Preface

Product is something that may be offered to a marketplace for attention, acquisition, use, or consumption which may satisfy a wish or want. In business and engineering, development is the complete method of delivery of a brand new or changed product to promote to rework a market chance into a product on the market purchasable. Products are often classified as tangible or intangible. A tangible product could be an object which will be perceived by touch or vision like a machine, instrument, equipment, gadget, vehicle etc. whereas an intangible product could be a product which will solely be perceived indirectly like an insurance, software etc. A decent understanding of client desires and needs, the competitive atmosphere and also the nature of the market represent the highest needed factors for the success of a launched product for an increased existence.

Cost, time, and quality are the most important variables that drive the client wants. Aimed toward these three variables, firms continuous develop / improve practices and techniques to satisfy the client necessities and reciprocally increase their market share and profit. There are several uncertainties and challenges throughout the method which are the main concerns for the management and usage of best practices eliminates hurdles or barriers. Most organizations realize that all products have a limited lifespan, and so products need to be developed and modified continuously by the company to stay in business. Designing and optimizing a new product is typically a huge part of any manufacturing process and in long run extends product life span.

The main objective of the book is product development and target audience are all Academics Students, Researchers and Industry Practitioners, Engineers, Research Scientists/ Academicians involved in design of Mechanical Engineering products.

The chapters in the book has been categorized in three sections, namely Section 1: Design and Development of New Component/Product and Usage of Alternative Design Methodology for Betterment; Section 2: Development of New or Alternative Material for an Existing Component/Product; and Section 3: Product and Process Optimization.

Section 1 contains Chapter 1 to Chapter 6, whereas Section 2 has Chapter 7 to Chapter 10, and Section 3 with Chapters 11 to 14

Section 1 starts with Chapter 1 which introduces the readers to different approaches to New Product Development and the various variables associated to them. It is a fact that new products are launched daily across the world providing answers to common or specialized problems, enrich lifestyles, provide alternatives to old solutions, amuse us etc. New Product Development is a major issue for most companies as they seek to reduce time to market, reduce the development cycle, access new technologies and develop more and better products and services. Companies that develop, design, manufacture, market and sell these products seek commercial compensation in the short, medium or long term “success”. Subsequently, new products that can successfully compete in local, national and global markets are a

key concern for the majority of companies, so this chapter reviews the New Product Development process and considers the variables associated with the different approaches, which may be needed when developing a new product.

Chapter 2 indicates development of a proper Resin Transfer Moulding process for a proper mould design. It is very much required for composite parts that are large and complex geometry and would be difficult to manufacture by hand layup method. The RTM process is a better substitute to it, but is not used readily due to the lack of proper manufacturing technology. In addition, the difficulty in the tooling design and mould fabrication cost increases with increase in size and complexity of the component. The scale down strategy of full scale product avoids bigger size mould requirements, prototype bulk production for product testing and quality check at the starting phase of product development. Moreover, the mould scale down strategy can be used to validate the process and the product with less capital input. In this chapter, a methodology to develop a RTM technology for manufacturing of a complex and large composite structure (high speed cab front) utilizing the process simulation were demonstrated.

Chapter 3 highlights the usage of two different methodologies namely Free vortex theory and mean stream line theory for designing of mixed flow pumps used in a wide range of application such as that in irrigation, flood control, dewatering and power station cooling systems. In this blades of the impeller of the mixed flow pump has been designed using Mean stream line theory and the free vortex theory and stresses arising due to static loading conditions has been obtained for both the cases. Comparison analysis for the equivalent stresses developed due to structural loading using various materials for the blade was undertaken. It was found that the stress for the blade designed using mean stream line theory is always on the higher side in comparison to that designed using free vortex theory.

In Chapter 4 Base Isolation System for Buildings is designed. Base isolation has now been implemented in numerous buildings in countries like Italy, Japan, New Zealand, and USA. It has also proven to be effective for retrofitting of important buildings (like hospitals and historic buildings). Seismic base isolation is one of the most widely implemented and accepted seismic protection systems and is a relatively recent and evolving technology. The most common isolation system used is Laminated Lead Rubber Bearings (LLRB). They combine the function of isolation and energy dissipation in a single compact unit, giving structural support, horizontal flexibility, damping, and a re-centering force in a single unit. The force deformation behavior of LLRB is modeled as bilinear system with viscous damping. In this chapter, a comprehensive design of LLRB is presented. Accurate evaluation of the structural properties and precise modeling of isolation devices are of utmost importance in predicting the response of the structure during the earthquakes.

Chapter 5 elaborates application of reverse engineering technique for designing a twin tube shock absorber which can be used in an automobile where presently mono tube shock absorbers are being used. The whole work has been done on a virtual platform form generating 3D CAD model of the damper to CFD analysis of the same. The data obtained was used as the datum for the design modifications and performance enhancement of the part. Subsequently similar analyses were conducted on the modified assemblies and most optimal one was highlighted.

