MODAPTO [101091996]: Modular Manufacturing and Distributed Control via Interoperable Digital Twins

1.2.2 Analyzing data to understand causes of discrepancies

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Introduction

When comparing performance between identical or similar production cells, manufacturers often encounter discrepancies that need thorough analysis to understand their underlying causes. These variations in performance, despite similar equipment and processes, can significantly impact overall manufacturing efficiency and product quality. Understanding the root causes of these discrepancies is essential for standardizing operations and achieving consistent results across all production cells.

MODAPTO's monitoring capabilities provide valuable data that can be used to analyze and understand the causes of performance discrepancies between production cells. This section explores methodologies and approaches for analyzing this data to identify root causes and implement effective solutions.

Root Cause Analysis Framework

Root Cause Analysis (RCA) is a systematic approach used to identify the underlying reasons for problems or defects in manufacturing processes. Rather than just addressing symptoms, RCA aims to pinpoint the core issues that lead to undesired outcomes. When applied to production cell comparison, RCA can reveal why seemingly identical cells perform differently.

The RCA process typically follows these steps:

1. **Define the Problem**
   - Clearly articulate the performance discrepancy between cells
   - Quantify the gap using specific metrics (OEE, throughput, quality, etc.)
   - Determine the impact of the discrepancy on production goals
2. **Gather Relevant Data**
   - Collect comprehensive data from both high and low-performing cells
   - Include production logs, quality control records, maintenance reports, and operator observations
   - Use both quantitative metrics and qualitative information
3. **Identify Potential Causes**
   - Use structured approaches to identify possible causes of the discrepancy
   - Categorize potential causes by major factors (people, methods, machines, materials, etc.)
4. **Analyze Data to Determine Root Causes**
   - Apply analytical techniques to validate or eliminate potential causes
   - Look for patterns, correlations, and causal relationships
   - Prioritize causes based on their impact and frequency
5. **Implement Solutions**
   - Develop and implement corrective actions to address root causes
   - Standardize best practices across all production cells
   - Document changes for future reference
6. **Monitor Results**

- Track key performance indicators to verify improvements
- Ensure the discrepancy has been eliminated or reduced
- Make adjustments as necessary

Analytical Tools and Techniques

Several analytical tools and techniques are particularly effective for identifying the root causes of performance discrepancies between production cells:

1. **The Five Whys Technique**
   - A simple but powerful method that involves asking "why" repeatedly to drill down to the root cause
   - Example:
     - Why is Cell A's throughput lower than Cell B's? Because Cell A experiences more downtime.
     - Why does Cell A experience more downtime? Because it has more frequent equipment failures.
     - Why does it have more frequent failures? Because preventive maintenance is performed less regularly.
     - Why is maintenance less regular? Because maintenance schedules are not standardized between cells.
     - Why aren't schedules standardized? Because there's no unified maintenance management system.
2. **Fishbone Diagram (Ishikawa)**
   - A visual tool that helps identify and categorize potential causes of a problem
   - Major categories typically include:
     - People (operators, training, skills)
     - Methods (procedures, work instructions)
     - Machines (equipment, tools, technology)
     - Materials (components, supplies)
     - Measurements (data collection, metrics)
     - Environment (layout, temperature, lighting)
3. **Pareto Analysis**
   - Based on the principle that 80% of problems come from 20% of causes
   - Helps prioritize issues by frequency or impact
   - Creates a visual representation showing the most significant factors affecting performance
4. **Statistical Process Control (SPC)**
   - Uses statistical methods to monitor and control production processes
   - Identifies when a process is operating outside normal parameters
   - Distinguishes between common cause variation (inherent to the process) and special cause variation (assignable to specific factors)
5. **Scatter Diagrams**
   - Visual tool that shows relationships between two variables
   - Helps determine if there is a correlation between potential causes and effects
   - Can reveal patterns that might not be apparent in tabular data

Common Causes of Performance Discrepancies

When analyzing discrepancies between identical production cells, certain causes appear frequently:

1. **Equipment Variations**
   - Differences in calibration or settings
   - Varying levels of wear and tear
   - Different maintenance histories or schedules
   - Subtle variations in machine components
2. **Operator Factors**
   - Differences in training or experience
   - Variations in work methods or preferences
   - Shift-to-shift differences in operation
   - Different levels of adherence to standard procedures
3. **Environmental Factors**
   - Variations in temperature, humidity, or air quality
   - Differences in layout or space constraints
   - Uneven lighting or ergonomic conditions
   - Proximity to other equipment or processes
4. **Material Variations**
   - Inconsistencies in raw materials or components
   - Different supplier batches
   - Variations in material handling or storage
   - Differences in material flow to each cell
5. **Procedural Differences**
   - Undocumented variations in standard operating procedures
   - Different interpretations of work instructions
   - Unofficial “workarounds” implemented in one cell but not others
   - Variations in setup or changeover methods

Using MODAPTO for Data-Driven Analysis

MODAPTO’s monitoring capabilities provide powerful tools for conducting data-driven analysis of production cell discrepancies:

1. **Real-Time Performance Monitoring**
   - Compare key metrics between cells in real-time
   - Identify when discrepancies begin to occur
   - Track the impact of changes or interventions
2. **Historical Data Analysis**
   - Review performance trends over time to identify patterns
   - Compare performance under similar conditions
   - Analyze the impact of external factors on cell performance
3. **Comparative Dashboards**
   - Create side-by-side visualizations of cell performance
   - Highlight differences in key metrics

   - Drill down into specific areas of concern
4. **Automated Anomaly Detection**
   - Use MODAPTO's analytics to automatically identify unusual variations
   - Receive alerts when performance discrepancies exceed normal thresholds
   - Focus investigation on significant deviations

Case Study: Resolving Throughput Discrepancies

To illustrate the process, consider this example of how a manufacturer used MODAPTO to analyze and resolve throughput discrepancies between two identical production cells:

1. **Problem Definition**: Two seemingly identical assembly cells showed a consistent 15% difference in throughput rates, with Cell A consistently underperforming compared to Cell B.
2. **Data Collection**: Using MODAPTO's monitoring capabilities, the team collected comprehensive data on cycle times, downtime events, quality metrics, and operational parameters from both cells over a two-week period.
3. **Analysis**: The team created comparative dashboards in MODAPTO and identified that Cell A experienced more frequent micro-stoppages (brief interruptions under 2 minutes) than Cell B. Further analysis revealed three potential root causes:
   - Different pneumatic pressure settings
   - Variations in preventive maintenance schedules
   - Differences in component feeding mechanisms
4. **Root Cause Verification**: By systematically testing each potential cause, the team confirmed that the primary issue was inconsistent pneumatic pressure settings, which caused more frequent jams in Cell A.
5. **Solution Implementation**: The team standardized pressure settings between cells, updated maintenance procedures to include regular pressure checks, and provided additional training to operators on monitoring and adjusting pressure settings.
6. **Results Monitoring**: After implementing these changes, the throughput gap between cells reduced to less than 3%, resulting in significant productivity improvements.

Analyzing data to understand the causes of discrepancies between production cells is a critical skill in modular manufacturing. By applying structured root cause analysis methods and leveraging MODAPTO's monitoring capabilities, manufacturers can identify the underlying factors contributing to performance variations, implement targeted solutions, and achieve consistent, optimized performance across all production cells.

The insights gained through this analysis not only improve current operations but also inform the design and implementation of future production cells, creating a cycle of continuous improvement that enhances overall manufacturing excellence.

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