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Research Paper

Mechanical Engineering—Its Origin, History, Progress, Paradigm Shift, Trends And Future

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ABSTRACT: *In this paper, the origin, history, progress, paradigm shift, trends and future of Mechanical Engineering have been dealt with briefly. Mechanical Engineering and the general development of science, technology, and industrial manufacture, including an epoch of scientific revolution in the sixteenth and seventeenth century, is extremely important. Also Industrial Revolution in the eighteenth and nineteenth centuries, and the scientific and technological progress of the twentieth century are happening simultaneously. Fundamental discoveries and the significant contribution of pioneering industrial engineers and of outstanding scientists are making these possible. Modern trends in the further development of Mechanical Engineering are reflected. The importance of the role of Mechanical Engineering in the solution of global problems of life support on the earth in the twenty-first century can never be over-emphasized. Mechanical Engineering in the ancient era, modern era and contemporary era have been discussed. Selective study of more prominent and more important departments and their present state and, how far improvement has progressed during late years are to be cogitated. A paradigm shift in design synthesis and technology forecasting has been noted. Design synthesis methodologies are to be adaptable and expandable as much as possible for application to a new problem not considered in the original development. Mechanical Engineering has to embrace sustainable technologies. As the sustainable approach has penetrated virtually all areas of life, energy conservation, water conservation, responsible production, and consumption patterns, all have become equally important. At present it is conjugated with research and development practices to develop technology alternatives for existing systems. To effectively benefit from technology applications, researchers must set themselves ready for transforming their research and practices and keep identifying effective ways for transformations in their contexts. The role and scope of the Mechanical Engineering profession has been transforming. Both what mechanical engineers do and how they do it are changing owing to the expansion of the discipline's boundaries, increased need to attend to global issues, increased professional and diversity expectations, and rapid technological innovation. These important factors impact the mechanical engineering profession and serve as motivators for significant change within mechanical engineering education. If the Mechanical Engineering profession is to remain viable, it will depend on the ability of mechanical engineers to provide continued value and expertise to industry and government.*

KEYWORDS: ***Mechanical Engg. , Origin, History, Progress, Paradigm Shift, Trends, Future***

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I. INTRODUCTION: ORIGIN OF MECHANICAL ENGINEERING

Improved transportation led to the exploration of steam power and the development of the steam engine. Discovery of electricity sparked off the real science and technology revolutions. This led to the fabrication of steam ships, locomotives, railways, and automobiles, and many other inventions. The development of the internal combustion engine and the car demonstrated the steady development of the fundamentals of machine science from the nineteenth century. Aspiration to ever-faster travel led people to fly. The atomic and aerospace industry have given an impetus to modern machine science development, and created new standards of safety and reliability for machines. Computerized human activity has shifted traditional approaches to methods and means of machine development. Medical diagnostics and public health services are protecting humanity from epidemic diseases. The world of micro-mechanics and robotics, success in bioengineering and biomedicine has paved the path to the development of novel approaches in human life support on the planet. The technology development in all spheres of human activity are improving standards of living, world outlook, communication between people, accelerated development of national economies, defense potential, expansion of opportunities to create a world without frontiers, global co-operation in outer space exploration and atomic energy, the design of supersonic airliners and high-speed transportation systems, up-to-date personal computers, modern communication networks and information transmission and finally in solving the most acute problems of the twenty-first century: the problems of life support on earth and the natural environment. All the above mentioned applications owe their origin to mechanical engineering from the day one to the present day civilized societies.

II. HISTORY AND PROGRESS OF MECHANICAL ENGINEERING

Historical stages of Mechanical Engineering are broadly classified into three eras: ancient era, modern era and the contemporary era. Key relations in the history of Mechanical Engineering are: Nature, Society, Science and Technology. Mechanical Engineering is driven by the same force behind science and technology in general. Mechanical Engineering is influenced by the society and it, in its turn, also influences the society in general. Mechanical Engineering and natural science are inseparable. Mechanical Engineering thrives on many related technological fields and vice versa. Mechanical Engineering has evolved through technological revolution and industrial revolution. Ancient machines have crossed three stages and three regions: West Asia where civilization dawned, brilliance and struggle of ancient China and the twists and turns in Europe's development. Various ancient machines are: simple machines, agricultural machines, blowers and blast technology, boats and ships, vehicles, textile machinery, timers and astronomical instruments, lifting machines, weapons, machines for rituals and entertainment, mechanisms and transmissions. There was ingenuity in supplying power to ancient machines. Ancient manufacturing technologies are casting, forging and other press processing, welding, machining and heat treatment. In this short-length paper, there is no scope for discussing ancient machines in detail.

