Certified in Planning and Inventory Management

Detailed Scheduling and Throughput

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Detailed Scheduling and Throughput

1. Fundamentals of Detailed Scheduling

Detailed scheduling translates the Master Production Schedule (MPS) and Material Requirements Planning (MRP) outputs into specific, time-phased task assignments at the work-center or machine level. It determines *what* will be produced, *when*, *where*, and *in what sequence*. Unlike rough-cut or capacity planning, detailed scheduling works with minute-level precision and real constraints such as machine availability, labor skills, lot sizes, setup times, and tooling. Mastering this concept enables planners to optimize shop-floor operations, minimize idle time, and improve adherence to production plans while supporting realistic delivery commitments.

2. Throughput and Bottleneck Analysis

Throughput represents the rate at which the system generates finished goods. Bottleneck analysis identifies constraints that limit this rate. By understanding how bottlenecks determine overall output, planners can prioritize work, allocate resources, and schedule operations effectively. Techniques such as constraint-based scheduling, load-leveling, and buffer placement help increase throughput. CPIM emphasizes that improving performance at non-bottleneck operations does not increase overall system performance—only bottleneck-focused improvements do. Effective throughput management is essential for shorter lead times, higher service levels, and improved resource utilization.

3. Theory of Constraints (TOC) Principles

TOC offers a structured method for managing bottlenecks through five focusing steps: identify the constraint, exploit it, subordinate everything to it, elevate it, and repeat the process. Within detailed scheduling, TOC guides decisions on prioritizing jobs, sequencing work, and managing capacity around constrained resources. TOC supports synchronized flow, reduced lead times, and increased throughput while avoiding local optimization. Planners use Drum-Buffer-Rope (DBR) scheduling and strategic buffering to protect throughput. Understanding TOC is crucial for diagnosing system limitations and improving flow efficiency.

4. Drum-Buffer-Rope (DBR) Scheduling

DBR is a TOC-based scheduling method designed to protect bottlenecks and ensure smooth flow. The **drum** is the bottleneck schedule that sets the pace for the entire system. **Buffers** protect the system from disruptions by ensuring that critical work is always available at the constraint. The **rope** synchronizes release of upstream work to avoid overloading capacity. DBR reduces WIP, shortens lead times, and increases predictability. CPIM requires understanding how DBR aligns material release, capacity scheduling, and throughput management to optimize performance.

5. Finite vs. Infinite Capacity Scheduling

Infinite capacity scheduling assumes unlimited capacity and schedules work based solely on demand timing. Finite capacity scheduling recognizes real constraints such as machine hours, labor availability, and resource conflicts. Finite scheduling generates practical, executable schedules but requires more data and computational power. Planners must understand which environments require each approach: infinite for strategic planning (MRP), finite for shop-floor scheduling. Mastery of both ensures realistic plans that avoid overload and minimize rescheduling.

6. Work-Center Loading Techniques

Work-center loading determines how much work is assigned to a work-center within a specific period. Key methods include forward loading, backward loading, and capacity-constrained loading. These techniques help planners manage capacity, avoid bottlenecks, and meet due dates. Overloading results in delays; underloading increases cost and reduces efficiency. Proper loading balances demand against available capacity while supporting smooth flow and predictable scheduling.

7. Forward and Backward Scheduling

Forward scheduling calculates the earliest possible completion date starting from a known start date. Backward scheduling works from the required completion date backward to determine start times. Each method serves different environments: forward scheduling maximizes utilization and visibility, while backward scheduling ensures just-in-time execution with minimal inventory. CPIM stresses understanding when to apply each method based on customer commitments, flow requirements, and capacity limits.

8. Scheduling Rules and Priority Dispatching

Priority rules determine the sequence in which jobs are processed. Common rules include First Come First Served

(FCFS), Shortest Processing Time (SPT), Earliest Due Date (EDD), and Critical Ratio (CR). Each rule impacts lead time, WIP, tardiness, and throughput differently. Dispatching rules help manage daily shop-floor decisions, particularly in high-variability or job-shop environments. Understanding these rules enables planners to choose strategies aligned with organizational objectives such as cost, speed, or service reliability.

9. Queue Management and WIP Control
Queues form when work arrives faster than it can be processed. High queue lengths increase lead times, WIP, and variability. Planners use techniques like WIP caps, kanban limits, and DBR buffers to control flow. Maintaining stable WIP levels ensures predictable scheduling and higher throughput. CPIM emphasizes Little's Law, which explains the relationship between throughput, WIP, and lead time. Effective queue management is essential for synchronized flow.

