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AI Production Planning and Quality Control

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Abstract: Production planning is the strategic process of organizing manufacturing resource labor. Material and machinery to meet customer demand efficiently with year set time frame it involves for casting demand determining product qualities and schedule in production to minimize costs and minimize efficiency. Quality control (QC) is a systematic process of inspecting, testing and reviewing products or services to ensure they meet established standards and or free from defects. It involves monitoring production strategy and using tool like control chart to identify and correct issue ultimately ensuring customer satisfaction reducing cost and boosting brand reputation. AI production planning and quality control drives smart manufacturing by using machine learning and computer vision to optimums schedules product maintenance and identify defects with >99% accuracy. It replace manual reactive methods with real time data driven decision that reduce down time cut costs by up to 40 percentage on the enhance efficiency.

Key words: Production Planning, Optimization, Automated Quality Control, and Predictive Maintenance; Intelligent Manufacturing Systems.

1. INTRODUCTION

AI production planning

AI given production planning optimizes manufacturing by leveraging real time data predictive analytic and automated scheduling to enhance efficiency reduce cost and improve adaptability key factor including high quality data integration from various sources k I powered demand forecasting dynamic resources allocation and crucially, the ability to make real time adjustment to minimize disruptions.

Key factors of successful production planning

- Data integration and quality: Successful planning requires high-quality, synchronized data from multiple sources (ERP, IoT, and supply chain) to provide a single, accurate “source of truth”.
- Predictive demand forecasting: Moving beyond historical averages, predictive models use machine learning to anticipate market fluctuations, reducing both waste and stock outs.
- Real time adaptability and scheduling: Digital twins and real-time monitoring allow systems to automatically adjust schedules when disruptions occur, ensuring continuous workflow.
 - Resource optimization: This involves the strategic allocation of “men, machines, and materials” to maximize output while minimizing costs and idle time.
 - Predictive maintenance: By using IoT sensors to predict equipment failure before it happens, planners can schedule repairs during natural downtime, preventing costly unplanned outages.
 - Collaboration with human expertise: While AI handles complex calculations, human planners provide critical context, handle ethical considerations, and manage high-level strategy.
 - System interpretability: For a plan to be actionable, the underlying logic of the AI or software must be transparent and understandable (interpretable) so managers can trust and validate the decisions made by the system.

AI quality control

Quality control include high quality representative data real time analytics continuous learning and robot infrastructure.

It leverages computer vision for defect deduction sensor for process monitoring and crucially cross functional collaboration to ensure accuracy and regulatory.

Effective quality control include

- AI quality data and annotation
- Ensuring high-precision labeling of datasets to train models that can distinguish between “minor surface noise” and “critical defects.”
- Real time monitoring
- Using edge computing to analyze production line data instantly, preventing the mass production of faulty units.
- Continuous learning
- Implementing feedback loops where human inspectors verify AI “uncertainties,” allowing the model to improve its accuracy over time.
- System integration and infrastructure

- Connecting Quality Management Systems (QMS) with shop-floor sensors to create a unified data pipeline.
- Collaboration and validation
- Establishing a “Human-in-the-loop” (HITL) approach where AI handles high-speed scanning and humans handle complex troubleshooting.
- Computer vision and specialized algorithms
- Deploying deep learning (CNNs) to detect microscopic fractures or color deviations that the human eye might miss.

Challenges unlimitations of AI in production planning

- Data quality
- AI is only as good as its input; “dirty data” (incomplete or biased) leads to flawed production schedules.
- Interoperation with other systems
- Difficulty syncing AI with legacy ERP systems that lack modern APIs.
- Skill gaps
- A shortage of workers who understand both traditional industrial engineering and data science.
- accuracy and consistency
- Models may suffer from “drift,” where their performance degrades as factory conditions (temperature, humidity) change.
- Reduced cost and waste

High initial investment costs can make it difficult to realize an immediate ROI in waste reduction.

- Real time monitoring
- Processing massive amounts of data at high speeds requires significant Local Edge Infrastructure.
- Predictive maintenance
- Difficulty in predicting “Black Swan” events or rare mechanical failures that have no historical Data.
- Improved safety and compliance
- Meeting strict ISO standards and ensuring AI-driven robots operate safely around human workers

Future trends in AI Production planning and quality control

- Autonomous planning and schedule
- AI that self-corrects schedules in seconds when a raw material delivery is delayed.
- Predictive inventory and supply chain
- Using global macro-data to adjust stock levels before a shortage occurs.
- Digital twins for stimulation
- Creating virtual replicas of the factory floor on platforms like NVIDIA Omnivores to test changes before they go live.
- A I given demand forecasting
- Moving beyond seasonal trends to analyze real-time consumer sentiment and social shifts.
- Computer vision and real time inspection
- Hyperspectral imaging that “sees” chemical compositions or internal structural integrity.
- Predictive maintenance
- Factories will transition to “zero-touch” maintenance, where machines predict their own failure points and automatically schedule their own repairs during low-impact production gaps.
- AI normalize detection
- Systems that flag “weird” patterns even if they haven’t been programmed to look for a specific defect.
- Edge AI for security Running AI locally on cameras and sensors to protect proprietary manufacturing

data from being sent to the cloud.

2. CONCLUSION

The integration of Artificial Intelligence into production planning and quality control represents a fundamental shift from reactive to proactive manufacturing. By adopting Advanced Quality Control measures such as real-time monitoring and specialized computer vision, organizations can move from merely detecting defects to preventing them at the source. While significant Production Planning Challenges remain—including data quality issues, legacy system interoperability, and critical skill gaps—addressing these hurdles is a prerequisite for achieving long-term operational efficiency and waste reduction.

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