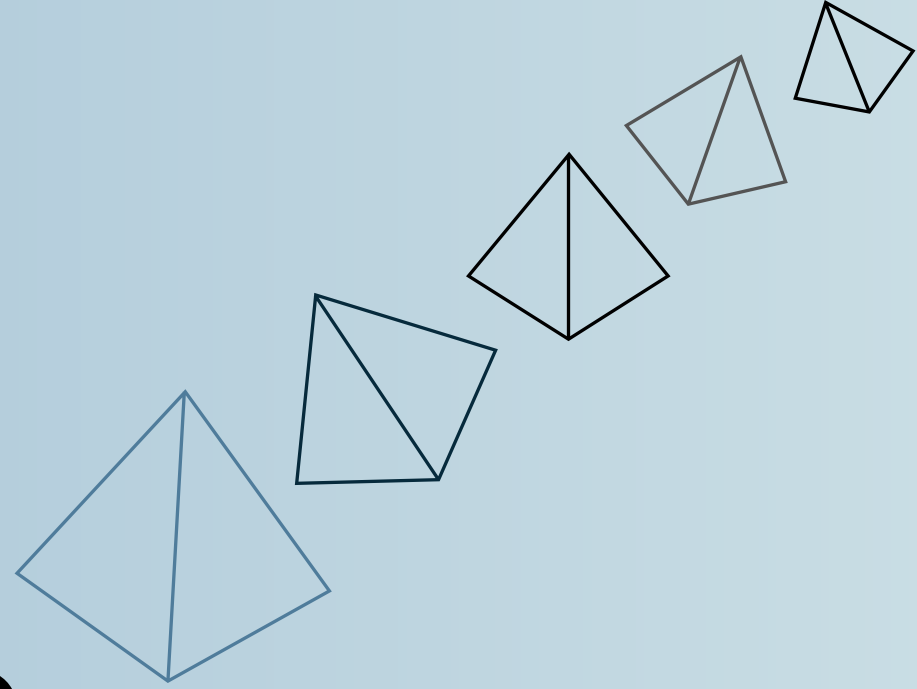


Evolution of Maintenance Repair Operations





How MRO Underwent Transformation

1995

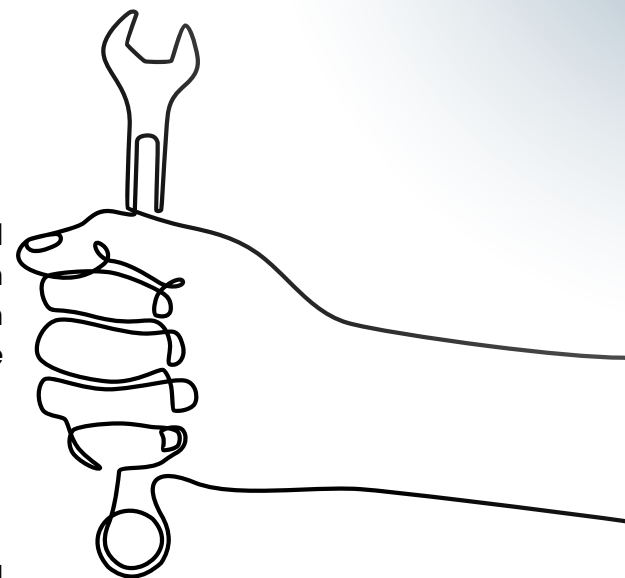
This period saw a paradigm shift from traditional to systematic and technology-driven methods and increased usage of CMMS for managing maintenance tasks. There was considerable emphasis on preventive maintenance, scheduled inspections, and repairs. Manufacturing companies focused on minimizing down-time while the transportation sector focused on safety and reliability. However, there were challenges pertaining to connectivity and data sharing.

2000

The 2000s saw an increased usage of technology, automation and digitization. RFID technology played a critical role in tracking and managing assets and inventory. Streamlining of workflows, and reduction of manual data entry were implemented. RCM methodologies improved the overall system reliability and this period saw a shift towards predictive maintenance. MRO practices were standardized globally, and companies started using conditioning monitoring systems to predict equipment failures and perform maintenance activities. Improved data connectivity also meant better collaboration and communication in the MRO processes.

2005

The year 2005 and onwards saw an increased integration of IoT technologies, connected devices and sensors for equipment monitoring in real-time. The focus was on improving the accuracy of predictive maintenance and reducing the unplanned downtime. The ability to analyse large datasets allowed better accuracy in prediction of equipment failures and better decision making in maintenance planning. Companies adopted a holistic approach of focusing on the entire lifespan of assets to procurement to retirement to optimize performances and reduce TCO. This period also witnessed an increased awareness about TPM and outsourcing of MRO activities. Regulatory compliance and safety adherence too had become an important aspect of the entire MRO ecosystem.



