Dispatching vs. Scheduling – Exploring Methods for Enhanced Fab Performance

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Content
Dispatching vs. Scheduling – Methods for Enhanced Fab Performance

• (1) Challenge: "Optimal" Manufacturing?
  – Classification and definition of „manufacturing"
  – Requirements of „optimal" manufacturing !?

• (2) Optimization of Manufacturing Performance
  – 1. Perspective: Long-term goals
  – 2. Perspective: Precise, measurable and agreed performance indicators
  – 3. Survey: Ranking of important indicators
  – 4. Perspective: Influencing factors and variability

• (3) Meaningful and proactive Manufacturing Control
  – Tools for optimizing the manufacturing performance
  – Pursuing a holistic approach
Content
Dispatching vs. Scheduling – Methods for Enhanced Fab Performance

• **(4) Dispatching and Scheduling**
  – Two typical solution methods for manufacturing control
  – Categorization and classification

• **(5) Pre-Requisites & Requirements**
  – Data quality and accuracy
  – Comprehensive reporting and monitoring
  – Simulation
  – Integration [& automation] of Dispatcher / Scheduler / Simulator

• **(6) ... more details ...**
**Production** = Making (Manufacturing, Processing)

a) Production is a process of combining tangible inputs (raw materials, semi-finished goods, subassemblies) and intangible inputs (ideas, information, knowledge) and transforming them into products (output)

b) In the *engineering literature* the term **Manufacturing** is often used for the industrial discrete final production and the term **Processing** for the chemical production

c) Complementary, production includes services, formation of rights, agricultural commodities, etc.

**Manufacturing Types**: Batch, Single Unit, Section, Mass, Series, Sorts

**Factory**: Location of Production

**Note**: Terms are often used as synonyms
Challenge „Optimal“ Manufacturing
Requirement „optimal“ manufacturing

Challenge: Manufacturing Companies must compete across many dimensions!

Strategy: Achieve an "optimal" production (manufacturing / processing), i.e. balancing
- faster, better, cheaper
- with equal or better quality
- than the competition
- leading through innovation
- ....

Solution: Achieve a reasonable (optimal) performance and maintain it!

To achieve reasonable production performance is not easy, because:
- “reasonable” performance is not well defined unclear targets
- inconsistent and misunderstood objectives
- non-deterministic production events
- difficult to measure and verify
- the system and optimization problem is very complex
- poor production control procedures and tools
- ...
Optimization of Mfg Performance

1. Perspective: long-term goals

- At first, the impression is of clear, long-term objectives (strategies)
- On closer inspection, imprecise definitions and unfortunately:
  - many
  - different
  - vague
  - inconsistent
  - often contradictory
  - ... strategies?
- Various opinions, perceptions and interpretations ?!
- How to proceed?

“When you two have finished arguing your opinions, I actually have data!”

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Optimization of Mfg Performance

2. Perspective: precise, measureable and aligned indicators

Problem 1: How to specify (quantify) and measure precise objectives?

- Each production facility has different goals and ideas of a reasonable performance in figures.
- Examples of performance indicators:
  - Cycle Time
  - Variance of Cycle Time
  - Throughput
  - Flow-Factor
  - Commit to and meet delivery dates
  - Inventory (WIP & Stock)
  - Utilization
  - OEE
  - Setup Effort
  - ...

Problem 2: How do I get this consistently defined and aligned?

- Individual indicators are often not comprehensive, and focus on specific but limited aspects of manufacturing.
- Frequently they are also inversely related, e.g. Cycle Time – Utilization - Inventory.
- Frequently they are inconsistently implemented (e.g. payment of shift personnel by quantities although the overall goal is adherence to delivery dates!)

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Optimization of Mfg Performance
Survey: ranking of important indicators

Ranking of Fab Performance Measures

<table>
<thead>
<tr>
<th>Performance Measure</th>
<th>Low</th>
<th>Moderate</th>
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<td>Cycle Time</td>
<td>0%</td>
<td>7%</td>
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Source: Handbook of Production Scheduling (Jeffrey W. Herrmann)

Not surprising ...
- Factory Throughput and Cycle Times measures rank high
- On-time delivery is increasingly important - lean manufacturing, JIT, etc.
- ... additional measures driven by business constraints

Surprisingly ...
- Equipment Throughput not important but Fab Throughput is important
- Labor utilization lower importance (hard to measure)
- OEE not so important?
- ...
Problem 3: Occurrence of highly variable “Manufacturing Events” are non-deterministic

- Variability is generated by a variety of planned and unplanned events, such as maintenance, failures, sickness, execution errors, processing time, poor planning, etc.
- Many of these events are difficult to influence from an operational perspective

But: manufacturing control can exacerbate these problems

- Which factors can truly be controlled?

Employee’s illness: Not / barely
Equipment Breakdown
Product Mix
Working Plan
Maintenance
Planning & Monitoring
Manufacturing Control

Certainly

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Consequence of variability - strong fluctuations within manufacturing lines related to the arrival of material (raw / WIP) and units to be produced

These variations result in wave-like movements of WIP within manufacturing line with resultant loss of production capacity for the particular equipment.
Meaningful and proactive Mfg Control
Tools for optimizing manufacturing performance

**Manufacturing Control** is one of the most important tools and methods to increase overall manufacturing performance!

- "Production control" means planning, initiating (production starts), monitoring and tracking the execution of released manufacturing orders and production processes.
- The task is to optimize to the extent possible all operations and activities within the production environment:
  - Material procurement, material storage, material supply
  - Control by product / process plan structure, route definition and BOM
  - Planning and execution of manufacturing orders
  - Setting capacity utilization and due dates
  - Accounting for yield loss, mis-processing, and equipment or process related bottlenecks / constraints
  - Equipment allocation with consideration of required and available process capabilities
  - etc.