Mechanical Engineering has witnessed social, scientific and technological progress of Europe. There was important social development before industrial revolution: Emergence of Capitalist Mode of Production, Great Discoveries of Geography, The Renaissance, Religious Reform (the Reformation), The Enlightenment, Bourgeois Revolutions. Mechanical Science and Technology before the Industrial Revolution was greatly influenced by Leonardo da Vinci. Also, Progresses of Machine Theory and Mechanical Technology before Industrial Revolution, Establishment and Development of Classical Mechanics, Breakthrough in Astronomy and Liberation of Scientific Spirit, Theoretical Background, Limitations of Classical Mechanics, Calculus and Differential Equations, Establishment of Calculus Theory of Differential Equation are important gradual development. Mechanical Engineering Development over the years is to be studied with the background of English Industrial Revolution and the first industrial revolution. The world has seen steam engine and transportation revolution. It has been a long process of invention. The creative genius, James Watt made a tremendous contribution. It had an epochal significance. Railway age started. Steam ships were developed. There is a great significance of transportation revolution. There are lots of mechanical inventions in first industrial revolution such as wide application of steam power, textile and sewing machines, agricultural machines, construction and mining machines, refrigeration machines, fluid machines, weapons and information machines. Birth and early development of modern machine is found in building industry. Status of machining in eighteenth century played an important role. Inventions and Improvements of machine tools, birth of interchangeable parts, beginning of standardization and perpetual motion machine concept are also extremely important. Second industrial revolution gave birth to the age of electricity and started the era of steel. One of the several important features of the second industrial revolution is the tremendous development of mechanical technology. Internal combustion engines are widely used in automobile industry, aircraft and aviation industry and other ways of transportation.

Power machinery, pumps and compressors, machine tools, cutting tool materials, progress in metrology, Taylor Scientific Management, Ford's Mass Production, Standardization and Serialization, trends of development of machinery, high speed and large capacity, precision, light weight, automation are important developments. Progress of mathematics related to Mechanical Engineering is calculus of variations, differential geometry, linear algebra, probability theory, graph theory. Further developments are Analytical Mechanics, Elastic Mechanics, Plastic Mechanics, Mechanics of Materials, Theory of Vibration, Fluid Mechanics, relationship between Mathematics and Mechanics, Mechanism Theory, Theoretical Kinematics, Theory of Linkages, Cam Mechanism, Theory and Application of Mechanical Vibration, Machine Dynamics, Dynamic Analysis Methods, Rotor Dynamics, Balancing of Mechanism, Evolution of Mechanical and Hydraulic Transmissions, Modern Machine Design, Descriptive Geometry, Strength of Mechanical Structures. The progress of Mechanical Engineering can be observed in formation of Design Method of Machine Elements, Modern Machine Manufacturing, Theory of Metal Cutting, Theory of Machine Precision, Subject Parturition and Advancing.

Progress is continuous. Revolution in Physics, Birth of System Science, Nonlinear Science, Third Technological Revolution during and after WWII in the fields of IT, Aerospace Technology, New Material and Energy, Modern Bio-Technology, Marine Engineering, New Industrial Revolution, Progress in Mathematics and Mechanics, Numerical Algorithms, Progress in Vibration Theory, Multibody Dynamics, Accuracy, Reliability and Quality Control, Higher Speed and more powerful actions, Higher Performance to Cost Ratio, Environmental Friendliness, Safety and Comfort, Diversification and Personalization, Robotics and Mechatronics, High Speed Rail Systems, Large Scale Construction Machinery, Automotive Manufacturing, Large Power Generating Systems, IC Fabrication, Complex Electromechanical System are some examples of continuous progress. Creative Design, Creatology, TRIZ, Bionic Design (Biomimicry), Reverse Engineering, Computer Aided Design, Computer Graphics are relative recent developments.

Optimum Design, Design for Reliability and Quality, Value Engineering, Industrial Design and Ergonomics, NC Machining and NC Machining Tools, Process Planning, CAD, CAPP, FMS, Robots in Manufacturing, Tool Materials, High Speed Machining, Precision and Ultra-Precision Machining, Machining of Difficult-to-Cut Materials, Near-Dry and Dry Machining, Vibration Control of Machining, Advanced Machine Tools, Free-Form Surface, Machining of Spiral Bevel Gears, Non-Traditional Machining, Additive Manufacturing like Rapid Prototyping, 3D Printing,, Green Manufacturing, Remanufacturing, Computer Integrated Manufacturing System, Distributed Manufacturing, MMS, Mechanical Power Transmission, Friction, Wear, Lubrication, MEMS, Subject Advancing, Intercrossing and Extension, Development of Casting Technology, Development of Metal Forming, Welding, Blank Forming are the more important developments.