In Chapter 6 a Louvered Cylindrical Mixing Pipe was designed with an aim of Maximum Air Entrainment. In order to achieve the same, Conservation equations of mass, momentum and energy have been solved numerically along with a two equation based k-ε turbulent model to determine the air entrainment into a mixing pipe. Two different louvered pipe configurations (one with entrance face closed to atmosphere while the other was opened) were used to entrain air into the mixing pipe and by changing various design parameters, the resulting effects were studied. For both the configurations, the

opening area and the number of nozzles (assumed exhaust pipe) had significant effect in bringing down the exhaust temperature especially the configuration with its entrance face opened to atmosphere and temperature as low as 309 K (approx.) was successfully achieved through the analysis. This ends the section which was dedicated to designing and development of new Components or products and also usage of alternative design methodology for betterment.

Section 2, dedicated to development of new or alternative material for an existing component or product, starts with Chapter 7. The chapter proposes composite based material as a replacement for braces of orthotic calipers where presently aluminium alloys are being used. Components were fabricated using both thermoset and thermoplast matrix material with compatible reinforcement. The components were tested for some of the mechanical properties both by experimentation and by simulation. The findings were quite encouraging as it not only had a higher mechanical strength but also had a much lower weight to volume ratio, making it more adaptable for the locomotion affected patients.

Chapter 8 describes Friction-stir processing as a property enhancement technique which, not only removes the defects of initial casting process, but also improves the microstructure of the metals and metal matrix composites. The technique can be specifically applied to develop fine-grained microstructures throughout the thickness of metal surface, to impart super plasticity and ensure homogeneous distribution of reinforced particles, if any. This chapter is a dedicated effort to consolidate the latest developments contributed by different researchers in last few years. The work covers various components and parameters, selected and used to obtain specific desired results. Also, it includes past researches to exhibit various changes in mechanical properties with a keen focus on morphological study of these MMCs.

In Chapter 9 looking at the environmental issues, energy generation using renewable resources has been targeted. Again in order to move further the blades of the rotor for the wind turbines have been developed using biodegradable and light weight natural plant fibres for reinforcement in polymeric resin to produce required polymer composites.

Chapter 10 investigates the performance of annular fin with functionally graded composite materials. The chapter involves computation of efficiency and effectiveness of such fins and compares the fin performances for different geometry and grading parameters assuming unidirectional temperature gradient i.e. along the radius. A general second order governing differential equation has been derived for all the profiles and grading considering thickness of fin and functional grading of thermal conductivity to be a power function of radial co-ordinate. The performance analysis reveals the dependence of thermal behaviour of annular fins on geometry and grading parameter. This ends the section dedicated to development of new or alternative material for an existing component or product.

The last section, i.e., Section 3, dedicated to product and process optimization, commences with Chapter 11. The chapter introduces application of a soft computing technique i.e. artificial neural network for performance optimization of Micro Electro Discharge Machining. Micro Electro Discharge Machining is a non-conventional or nontraditional machining technique currently having high market demand due to accuracy, ability towards complicated machining as well as machining of extremely hard materials like Tungsten Carbide. This chapter discusses about micromachining on Electric Discharge Machining, its working principle and problems associated with it. Solution to those problems is suggested with the addition of powder in dielectric fluid. The optimization of Material Removal Rate was done with the help of ANN toolbox in MATLAB software.

Today all forums and organizations are very much concerned about Global Warming. The next chapter in this section, Chapter 12 introduces multi-criteria decision making optimization tool towards green manufacturing. Presently industries, especially manufacturing industries, are implementing using various

advanced manufacturing processes for optimal product development. The advance manufacturing process generates large amounts of toxic substances results in various environmental issues during the optimal product manufacturing. Minimization of environmental issues and the amount of waste generated are strongly depends on its process and response parameters. Thus, optimization of process parameters for Green Manufacturing is essential and is a problem. This chapter provides an overview of applications of some multi-criteria decision making methods for optimization followed by detailed fundamental aspects of optimization issues in green manufacturing. The work proposed an integrated method consisting of AHP coupled with MOORA and validated through an experimental case study.

Most of the moving product usually undergoes wear and tear. The situation becomes very critical in case of coated products. Chapter 13 aims to determine optimal tribo-testing condition for minimum coefficient of friction and wear depth of electroless Ni-P, Ni-P-W and Ni-P-Cu coatings under lubrication using Taguchi coupled multi objective optimization tool namely, grey relational analysis. Electroless Ni-P, Ni-P-W and Ni-P-Cu coatings are deposited on AISI 1040 steel substrates. Coating characterization was ensured by studying results of scanning electron microscope monographs, energy dispersive X-Ray analysis and X-Ray diffraction techniques. Friction and wear tests under lubricated condition were carried out following Taguchi's experimental design principle. Finally, the predominating wear mechanisms of the coatings were discussed and the optimal parameters were suggested.

The last chapter of the book and the section Chapter 14 optimizes the input variables like pulse on time, pulse off time, peak current, and servo voltage in Wire Electro Discharge Machine for achieving simultaneous optimization of cutting rate, surface roughness, dimensional deviation, and wire wear ratio for machining of Inconel 625. Inconel 625 is a nickel-chromium based super-alloy which is mostly used in high end applications due to its excellent chemical and fabrication properties combined with high strength and outstanding corrosion resistance. Here using Taguchi's L9 orthogonal array with one replication experimental investigation was undertaken. Taguchi method has been combined with grey relational analysis for multi-characteristic optimization and analysis of variance (ANOVA) has been applied to determine the significant parameters and their contributions on response variables. Finally, results were validated with the help of confirmation experiments.

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