ABSTRACT

The manufacturing sector faces a lot of difficulties to compete in the market and nowadays most of the foreign companies started their manufacturing operations either with partnership or on their own, in diversified areas with the support of already existing ancillary industries. The tremendous growth in the expectations and need in the manufacturing sector calls for lot of critical processes with very higher quality levels and at the mean time, there is a huge competition arises, between market participants in terms of quality, cost and delivery. Nowadays customers also demanding the technical and quality requirements and they are more sensitive to cost of the products as well. It is mandatory to optimize all manufacturing processes (Productivity to be maximized, Cost to be minimized and Quality at its best level) to stay competitive in the global environment and at the same time the optimum prediction in manufacturing process involves lot of experimentation as it involves time and cost. So it is essential to optimize any manufacturing process for better quality parameters and productivity requirements. At the mean time optimum parametric combination has to be identified with minimal effort (minimum experimental runs) and with highest possible accuracy as it involves lot of cost and time.

Sleeve synchroniser manufacturing involves operations such as Rough broaching of inner splines, Internal teeth roll forming using roll forming machine, Inner teeth V Chamfering, Key way milling for hub locking, gear hobbing, Gear Radius chamfering for burr removal, gear Shaving, Carburising, Gear teeth Induction hardening and sleeve hard groove turning. In the above said operations Hard Groove turning and Hobbing are very critical operations with high quality requirements.

Gear Hobbing is more critical, as any problem in pressure angle variation (Profile Bias) and helix angle variation (Lead Bias) will lead to noise during vehicle running. Profile and Lead bias can’t be checked 100% during machining operations. After transmission assembly, during
testing in Gear tester or testing the vehicle at road test, it will be detected as gear rubbing noise and Gear Humming noise. Entire transmission has to be reassembled for repair, where huge amount of repair cost and time are involved. Being origin of the problem is in Gear Hobbing, it has to be either detected in same machine or occurrence of the problem can be eliminated by robust parameter optimization, So Optimization of gear Hobbing process for better profile bias and Lead Bias becomes very crucial.

Hard groove turning process is critical in sleeve synchroniser manufacturing process, as any surface finish related issues will lead to Gear shifting noise, where the customer will feel the gear shifting during driving. Hard turning is the bottleneck operation in terms of cycle time, so optimization of sleeve hard turning process for better cycle time and better surface roughness is critical one.

Both the cases, machines are running 24 hours a day and 7 days a week pattern. Process optimisation requires lot of experimentation and time, which cannot be barred in the real working environment. It is essential to select the optimisation technique which uses lesser number of experiments (Taguchi Parameter design is one such method) but at the mean time the experimentation should give results right at First time.

Taguchi parameter design was analysed in detail, major drawback of the Taguchi parameter design is confounding, and where interaction effect is confounded with factor effect due to which exact results may not be achieved right at first time. RABAL algorithm, a 12 step approach with 3 rules, was developed to address confounding issues in Taguchi parameter Design. RABAL algorithm along with Taguchi PDE was applied in Sleeve synchroniser Gear Hobbing and Hard Groove Turning processes and both the processes were optimised and results are achieved First time Right.