ABSTRACT

Lots scheduling problem with setup times Cyclic dependent and independent of the sequence Paint Systems Applications.

To define an efficient way to sequence a series of products in a production process affects in a relevant form, productivity and manufacturing costs.

In the painting process of manufacturing companies of auto parts for the automotive industry the schedule and sequencing of products is done based on the customer master schedule. The manufacturing program is carried out following the requirements of models and colors that are requested and need to be delivered. In factories with these processes the information on the specifications of the products is often met with a very short window of time, in some cases as little as six hours. This requires a very flexible response. This thesis analyzes and seeks to improve the sequencing procedures to minimize changes that generate a *setup* in painting processes.

The generation of setups in an auto parts painting plant may occur by two situations: 1) changes in the product model and 2) changes in the color used to paint. These cases occur independently from each other, in a specific time it is possible that either one case can occur or both simultaneously. It has been found that existing sequencing techniques do not contemplate the situation to optimize a production process of painting minimizing the number of changes that are generated by the two situations presented.

The main motivation in this thesis is to develop procedures for solving the problem of bi_objective sequencing painting processes because existing techniques to minimize the number of setups do not consider this case. The application of conventional techniques is not sufficient to achieve efficiency at generating the best sequence.

We part from the case of some specific number of companies to define the problem in working hypothesis. A review of the references included in related topics like “Sequencing in closed circuit processes”, “cyclical scheduling” and “Optimization of setups” is done. Having given the hypothesis and reviewed the literature, the lack of models, methods and procedures in this environment is confirmed, with the exception of two references. The initial hypotheses were expanded to a wider focus of the problem: not only the basic case which looks for

minimizing the number of changes of pattern and color, but a second problem is analyzed: to minimize the number of gaps that are generated when a setup occur either by changing color or pattern. In both cases, new mathematical models were designed and widely explained. In the model with gaps a very important contribution was done: the form of counting the empty spaces with uncertain horizon. It is explained in depth.

Since both problems are *NP_hard,* if they are explored through optimization software, they quickly grow in resolution time. For this reason it is necessary the development of different heuristic procedures that provide a good solution where a reasonable computational time is warranted. For all of these processes it has been made a program code that simulates each case. In the problem without gaps 27 heuristic procedures were generated. For the problem with gaps, 19 procedures have been designed. For both problems conclusions were presented and the most efficient heuristics were justified by both points of view: statistically and analytically. A comparison with the theoretical optimum was made.

Finally general conclusions are presented indicating possible future research in which the problems explained can be expanded and also indicating the possibility of extending the approach presented to other bi_objetive manufacturing lines, not necessarily painting systems.