says about their technicians:

- 29% of FM believe their technicians are “very prepared”.
- 45% of FM say their technicians are “somewhat prepared”.
- 26% of FM say their technicians are “**not at all prepared**”.





Maintenance Training Programs



2- Electrical and Occupational Health Safety Training:

Provides maintenance personnel with knowledge about electrical safety standards, safe work practices, and how to identify potential electrical hazards.

NFPA 70E: Electrical safety program tailored to their workplace's specific needs.

Prevention of Electrical Accidents by training maintenance staff on how to properly and safely execute electrical work have higher chances of preventing electrical accidents like electrical shocks, burns, or arc flashes.

Job Safety Analysis by assessing the risks of executing the works and identifying the mitigation measures and tools to avoid the accidents.



Maintenance Training Programs

3- Reliability-Centered Maintenance (RCM) Training:

RCM training introduces the concept of analyzing and optimizing maintenance strategies, failure modes, and risk assessment

- What are its functions?
- In what conditions can it fail?
- What causes it to fail?
- What happens when it fails??
- Does it matter if it fails?
- Can anything be done to prevent the failure?
- What if the failure cannot be prevented?





Maintenance Training Programs

4- Computerized Maintenance Management System (CMMS) Training:

CMMS training teaches individuals how to effectively use maintenance management software to:

- Streamline work orders,
- Track equipment history,
- Track maintenance trends metrics
- Manage spare parts inventory,
- Manage performance and KPI,
- Manage asset life cycle,
- Generate reports,
- Track cost,
- Track safety





Maintenance Training Programs



5- Time Management Training:

- This training ensures that tasks are completed in a timely manner, resources are utilized efficiently, and preventive maintenance activities are prioritized.
- It allows maintenance professionals to allocate their resources, including personnel, tools, and equipment.



Maintenance Training Programs

6- Preventive Maintenance Training:

This training empowers maintenance professionals with the necessary skills and knowledge to implement proactive maintenance strategies, improve equipment reliability, minimize downtime, and optimize maintenance resources efficiency.

- Regular inspection
- Adjustment and calibration
- Lubrication
- Cleaning
- Painting
- Replacement
- Minor repair
- Major repair

