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

5.3.1. Types of Machines in Production Systems

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Production systems can be classified by how machines are structured and how jobs flow through them. The most basic environment is the single machine system, where all jobs are processed one after the other on a single machine. Although this setup may seem simple, it often involves complex scheduling decisions, especially when accounting for real-world factors such as due dates, setup times, or job priorities.

On the other hand, parallel machine environments consist of multiple machines that can perform the same or similar operations. In these systems, scheduling involves not only the order of processing (as in the single machine environment), but, also, the assignment of jobs on machines. Depending on their specifications, machines may belong to different types. First, they may be assumed as “identical”, where they require the same amount of (processing time) to process the same job. The second category includes “uniform” machines, which operate at different speeds. Finally, the last division of machine types in the parallel machine environment refers to the “unrelated” machines, which commonly vary significantly in how they process different jobs and thus, the corresponding processing times.

Shop environments involve multiple stages, and jobs may pass through them in predefined ways. In flow shop systems, all jobs follow the same sequence of machines, while in hybrid flow shops, some stages may include multiple parallel machines. Hybrid Flexible flow shops consider the possibility of jobs skipping some of the production stages. Job shop environments allow each job to follow a unique route through the machines, increasing flexibility but also complexity. Open shop systems provide the most flexibility, as jobs can be processed in any order across available machines.

Each machine environment presents distinct challenges for scheduling and optimization. The choice of configuration affects not only the complexity of the problem but also the solution methods that can be effectively applied.

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