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

5.6.3 Optimization vs Re-optimization: Scheduling Horizon

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The timing of scheduling decisions – whether made in advance or during production – plays a major role in choosing the right optimization method. When planning is done ahead of time and the full scheduling horizon is visible, it is possible to use more computationally intensive methods such as exact algorithms or hybrid techniques. These methods are appropriate for strategic or tactical planning, where longer computation times are acceptable, and the focus is on building high-quality schedules from scratch.

As operations begin, however, production systems often face disruptions like delays, machine failures, or last-minute changes in demand. In these cases, re-optimization must happen quickly to keep production on track. Instead of creating an entirely new schedule, the system must adjust the existing one while preserving stability and minimizing disruption.

This shift from long-term planning to real-time response means a shift in methods too. While initial scheduling can rely on precise, slower methods, re-optimization typically uses faster metaheuristics that can return good solutions quickly. These methods are better suited for adapting existing schedules to new conditions within seconds or minutes, especially when many scheduling decisions have already been implemented.

In re-optimization, the goal is often to make the smallest possible changes to the current schedule while still resolving the issue. This helps maintain stability across machines and work teams. Some changes may simply delay affected tasks, while others require partial rescheduling of only a portion of the timeline. The shorter the scheduling horizon, the more important practical factors like machine setup states, current inventory locations, and staff availability become.

Metrics for success also vary with the planning horizon. Strategic planning is judged by long-term goals like average throughput or cost efficiency. Tactical scheduling might focus on weekly productivity or minimizing idle time. Real-time re-optimization is typically evaluated by how quickly the schedule recovers, how many operations are affected, and whether promised delivery times are still met.

Because each level of scheduling requires different priorities and methods, effective systems must coordinate across all time horizons. Short-term disruptions can lead to medium-term plan adjustments, and repeated issues at the operational level may prompt changes in long-term planning. Integrating scheduling decisions across these horizons ensures that the system remains both efficient and responsive.

References

1. Vieira, G. E., Herrmann, J. W., & Lin, E. (2003). Rescheduling manufacturing systems: A framework of strategies, policies, and methods. Journal of Scheduling, 6(1), 39-62.
2. Aytug, H., Lawley, M. A., McKay, K., Mohan, S., & Uzsoy, R. (2005). Executing production schedules in the face of uncertainties: A review and some future directions. European Journal of Operational Research, 161(1), 86-110.
3. Ouelhadj, D., & Petrovic, S. (2009). A survey of dynamic scheduling in manufacturing systems. Journal of Scheduling, 12(4), 417-431.
4. Pfeiffer, A., Kádár, B., & Monostori, L. (2007). Stability-oriented evaluation of rescheduling strategies, by using simulation. Computers in Industry, 58(7), 630-643.
5. Sabuncuoglu, I., & Bayiz, M. (2000). Analysis of reactive scheduling problems in a job shop environment. European Journal of Operational Research, 126(3), 567-586.
6. Shachnai, H., Tamir, G., & Tamir, T. (2012, April). A theory and algorithms for combinatorial reoptimization. In *Latin American Symposium on Theoretical Informatics* (pp. 618-630). Berlin, Heidelberg: Springer Berlin Heidelberg.