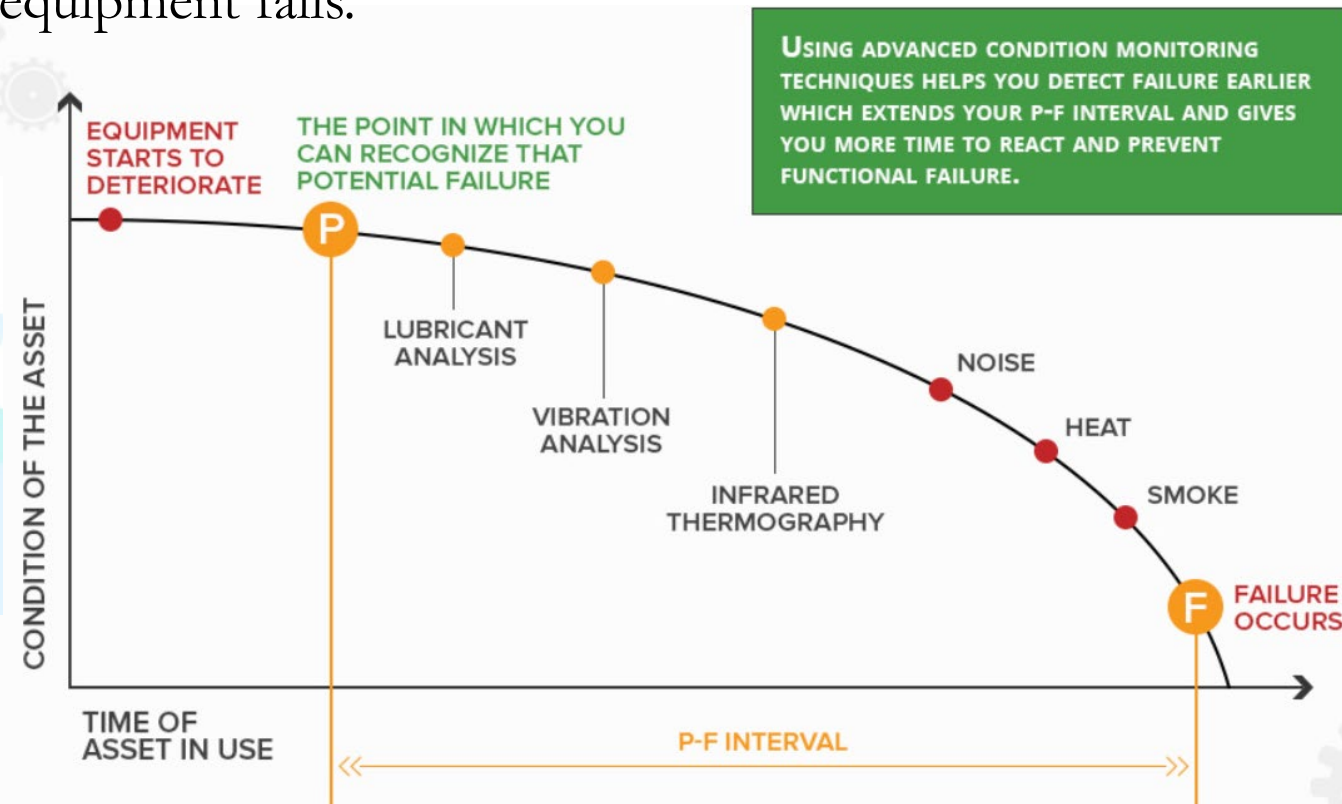
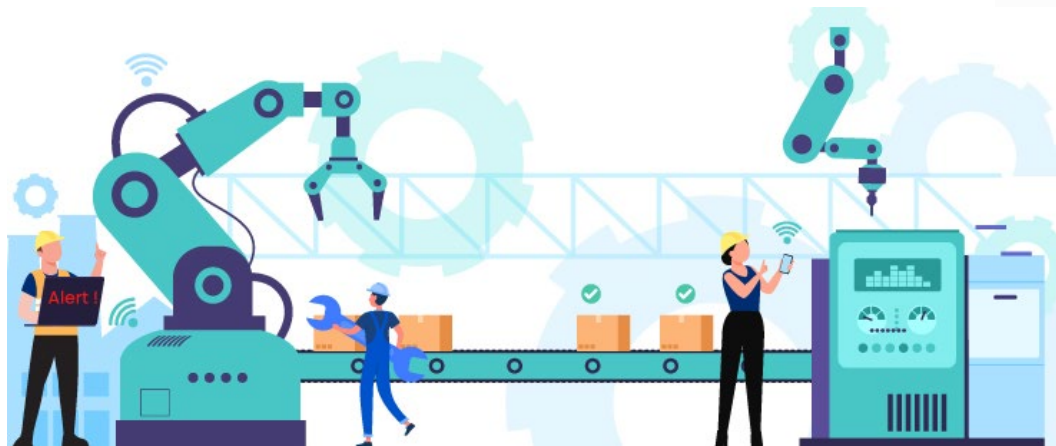




Maintenance Training Programs

7- Predictive Maintenance Training:

- Predictive maintenance is a technique built on condition based maintenance that uses data analysis tools and condition monitoring data, OEM recommendations, maintenance logs, and other data to build algorithms that can predict **WHEN** the equipment fails.





Maintenance Training Programs

8- Soft Skills Training:

Soft skills training can help maintenance staff:

- Customer service
- Effective communication,
- Teamwork,
- Problem-solving,
- Leadership skills,
- Time management,
- Stress management,
- Attention to details





Maintenance Training Programs



9- Industry Standards and Compliance:

Maintenance training ensures that professionals are aware of and trained in:

- Latest industry standards, regulations, and compliance requirements.
- Organization's regulations, policies, or adherence to laws.
- Information security and data protection
- Workplace anti-harassment
- HR compliance
- Environmental compliance



