The coordinated use of computers throughout the entire spectrum of manufacturing and business operations has been growing during the 1990s and is expected to continue during the 21st century. With the continued increases in computing power and advances in telecommunications, the use of optimization has expanded as well, including planning and scheduling.

For years, continuous operations have been the most prevalent mode in chemical processing. The most appealing feature of batch processes is their flexibility in producing multiple products in a single plant through sharing of process equipment. The batch operations are economically desirable, especially when small amounts of complex, high-value-added chemicals are produced or when a large number of products are made using similar production paths.

The manufacture of all chemical products involves three key elements: a process or recipe, which describes the set of chemical and physical steps, required to make product, a plant comprising a set of equipment within which these steps are executed and a market, which defines the amounts, timing and qualities of the product, required. The equipment configuration may change each time that a different product is made. Thus, in the batch case there exists an additional engineering decision level: the assignment of recipe steps to equipment items over specific intervals of time.

A key problem which arises in batch operations is the scheduling of the plant to meet specified product requirements. The scheduling problem involves three closely linked elements:

* Assignment of units and resources to tasks
* Sequencing of the tasks assigned to specific units
* Determination of the start and stop times for the execution of all tasks.

The above problem elements are shared by scheduling problems arising in a wide range of applications – ranging from machine shops to transportation systems to class room allocation. The assignment component of the problem involves binary decisions as does the sequencing component. The timing component can be a discrete decision problem or not depending upon whether time is treated as a continuum or divided into individual time quanta.

The staged nature of a processing network, consisting of a number of units in series, allows four different storage operations:

* Unlimited (infinite number) intermediate storage (UIS)
* Finite (specified number) intermediate storage (FIS)
* No intermediate storage (NIS)
* Zero wait or no wait (ZW or NW)

The solution of the scheduling problem is critically affected by the performance criterion, the intermediate storage and the structure of the network. In terms of performance criteria, different objective functions can be used. Minimum total time required to produce all products or makespan is one of the most studied objective functions. To sum up, a single, universal solution approach to all scheduling problems does not exist and it is highly unlikely that one will ever be found.

The categories of solution algorithms which have been advanced for the solution of scheduling problems include: rule-based dispatching methods, randomized search methods, artificial intelligence related methods, simulation approaches and model-based optimization methods. Model-based optimization employs a mathematical model of the application as the basis for conducting a systematic search of the solution domain using numerical and logical methods, such as linear programming. The advantage of a model is that it offers a rigorous measure of the quality. However, model formulation may require considerable expertise and the optimization process can be quite computationally intensive.

The recurrence relations indicate that the completion time of a job on a unit is its processing time plus the time at which processing can start. This implicitly assumes that the transfer time of the job from one unit to another is negligible. Applying these questions recursively, the completion times for the entire sequence of jobs on all processing units can be calculated with an amount of computational effort proportional to MxN. As the complexity of the flowshop increases, the recurrence relations become more complex to formulate.

Production scheduling is of immense importance in noncontinuous processes of the chemical process industry. Application of the scheduling methodology can significantly improve the productivity and cost-effectiveness of batch processes. The determination of completion times for a given product sequence in serial multiproduct noncontinuous plants is examined thoroughly. The categories of solution algorithms which have been advanced for the solution of scheduling problems include: rule-based (heuristics) dispatching methods, randomized search methods, artificial intelligence related methods, simulation approaches and model-based optimization methods. The advantage of a model-based optimization approach is that it offers a rigorous measure of the quality and the feasibility of any solution that is obtained.

*Скоординированное использование компьютеров всюду по всему спектру технологических и деловых операций росло в течение 1990-х и, как ожидают, продолжится в течение 21-го века. С длительными увеличениями вычислительной мощности и достижениями в телекоммуникациях, использование оптимизации расширилось также, включая планирование и планирование.*

В течение многих лет непрерывные операции были самым распространенным способом в химической обработке. В последние годы, однако, был возобновившийся интерес к серийным производствам по ряду причин. Самая привлекательная особенность серийных производств - их гибкость в производстве многократных продуктов на единственном заводе посредством разделения технологического оборудования. Периодические операции экономически желательны, особенно когда небольшие количества