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Editorial

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Multi - Objective Optimization and Engineering Management

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This editorial is the occasion of opening the exciting experience of the *Industrial Engineering* and *Management* journal from the OMICS group. The aim of this journal is to become a reliable source of information between the leaders in the field of industrial engineering management journals with a quick review process.

The subject discussed in the paper is the multi-objective optimization of industrial management which is one of the topics of the journal. Indeed, as the economic competition turns harder and harder, industrial companies have to face much more difficulties. To afford that problem, they have to optimize different criteria simultaneously. In addition to that, today's customers want the right product at the right price and at the right time. That is why multi-objective optimization becomes more and more a main issue in the management of production systems. The rest of this short document aims to underline the main techniques and resolution methods used in the multi-objective optimization and especially to solve multi-objective scheduling and lines design problems.

As a starting point, we have to claim that the different objectives must be contradictory. Otherwise, the problem can be easily solved with the scalar multi-objective optimization. Since scheduling problems are first discussed here, specific objectives usually studied are described. In scheduling problems; the most studied criterion is the makespan minimization which increases the production rate of the system. Another objective is the minimization of the total tardiness of the tasks which increases the service quality and customers' satisfaction. Another objective is the variability of the cycle time which decreases sudden changes in the workload. Thus, dealing with multi-objective optimization is essential if one wants to increase the production rate without decreasing the quality of service. The multi-objective optimization is therefore with a challenge to tackle and encounter the tradeoff between several criteria or objectives.

For the multi-objective lines design problems such as buffers sizing, line balancing or equipment selection s, different objectives may be taken in consideration. Two criteria are generally the most studied ones: the minimization of the cost of the line and the maximization of the line throughout rate. The cost minimization allows lines manufacturers to be more competitive in the market. Besides, the line throughput rate maximization allows enhancing the service level for example. However, throughput rate maximization means automatically being constraint to use efficient machines which are naturally more expensive than less efficient machines. A trade-off must be found to maximize the technical objective (throughput rate) and to minimize the financial objective (the cost of the line).

From the end of the 80's until recently, the main and usual way to cope with multi-objective optimization is to get the weighted sum of several objectives. With this technique, many single objective methods can be used to solve problems because several objectives are turned into only one. By this way, the classical techniques such as: Branch and bound, Linear programming, Simulated Annealing, Tabu Search, Genetic Algorithm, Ant Colony System and others can be applied to solve the problems. This kind of optimization is a good start but they have some limitations: the link between the objectives is fixed with a specific weight and sometimes good solutions are lost by this additional constraint.

The understanding of the scalar multi-objective optimization limitations is the initialization point of the multi-objective optimization with the use of the objective vector. In this type of optimization techniques the objectives are not linked and then no constraints are added to the problem. Consequently, a question is highlighted: when I have two solutions, which one is the best one? This question is answered by using specific dominance properties.

The most common dominance relationship is the Pareto one which introduces not a best solution but a set of best solutions to the problem. Nowadays researchers have succeeded to develop new dominance relationship such as the Lorenz dominance relationship of S-cone properties to get the most relevant solutions to solve a problem. This way of improvement is completed by another one which is the construction of specific metaheuristics like genetic algorithms.

One of the most applied multi-objective algorithms is the Non-dominated Sorting genetic Algorithm [1,2]. In this algorithm, the solutions are assigned to different sets of non-dominated solutions (which are the best according to the adopted dominance relationship) and these solutions are then mixed to get improved solutions. A specific mechanism o f the algorithm is the crowding distance which maintains diversity of the solutions. Another well-known multi-objective algorithm is the Strength Pareto Evolutionary algorithm which uses an archive mechanism to get the same results of the Non-dominated Sorting genetic Algorithm.

Another way of optimizing in a multi-objective way is the use of Multi-objective Ant Colony System. In this type of resolution techniques, a classical (i.e. single objective) Ant Colony System is considered as the base but adapted to multi objective procedure. Indeed, there are as many pheromones matrices as the number of objectives.

The interest for multi-objective optimization of scheduling problems is growing every day. There are different ways to improve the results: by using improved dominance relationships, by applying new dominance properties, or by adopting specific mechanisms to discard low quality solutions. We have not discussed about parallel computing or exact methods which are promising ways too. We hope to see high level papers dealing with multi-objective optimization in the industrial engineering and management journal.

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