Maintenance Training Programs

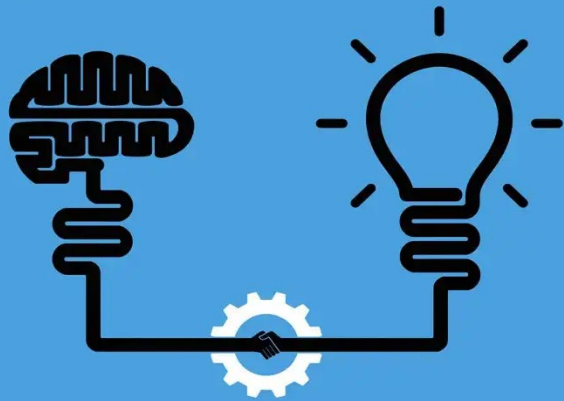
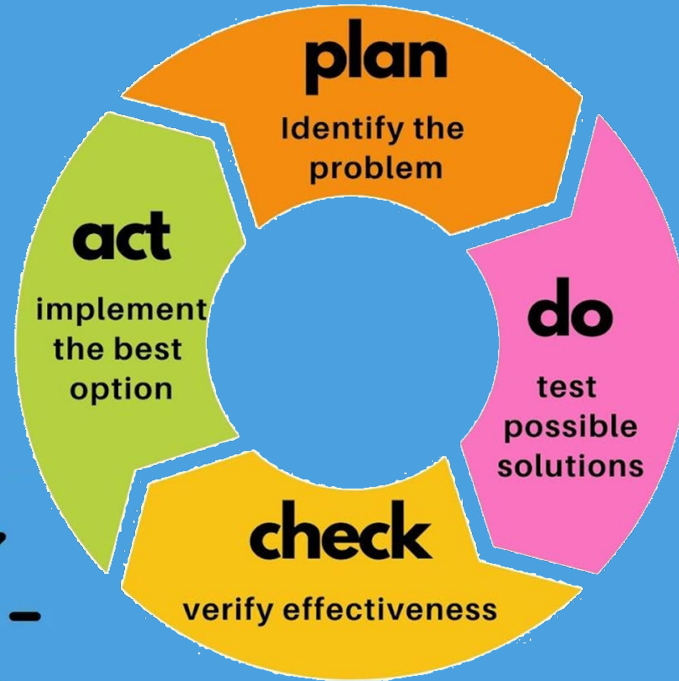
10- Adaptability and Flexibility:

Maintenance training promotes adaptability and flexibility by teaching:

- Ability to adjust to new methods, tools, and technologies
- Ability to quickly adapt to new challenges,
- Ability to learn new skills



Maintenance Training Programs



11- Innovation and Continuous Improvement:

Structured approach to developing the knowledge, skills, and mindset necessary for fostering creativity and generating new ideas. It equips maintenance staff with techniques and strategies to:

- Think critically,
- Solve problems,
- Approach challenges with an innovative mindset.
- View failures as learning opportunities,
- Continuously seek improvement,
- Individuals are motivated to fearlessly explore new ideas

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Effective Maintenance Training Techniques

Maximizing Learning Outcomes

Hands-on Practical Training

Providing real-world experience to enhance skills and confidence

Simulation and Virtual Training

Using technology to create realistic training scenarios

Mentorship and Job Shadowing

Pairing trainees with experienced professionals for on-the-job learning

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Return on Investment in Maintenance Training

- ROI in maintenance training refers to the **measurable benefits** and value that an organization receives from investing in training their maintenance personnel
- It assesses the **financial gain** or cost savings that can be attributed to the training program





Return on Investment in Maintenance Training

ROI calculations of training aim to answer two broadly similar questions:

- Are trainees gaining new knowledge and skills that they can increase efficiency and/or reduce costs in the workplace?
- Can we measure the cost of this training against the benefits to both the individuals and the organization?