10. Setup Time Reduction (SMED)
Long setup times increase cycle times, reduce throughput, and force larger lot sizes. Single-Minute Exchange of Die (SMED) principles help reduce setup times through task standardization, tool organization, and internal/external task separation. Reducing setup time increases capacity, improves flexibility, and enables smaller batches without sacrificing productivity. Planners must understand setup time impacts on scheduling, resource allocation, and lead-time accuracy.

11. Lot Sizing and Its Impact on Scheduling

Lot sizes influence inventory levels, machine efficiency, setup frequency, and scheduling flexibility. Large lot sizes reduce setup costs but increase WIP and lead time. Small lots improve responsiveness but may increase operating costs. Planners must evaluate trade-offs using methods like EOQ, fixed lot size, or dynamic lot-sizing techniques. Understanding lot size impacts is essential for accurate capacity planning and smooth production flow.

12. Lead Time Components and Variability

Lead time includes queue time, setup time, run time, wait time, and move time. Variability in any component affects scheduling predictability and throughput. Planners must identify sources of variability and implement controls such as standardization, WIP limits, buffer management, and coordinated flow. Accurate lead-time data improves MRP accuracy and customer delivery performance. CPIM emphasizes decomposing lead time to support continuous improvement.

13. Sequencing Optimization

Sequencing determines the exact order of jobs at each work-center to minimize total completion time, lateness, setups, or changeovers. Optimization techniques include heuristic rules, linear programming, and algorithms like Johnson's rule for two-machine scheduling. Sequencing directly affects throughput and due-date performance. CPIM learners must understand sequencing principles to reduce inefficiencies and prevent bottlenecks.

14. Capacity-Constrained Scheduling (CCS)
CCS integrates capacity limits directly into scheduling decisions. It includes finite capacity planning, constraint-based scheduling, and resource synchronization. CCS produces realistic schedules that avoid overload and minimize the amount of corrective rescheduling. CCS tools help planners align material and capacity availability at detailed levels. Understanding CCS is essential for environments with complex routings or shared resources.

15. Synchronization of Material and Capacity
Material availability must align with machine and labor capacity to avoid idle time, shortages, and schedule disruptions. Synced planning requires accurate lead times, BOMs, routing data, and real-time status updates. Tools like CRP, detailed scheduling, and MES support synchronization. CPIM emphasizes that mismatched material and capacity planning is a major cause of schedule instability and reduced throughput.

16. Manufacturing Execution Systems (MES)
MES systems provide real-time visibility into shop-floor operations, including job status, machine utilization, downtime, and quality metrics. Integrating MES with ERP enhances scheduling accuracy, rapid rescheduling, and performance monitoring. MES supports execution of detailed schedules and enables immediate response to disruptions. CPIM candidates must understand how MES strengthens throughput and flow management.

17. Visual Scheduling Tools (e.g., Gantt Charts)
Visual scheduling tools display work orders, time

constraints, and resource assignments in an easy-to-analyze format. Gantt charts help planners identify overlaps, bottlenecks, idle periods, and capacity conflicts. They support communication between planners, supervisors, and operators. Visual tools enhance understanding of flow behavior and speed up schedule adjustments. CPIM stresses their role in maintaining clarity on the shop floor.

18. Shop Floor Control and Dispatching

Shop floor control (SFC) tracks work progress, provides performance feedback, and supports dispatching decisions. Effective SFC ensures adherence to the detailed schedule, triggers corrective action, and helps evaluate throughput. Dispatching communicates real-time job priorities to operators. SFC also captures actual lead times, scrap, downtime, and changeovers—all key inputs for future scheduling improvements.

19. Variability and Flow Management

Variability in demand, processing times, machine uptime, and material supply disrupts schedules and reduces throughput. Flow management strategies—including standard work, preventive maintenance, cross-training, and buffer placement—help reduce variability impacts. CPIM emphasizes understanding how variability affects WIP, lead time, and overall throughput. Reducing variability strengthens schedule reliability.

20. Continuous Improvement in Scheduling and Throughput

Continuous improvement tools—Lean, Six Sigma, Kaizen, and PDCA—drive ongoing enhancements in scheduling accuracy and throughput performance. These methods help identify root causes of schedule disruptions, reduce waste, and optimize workflows. Improvements may involve setup reduction, process standardization, equipment upgrades, or better load balancing. CPIM stresses that continuous improvement enhances responsiveness, reduces costs, and strengthens system performance over time.

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