ABSTRACT

In the Integrated Manufacturing scenario, the Computer Aided Process Planning (CAPP) is recognized as a significant tool, to achieve the integration between the design and manufacturing activities. In dealing with dynamic changes in product development and the manufacturing environment, the knowledge of developing the integrated CAPP systems has been increased.

The main objective of this research work is to develop an integrated process planning system for the manufacture of the leaf spring assembly, that helps the designers, and the process planners to improve their design, and planning in the early stages of the product life cycle. In order to achieve this goal, the following specific objectives have been accomplished:

- A software system model has to develop using a feature modeller with a mechanical modelling system, to build the part, the leaf spring assembly, using high-level design features. The feature modeller is capable of interconnecting the high-level product data and the mechanical design system. The product information is stored in the database, which is used to integrate the design and manufacturing phases.

- The data file in the developed feature-based process planning system for the leaf spring assembly, maps and produces the
corresponding manufacturing processes with optimized parameters to generate a process plan.

- The developed system is integrated with the Solidworks 2010 application program interface. An example is presented to demonstrate and verify the applicability of the developed system. Based on the features and their mapping, the machining processes, cutting tools, and machine tools are selected from the shop floor database module. The optimized process parameters for the significant processes are generated by the optimization methodology adopted in this system.

- As a single response problem, the manufacturing processes are mathematically modelled based on the interrelationship between the parameters. The simulated annealing algorithm procedure is applied to obtain the optimal response values.

- The multiple responses of the significant manufacturing processes are optimized, by the combined approach of the Taguchi based Grey Relational Analysis and Simulated Annealing Algorithm. Subsequently, the optimal processing sequence with respect to the parameters is obtained by the simulated annealing algorithm.

In the present work, an attempt has been made to obtain the optimal parameters for the shearing, hole punching, eye forming and cambering processes in the manufacture of leaf spring assembly. The analysis has been
carried out to measure the effect of squareness, length, hole diameter, hole offset, eye diameter, eye end gap, eye twist, camber distance and hardness number by adopting Taguchi’s design of experiment concept. This study was done to analyze and develop a mathematical model using statistical tools.

Multiple performance optimization was carried out to optimize the process parameters using the Grey relational analysis. After converting the multiple responses into a single response by the grey system theory and non-linear regression models were developed for the significant processes using a statistical software SPSS. The results of the model indicate that the experimental values were in close proximity to the values at 95% confidence level. The influence of the various parameters in the leaf spring manufacturing has been identified through the integrated approach of the Taguchi based Grey relational analysis and the simulated annealing algorithm.

The optimized process parameters obtained in this research work help the process planner to reduce the product manufacturing lead time, and product cost, and improves the utilization of the manufacturing resources.

Finally, this research will contribute significantly for the manufacture of the leaf spring assembly with development of the CAPP system. The implementation of the feature based design technique used in this research will support the integration of the CAPP system with other systems in an integrated manufacturing environment. The developed system is proposed to be an effective concurrent engineering tool that fills the gap between design and manufacturing.