Return on Investment in Maintenance Training

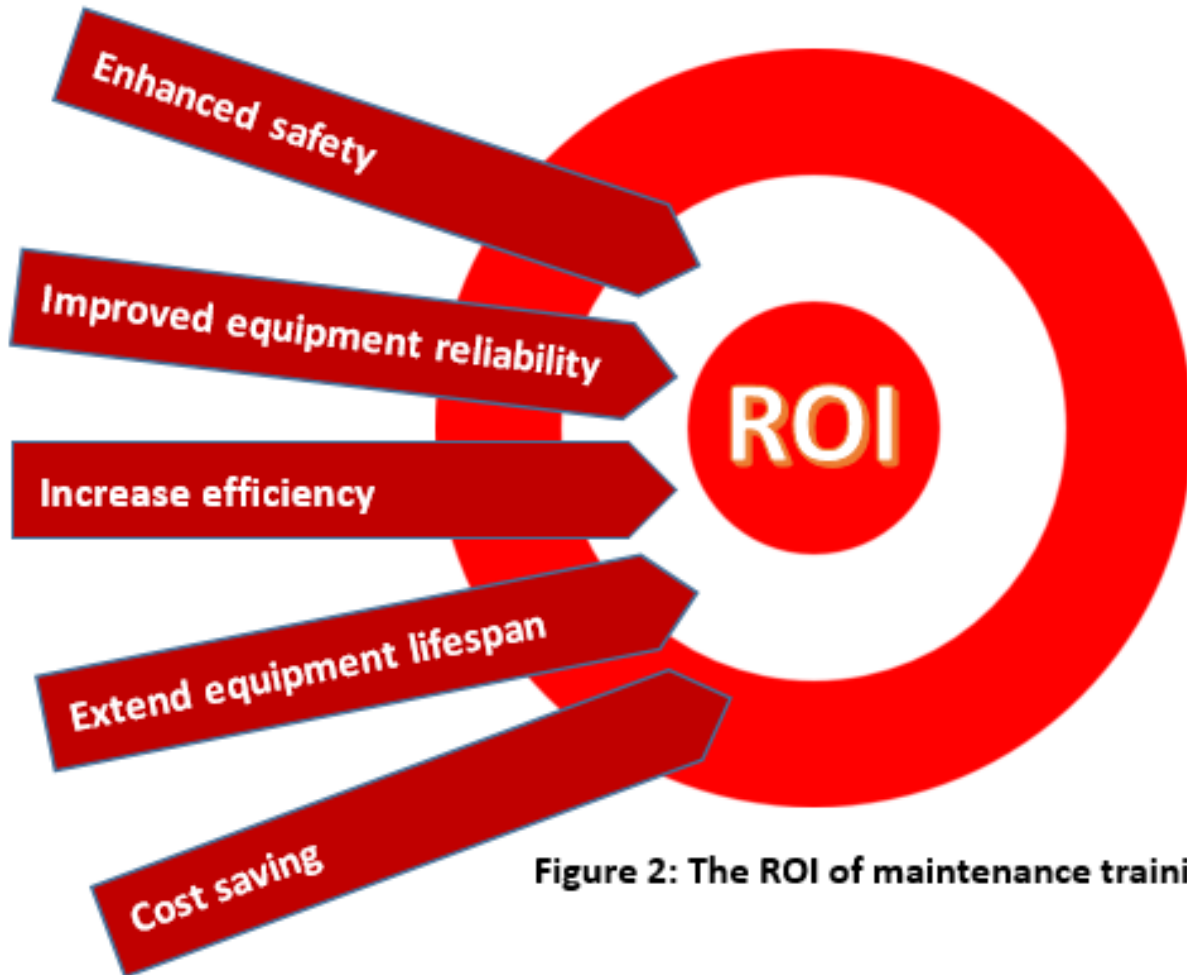


Figure 2: The ROI of maintenance training

How to calculate the ROI of maintenance training?

$$\text{ROI} = \frac{\text{Return (Benefit)}}{\text{Investment (Cost)}}$$



Return on Investment in Maintenance Training

Improved equipment reliability:

- Well-trained maintenance technicians can perform tasks more effectively, resulting in reduced downtime and increased productivity
- According to **Aberdeen Group**, organizations that invest in comprehensive maintenance training experience:
 - **20% average decrease in equipment downtime**
 - **30% reduction in emergency maintenance**



Return on Investment in Maintenance Training



Enhanced safety:

- The **Occupational Safety and Health Administration (OSHA)** reported that effective safety training programs can **reduce injury and illness costs by 20-40%**, resulting in significant savings for organizations
- By learning about hazard identification, proper use of personal protective equipment (PPE), and safe work procedures, individuals are better equipped to prevent accidents and minimize risks in the workplace



Return on Investment in Maintenance Training

Extended equipment lifespan:

- **Life Cycle Engineering** found that implementing a comprehensive maintenance training program resulted in:
- **60-70% increase in mean time between failures.**
- **35-45% reduction in corrective maintenance costs.**





Return on Investment in Maintenance Training



Increased efficiency:

- The **International Society of Automation** stated that organizations that invest in ongoing maintenance training see a **20-30% increase in workforce productivity**, as technicians are equipped with up-to-date skills and knowledge to perform tasks efficiently



Return on Investment in Maintenance Training

Cost savings:

- **Society for Maintenance and Reliability Professionals (SMRP)** stated that for every \$1 spent on maintenance training, companies can expect a **return of \$3 to \$10 in cost savings** due to improved equipment reliability, reduced downtime, and increased productivity.
- Studies show that organizations with robust maintenance training programs experience **reduced equipment downtime** by 20-30%
- Maintenance training contributes to overall cost savings, with businesses reporting a 15-30% **reduction in maintenance expenses.**





Maintenance Future Needs



Maintenance Future Needs



Technological Advancements:

- Future maintenance needs to involve upskilling technicians to work with advanced equipment, understand data analytics, and effectively utilize digital tools.
- Continuous learning and professional development programs will play a crucial role in meeting these needs and ensuring a skilled workforce capable of adapting to technological advancements



Maintenance Future Needs

Technology integration:

- The maintenance field is witnessing the integration of advanced technologies such as:

Internet of Things (IoT)

- Temperature, pressure, humidity, vibration

AI and Machine learning,

- Analyse data to determine the health of an asset
- Check metrics according to 100% customizable criteria
- Produce reports and work orders with an intuitive interface
- Automate preventive actions
- Organize the work routines of industrial maintenance teams



- Future maintenance needs include leveraging these technologies to enable:
 - Predictive maintenance,
 - Real-time monitoring,
 - Automated diagnostics.



Maintenance Future Needs

IoT Certifications:

1. Cloud Credential Council (CCC) IoT Foundation (IoTF)
2. CertNexus Certified Internet of Things Practitioner (CIoTP)
3. CertNexus Certified Internet of Things Security Practitioner (CIoTSP)
4. Cisco's 'Introduction to IoT and Digital Transformation'

AI Predictive Maintenance Platforms

C3.ai: AI-based predictive maintenance platform

Dingo: Predictive maintenance for asset health management for heavy industries such as mining, oil and gas, and utilities.

ABB's Ability: Predictive Maintenance software utilises AI algorithms.

Honeywell: Advanced predictive maintenance solutions.

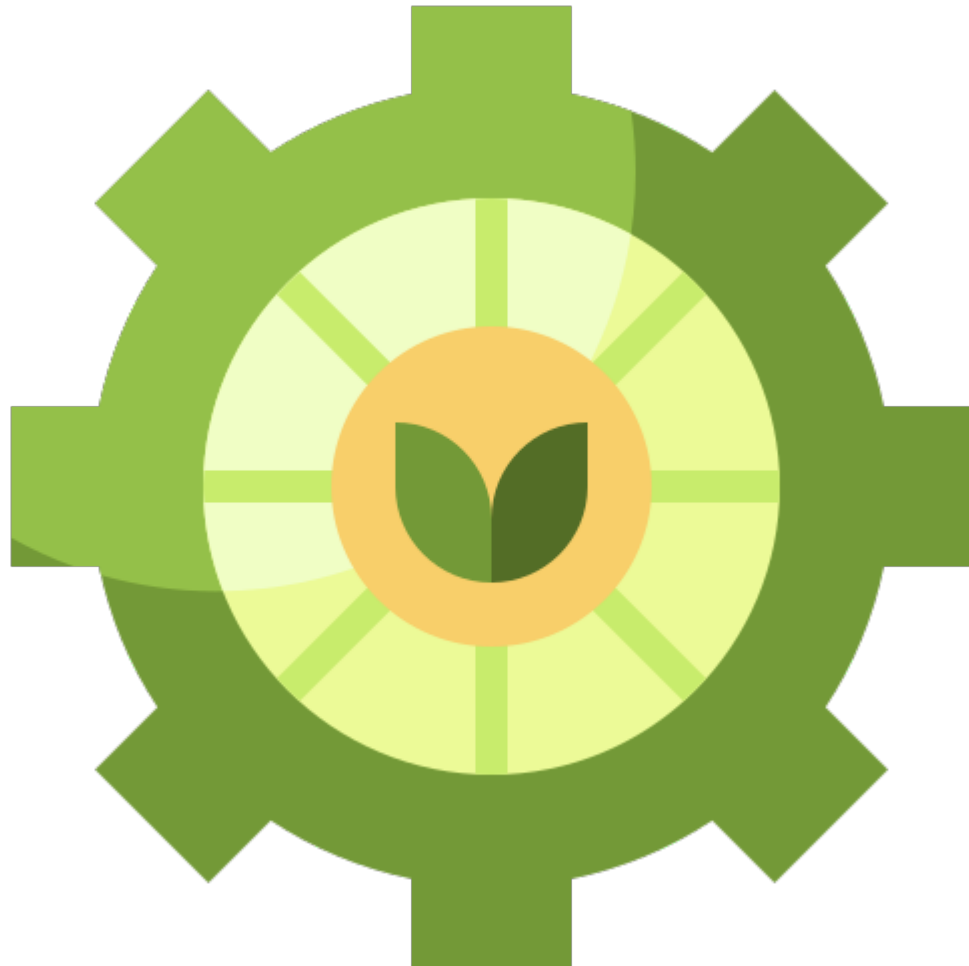
PTC ThingWorx: Augmented reality (AR)-enabled predictive maintenance platform.