*Source*: Wirtschaftslexikon
Meaningful and proactive Mfg Control
Chasing a holistic approach

- Clarification and specification of objectives to be achieved
- Selection and accurate measurement of key performance indicators
- Highest possible level of automation (minimize manual interventions)
- Use of appropriate methods and tools to control manufacturing (for example, scheduling, dispatching, ...)

Sensible Manufacturing Control

+ 

Acting instead of Reacting (proactive)

- Planning and coordination of production factors such as ...
  - Maintenance
  - Workforce
  - Bottleneck Management
  - Production planning
  - Operational Control
- Continuously (dynamically) adapting the production control to known issues
- Ensuring resp. enforcing data quality
Dispatching and Scheduling are two frequently used tools and processes for meaningful and proactive manufacturing control. They are often incorrectly used as synonyms.

**Dispatching** and **Scheduling** are two typical solution methods for manufacturing control.

**Is scheduled**
- Method of calculating resource loading (tasks, resources, constraints)
- Plan for a period = \([t_1 : t_2]\)
- Every 15 min – 8 h; lasts min - h
- Increased level of abstraction of manufacturing models and states

**Is dispatched**
- Method for determining sequencing of tasks / resources
- Prioritization at the time = t0
- Continuously in real time; immediately
- Highly detailed / precise manufacturing relevant models and states (for example, "Process Capabilities")
Instruments Dispatching and Scheduling

Categorization and classification

Level 1: Production Plan
In the long term (½ - 2 years)
Static (throughput, availability, ..)
On demand

Level 2: Capacity and demand plan
In the long term (months - ½ year)
Static (throughput, availability, ..)
On demand

Level 3: Resource Scheduling (Tool Type or single Tool)
15 min - 8 hrs
Semi-Dynamic, periodically

Level 4: Equipment Dispatch List (all details)
Real Time / Current state (sec)
Dynamic, real time, event driven, ...
Pre-Requisites & Requirements: Data quality and Accuracy

Data quality: Meaningful manufacturing control and optimization are only possible with sufficient detailed and correct data quality! This begins with the recognition of the actual problem ...

Often to deal with ...

• Manual Event Collection
• Maintenance schedule not available
• No / Inaccurate process times
• No tracking of rework, Loss, Bonus
• Need for cleaning, calibration, monitor run, etc. is not in the system
• No Process Capability Model
• Agreements on paper or by calling
• Many rules only in the minds of the staff
• ...

"Yes sir, you can absolutely trust those numbers"
Pre-Requisites & Requirements

Comprehensive Reporting and Monitoring

Reporting and Monitoring is fundamental to future optimization projects; the elements of manufacturing reporting should be **trustworthy, comprehensive and correct** and not "whitewash" the current state.

- **Lot related**
  - Accurate lot states and data collection
  - Lot-type specific tracking of productive time

- **Process related**
  - Consider low-runner technologies
  - Consider non productive lots & wafers
  - Measure both transport and wait time

- **Equipment related**
  - Don’t track test activities as productive
  - Precise tracking of states
  - Precise separation of status events
Pre-Requisites & Requirements

Simulation

**Objective**: Simulation of overall manufacturing systems and solutions with higher accuracy (e.g. transport, identification, product & material flow, dispatching, scheduling, prediction algorithm, etc.)

**Why Simulation?**
- Design of New Manufacturing Lines
- Efficiency Improvement for existing Lines
- Behavior Rules for High Automation Solution
- Dispatching [& Scheduling] Rules (EDDI)
- Real time KPI prediction by BI & Reporting (RI Suite)
- Automated Software / Configuration Testing
Pre-Requisites & Requirements
Simulation

Basic Features
• Event Driven simulation of discrete manufacturing including transportation and supply chain
• Process and Metrology tools, Resources (human, containers)
• Transport and storage tools (Material Flow)
• Material, Products, Routes, Operations (Process Flow) …
• Recipes, Capabilities, Rules, Activities
• Business Logic and Rules (e.g. dispatching)

Further Functional Capabilities
• Experiments & Scenarios
• Scheduling & Optimization
• Deliverable “Customer Model Result”
Pre-Requisites & Requirements
Integration [& Automation] of Dispatcher / Scheduler

What ...
• Master data (products, routes, operations, equipments, recipes, ...)
• Dynamic data (traceability, lot movement & state changes, equipment state changes, timers, cycle time, critical ration, due date, WIP & inventory, ...)
• Run-able and capable validation
• Exception handling (timer expiration, where-capable (WIP) ...)
• Process Capability Model and Consumption
• Kanban System
• ...

How ...
• SOA architecture (MoM or ESB based)
• Event Driven
• Publish / Subscribe
• Resynchronization strategy
• ...
Objective is a holistic solution for manufacturing optimization using a variety of components.

More details in the following presentations …