ADVANCED AND
INTEGRATED MRO
PRACTICES TO ENHANCE
EFFICIENCY, REDUCE COSTS,
AND IMPROVE THE OVERALL
RELIABILITY OF ASSETS AND
EQUIPMENT

The New Age MRO



2010

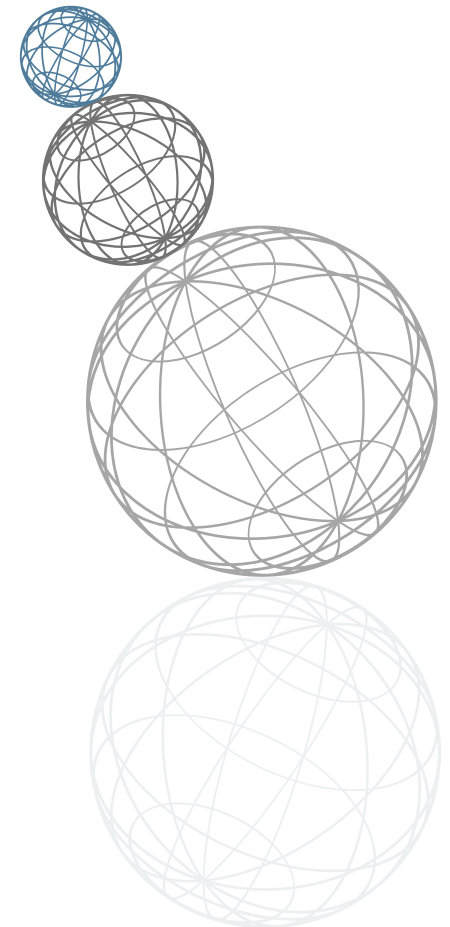
Sophistication of Predictive Maintenance using complex algorithms, machine learning and data analytics witnessed exponential prominence starting 2010. The rise of industry 4.0 and smart manufacturing, integration of digital technologies, IoT and automation into maintenance processes lead to more inter-connected and intelligent systems. In addition, the new age cloud solutions offered advantages such as remote access, scalability, and cost-effectiveness. The increased usage of smart phones and tables paved the path of real-time data access, work order management and on-field inspections. Organizations realized the importance of data security and condition monitoring. This era saw a standardization of maintenance practices across distributed geographies while attaching importance to sustainability and green initiatives.

2015

2015 and onwards is when MRO practices underwent significant changes, driven by technological advancements, increase connectivity and growing focus on efficiency. While embracing the aspects of IoT integration, enhanced use of CMMS and EAM systems, cloud and mobile technologies, the period witnessed the increased adoption of Augmented Reality Tools. AR tools were used for maintenance training, providing real-time guidance to technicians, and enhancing visualization in complex maintenance procedures. Companies also sought to streamline the procurement of spare parts, reduce lead times, and enhance overall supply chain efficiency to minimize disruptions.



REGULATORY COMPLIANCES, DATA SECURITY, SUSTAINABILITY AND GREEN INITIATIVES CONTINUED TO BE CRITICAL ASPECTS OF THE MRO ECOSYSTEM



The New Normal Era



2020 AND ONWARDS

The period starting 2020 and onwards accelerated the digital transformation in MRO. Organizations increasingly adopted cloud-based solutions, digital platforms, and remote collaboration tools to enhance flexibility and resilience in maintenance operations. Remote monitoring, virtual inspections, and augmented reality (AR) were utilized for troubleshooting, training, and remote assistance in maintenance tasks. Predictive maintenance continued to evolve with advancements in artificial intelligence (AI) and machine learning. Organizations utilized more sophisticated algorithms to predict equipment failures, optimize maintenance schedules, and reduce downtime.

The Internet of Things (IoT) became more integrated into MRO practices. Connected devices and sensors provided real-time data on equipment conditions, enabling more accurate predictions and proactive maintenance. Organizations placed a heightened focus on resilience and risk mitigation. Supply chain disruptions during the pandemic prompted companies to reassess and strengthen their supply chain strategies for spare parts and critical equipment.

The use of augmented reality (AR) in MRO expanded. AR applications were increasingly used for remote training, equipment maintenance guidance, and real-time collaboration between on-site and remote teams. Data analytics and artificial intelligence played a crucial role in optimizing MRO processes. Organizations leveraged these technologies for predictive maintenance, trend analysis, and continuous improvement in maintenance strategies.

Organizations continued to implement environmentally friendly and energy-efficient maintenance practices, aligning with broader corporate sustainability goals. With the increased reliance on digital systems, there was a heightened emphasis on cybersecurity and data protection. Organizations invested in robust cybersecurity measures to safeguard sensitive maintenance and operational data.

THE MRO SECTOR ADAPTED TO THE NEW NORMAL. REMOTE WORK, DIGITAL COLLABORATION, AND THE INTEGRATION OF TECHNOLOGIES THAT FACILITATE REMOTE MAINTENANCE ACTIVITIES BECAME ESSENTIAL COMPONENTS OF MRO STRATEGIES

MRO Situation in 2029

THE MRO MARKET
SIZE IS ESTIMATED
TO REACH USD
482.40 BILLION BY
2029, GROWING
AT A CAGR OF
2.28%

The Game Changers for the MRO Industry

- Digital Transformation and Industry 4.0
- Advanced Predictive Maintenance Models
- Augmented Reality (AR) and Virtual Reality (VR)
- Robotics and Automation
- Blockchain for Supply Chain Management
- Cloud-Based Solutions
- Sustainability and Green Practices
- Integration with ERP Systems
- Cybersecurity Focus
- Adaptation to Industry-Specific Changes



THE ABBREVIATION “MRO”
FIRST APPEARED IN THE 1930S



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