



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



1.2.1 Methods for comparing identical production cells

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Introduction

When implementing modular manufacturing with identical or similar production cells, effective comparison between cells becomes a powerful tool for optimizing overall manufacturing performance. By systematically analyzing performance data across cells, manufacturers can identify best practices, troubleshoot issues, and standardize operations to achieve consistent quality and efficiency.

MODAPTO's monitoring capabilities provide powerful tools for comparing production cells, allowing for data-driven decision making and continuous improvement. The following methods and metrics are particularly useful for comparing identical production cells.

Key Performance Metrics for Cell Comparison

To effectively compare identical production cells, manufacturers should focus on these key metrics:

1. Overall Equipment Effectiveness (OEE)

- This comprehensive metric combines three critical factors:
 - Availability: The percentage of scheduled time that the cell is available to operate
 - Performance: The speed at which the cell operates compared to its designed capacity
 - Quality: The percentage of good units produced out of total units started
- $OEE = Availability \times Performance \times Quality$
- A score of 100% would mean the cell is manufacturing 100% of the time, at 100% capacity, with 100% quality yield (no defects)

2. Throughput

- Measures the production output during specific timeframes
- As one industry expert described it, "Throughput is the lifeblood of a manufacturing cell, and if the production rate is high, there will likely be few issues relating to downtime or lead times, improving both the health of the business and the impression given to the end customer."

3. Cycle Time

- The total time from the beginning to the end of the production process
- Comparing cycle times between identical cells can quickly reveal efficiency differences

4. First Pass Yield Rate

- Calculates the percentage of products manufactured to specification the first time through the process, without requiring rework or becoming scrap
- $First\ Pass\ Yield = (Quality\ Units / Total\ Units\ Produced) \times 100$
- Higher rates indicate better process control and efficiency

5. Capacity Utilization

- Measures how much of the cell's total available capacity is in use
- $Capacity\ Utilization = (Total\ capacity\ used\ during\ a\ specific\ timeframe / total\ available\ production\ capacity) \times 100$



- This metric helps identify underutilized resources and opportunities for growth
- 6. Manufacturing Cost Per Unit**
 - Takes into account all costs associated with production and divides by the number of units manufactured
 - Includes materials, overhead, depreciation, labor, etc.
 - $\text{Manufacturing Cost Per Unit} = \frac{\text{Total Manufacturing Cost}}{\text{Number of Units Produced}}$
 - Comparing this metric between cells can reveal inefficiencies in resource utilization
- 7. Machine Downtime**
 - Measures periods when equipment is not operational due to breakdowns, maintenance, or setup changes
 - Comparing downtime between identical cells can identify maintenance or operational issues

Methods for Effective Comparison

- 1. Benchmarking**
 - Establish baselines on internal performance metrics for each cell
 - Compare the baseline results with actual results
 - Formulate best practices based on the best-performing cells
 - Implement these practices across all cells
- 2. Real-time Monitoring Dashboards**
 - Use MODAPTO's digital twin visualization capabilities to create side-by-side views of identical cells
 - Set up real-time dashboards that show comparative metrics for all cells
 - Configure alerts for significant performance deviations between cells
- 3. Statistical Process Control**
 - Apply statistical methods to monitor and control production processes
 - Create control charts for key metrics to identify when a cell's performance falls outside normal variation
 - Use trend analysis to spot gradual changes in performance
- 4. Standardized Work Instructions**
 - Develop detailed work instructions for each process within the cells
 - Compare adherence to standards across cells
 - Identify variations in process execution that may impact performance
- 5. Periodic Performance Reviews**
 - Schedule regular reviews of comparative cell performance
 - Involve operators and supervisors from all cells to share insights
 - Document findings and implement improvement actions

Effective comparison of identical production cells requires a systematic approach using standardized metrics and analysis methods. By leveraging MODAPTO's monitoring capabilities to track these metrics in real-time, manufacturers can quickly identify performance gaps, implement best practices across all cells, and drive continuous improvement in their modular manufacturing operations.