Uptake: Predictive analytics SaaS

IBM Watson IoT: Predictive maintenance with its comprehensive suite of tools and technologies



Maintenance Future Needs



Sustainability and environmental considerations:

- The future of maintenance requires practices that prioritize:
 - Energy efficiency,
 - Waste reduction,
 - Green solutions.
- Organizations will need to implement sustainable maintenance strategies, such as optimizing energy use, adopting eco-friendly materials, and embracing circular economy principles.



Maintenance Future Needs

Training Topics:

Environmental awareness training



Sustainable practices and strategies training



Renewable energy & energy efficiency training



Sustainable transportation and commuting training



Green building and facility management training



Waste management and recycling training





Maintenance Future Needs

Remote and virtual maintenance:

Maintenance teams can diagnose issues, provide guidance, and perform repairs without physically being on-site using:

- **Virtual reality (VR)** allows technicians to immerse themselves in a simulated 3D environment that mirrors the actual machine or system → They can identify issues and experiment with different solutions without the need for physical access.
- **Augmented reality (AR)** can overlay digital information and instructions onto the real-world view of the machine, guiding the technician through the repair process and reducing the risk of error.





Maintenance Future Needs

Remote and virtual maintenance:

1. **Resonai:** AR platform, Vera, is designed to convert physical buildings into interactive 3D models or digital twins.
2. **UpSkill:** AR with wearable tech platform to guide workers in maintenance and repair tasks.
3. **XMReality:** AR-based remote guidance tool uses point-pads and gesture control to facilitate maintenance and repair tasks.
4. **Taqtile:** Step-by-step AR instructions for maintenance and repair.
5. **Scope AR:** AR real-time 3D animations solutions for industrial use.



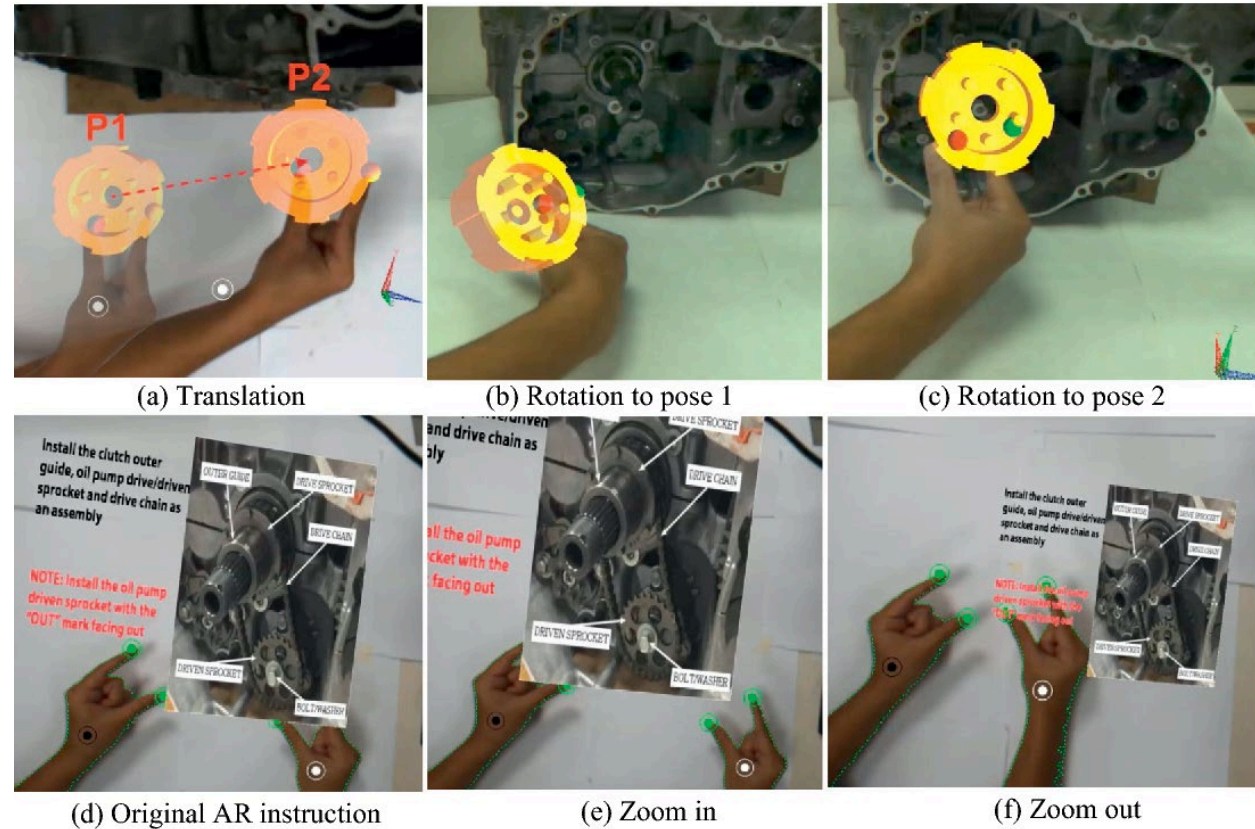
Remote and virtual maintenance:

Augmented Assembly Instructions

Assembling complex machinery and equipment by using AR overlays → workers receive real-time, step-by-step, visual guidance on how to assemble parts.

This approach:

- Reduces errors
- Accelerates the learning curve for new employees.
- Workers focus on the task at hand, leading to improvements in both efficiency and quality.





Maintenance Future Needs

Remote and virtual maintenance:

Remote Assistance Using AR Glasses

AR glasses help field engineers to share their real-time view with a remote expert.

Remote Expert:

- Provide instant feedback and guidance.
- Draw annotations and instructions directly onto the field engineer's field of view,
- Help in solving complex problems on-site and reducing the need for repeat visits.



- Reduces downtime,
- Increases operational efficiency,
- Enables the transfer of knowledge and skills across geographically distributed teams.



Maintenance Future Needs

Remote and virtual maintenance:

Remote Assistance Using AR Glasses

- Vuzix: AR smart glasses are designed for industrial applications.
- ThirdEye Gen: AR glasses provide remote assistance and shared digital workspaces.
- RealWear: Hands-free wearable computer that provides AR overlays to support industrial work.
- Atheer: AR platform offers remote collaboration tools to improve the productivity and safety of deskless workers.
- TeamViewer Pilot: AR-enabled remote assistance.



- Reduces downtime,
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Maintenance Future Needs

Remote and virtual maintenance:

Digital Twin Visualization

- A 'digital twin' refers to a virtual replica of a physical product, system, or process. It acts as a real-time mirror, simulating the behavior and performance of its physical counterpart.
- Help engineers and operators better understand and manage their systems.
- Operators can gain a comprehensive understanding of systems operation and performance in real time.
- Allows for proactive maintenance, predictive analysis, and improved decision-making.
- Test solutions in the virtual environment, and implement them in the physical world.





Maintenance Future Needs

Remote and virtual maintenance:

Digital Twin Visualization

1. **Cityzenith:** Digital twins of buildings and cities.
2. **Ansys:** Comprehensive digital twin solutions for various industries.
3. **TwinThread:** Predictive operations platform leverages digital twins to provide insights and recommendations to manufacturers.
4. **Cognite:** Digital twins for asset-intensive industries.
5. **Siemens MindSphere:** IoT system that leverages digital twins to predict system behavior. It collects and analyzes data from physical systems, enabling predictive maintenance, reducing downtime, and improving overall operational efficiency.





Maintenance Future Needs

Data-driven decision-making:

- Maintenance needs will involve embracing data analytics tools and practices to identify trends, predict failures, and make data-driven decisions for maintenance planning and resource allocation.





Maintenance Future Needs

Training Topics:

Data literacy



Statistical analysis



Data visualization



Data analysis tools
& software



Metrics dashboard
creation



Critical thinking &
problem-solving



Data ethics &
privacy



Aligning data metrics with
organizational performance





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