In the beginning of this work, the manufacturing systems are hierarchically approached on three levels: the first one corresponds to the global enterprise, the second one to the production planning sector and the third level corresponds to the scheduling sector. A Job Shop Scheduling (JSS) problem tries to allocate a finite set of resources over time to a finite set of different jobs in a minimum time, while satisfying temporal and resource constraints. Each job has a fixed order of operations, these are to be processed on a specific machine for a specified duration and the solution of the problem is an optimal schedule (an optimal table of starting times for each operation of all jobs).

The thesis focuses on Multiobjective Flexible Job Shop Scheduling (MOFJSS) problems, which are tackled as scheduling processes; the flexibility considered here is a type II flexibility (the routings of the jobs on the resources are flexible) and the processes objectives are three: minimizing the makespan, reducing the number of late jobs and minimizing the average ratio of the idleness time of the jobs. The author extends the mathematical framework associated to the JSS problems to a formal definition of the MOFJSS processes within the systems theory context, by specifying the process hypothesis, the input, the state and the output variables, the constraints and the objective. The hallmark of these processes consists in their high level of complexity, mainly conditioned by the huge dimension of the search space, by the difficulty in the representation, by the hard constraints and the enormous effort to evaluate the candidate-solutions.

The primary contributions of the thesis address a poorly approached direction in the literature, namely the systemic modeling of the optimization processes control based on genetic algorithms. These contributions consist in the following aspects:

- providing a procedural model for the optimal control of MOFJSS processes based on genetic algorithms;
- designing a particular genetic algorithm enriched with a control strategy able to avoid the premature convergence of the genetic algorithm to suboptimal regions of the search space (imperative for the complex processes);
- proving the model viability by experiments on two deterministic scheduling processes in the manufacturing area, approached as uniobjective and multiobjective
processes: a complex FJSS process instance in the pharmaceutical industry and the JSS process associated to the famous test-instance \( f_{10} \).

*The proposed model* is an intelligent state reactive production control system. The controller output addresses to the genetic operators block to produce a set of virtual allocation scenarios for the resources, set which constitutes the current state of the modeled system at a discrete moment of time (generation of the genetic algorithm). A transducer estimates this state as the fitness of the current population and a comparing element informs the controller if the stop evolution criteria are met. These criteria once satisfied, after hundreds or thousands of generations, the system state is transferred to a final decision element to select the optimal schedule, which represents the effective allocation command for the resources. Beyond the specifics of the JSS processes, the model proves the advantage of generality; it is able to embody any optimization process for that exists a genetic encoding and to use any sequential genetic algorithm.

*The designed particular genetic algorithm*, named *NSGA_II ADR*, reinforces the well-known NSGA_II algorithm with a command strategy that is a procedure for heuristic adaptive control of the optimization process. The role of this strategy - avoiding the premature convergence of the algorithm through population diversity preservation - is fulfilled by two mechanisms submitted to research by the author: the dynamic application of many genetic crossover and mutation operators and the partial reinitialization of the genetic population, both of them being based on the average progress of the genetic operators during the evolution.

The results obtained by the NSGA_II ADR algorithm compared with those of applying other three genetic algorithms in the accomplished experiments prove the efficiency of the designed model for the MOFJSS processes control.

*Additional contributions of the work to the field* are the following:

- a critical analysis for the most of scheduling techniques and for the most of systemic models associated to the (MOF)JSS processes;
- locating the scheduling problem on the intersection of many research areas: combinatorial optimization, operational research, cybernetics, theory of discrete events systems control and evolutionary computation;
- finding multiple possibilities to model the FJSS processes, such as: coloured timed Petri nets, procedural models (for example multiagent systems, genetic algorithms, expert systems, fuzzy techniques, artificial neural networks), decision support systems, logic frameworks such STRIPS language, Markov chains and Monte Carlo simulation;
- efficient implementation procedures for some genetic mutation operators (frame-shift, translocation and inversion) for the permutation encoding;
- developing a Java software application in order to simulate the designed GA-based control system, which supports any genetic algorithm, any genetic encoding and any optimization process (uniobjective or multiobjective).