III. PARADIGM SHIFT IN MECHANICAL ENGINEERING

Some of the paradigm shifts observed in heavy and other industries like shipbuilding are shifts toward gigantic structures with the advent of riveting and welding technologies, toward labor and total cost saving, speedy systems with the availability of automation technology, various computers and workstations, and advanced information technology (IT). This has led to a paradigm shift from hardware- to software-oriented systems. The advancement of material and its manufacturing technology has led to availability of light-weight vessels and higher performance goods, and oil crises have led to a paradigm shift toward energy conserving vessels and goods. The advent of semi-conductor and integrated circuits has led to a paradigm shift from “big is great” to “small is beautiful” worlds, leading to further emphasis and promotion of micro- and nano-technologies. Paradigm shifts in transportation architecture and the lightweight design is also commonplace now-a-days. Several other examples may be cited.

IV. TRENDS IN MECHANICAL ENGINEERING

The glimpses of trends of Mechanical Engineering may be obtained by looking at the following:

- Impact of Armor-Perforating Projectile on a Bullet-Resistant Silicon-Carbide-Graphene Composite through Finite Element Method
- Artificial Neural Network Model Development for the Analysis of Maximum Pressure of Hole-Entry Journal Bearing Using Sci-Lab
- Design and Simulation of Wind Tunnel Using CFD Analysis
- Evaluation of Seat to Head Transmissibility at Different Backrest Conditions during Whole Body Vibration Using Fem
- Developments in Three-Dimensional Scanning Techniques and Scanners
- Damping Behaviour of Bias Flow Perforated Acoustic Liners: A Parametric Study.
- Design and Fabrication of a Socket Jockey and Its Use in Home Automation:
- Algorithm for Translation and Rotation Motions of Gantry Robot
- Optimal Selection of Circular Interpolation for CNC Turning Centers Classification of Motorcycles and Prediction of Indian Motorcyclist’s Posture at the Conceptual Design Stage
- Performance Enhancement of Evaporative Cooling Device Using Silica Gel as an Adsorbent Material
- Design and Analysis of an Air-Purifier Using Cyclone Separator for Industries
- Development of a Surge Tank Set-up and Its Utilization in the Diesel
- Engine for NOX Emission Reduction

- Numerical Study of Swan Neck Rear Wing for Enhancing Stability of Ground Vehicle Bodies
- CFD and Thermal Analysis of the Flat Plate Collector—Solar Water Heater under Steady-State Conditions
- Performance Comparison of Refrigerants HFO1234yf And HFO1234ze in a Vapour Compression Refrigeration
- System Operating Under Fouled Conditions
- Computational Model Sensitivity and Study of Joint Bias-Perturbed
- Grazing Flow through Perforated Liner
- Role of Agitator Diameter and Nusselt Number for Finding Heat
- Transfer Equations in Jacketed Vessel
- Performance and Emission Testing of Diesel Engine Using Blends of Biodiesel from Castor Oil and Neem Oil Prepared Using Lithium-Doped CaO Nano-Catalyst
- Analysis of the Aerodynamic Characteristics of NREL S823 and DU 06-W-200 Airfoils at Various Reynolds Numbers Using QBlade
- Design and Simulation of Wind Tunnel Using CFD Analysis
- Exergy Analysis of Cogenerative Steam Power Plant

V. FUTURE OF MECHANICAL ENGINEERING

The new subject areas are several emerging and promising fields, including artificial intelligence, biomechatronics, and nanotechnology. The transportation sector continues to generate the largest share of greenhouse gas emissions. Mounting pressures to use alternative sources of energy has helped to fuel the rise of electric vehicles. Replacement of the traditional internal combustion engine with cleaner, battery-powered systems brings new challenges regarding torque and energy loss, and the design of mechatronics to support new electrical systems. Furthermore, as vehicle manufacturing becomes more automated, mechanical engineering is in the front and center in the design of robotics and assembly lines. Nanotechnology refers to the manipulation of materials at the smallest level. In the years ahead, mechanical engineering is expected to be integral in using nanotechnology to:

- Create stronger composite materials.
- Develop superior renewable energy storage systems.
- Create advanced biomedical devices.

The role of mechanical engineering in robotics is taken a step even further with the rapid growth of biomechatronics. This field, which seeks to merge body and machine, involves the design and testing of complex and intricate device architectures that mimic the body's musculoskeletal design. Mechanical engineering is involved in the design of mechanical sensors, controllers, and actuators for biomedical devices used in prosthetics and miniature medical implants. In addition to the medical field, research is also being carried out on the use of biomechatronics in the military industry. Manufacturing is an ever-evolving field. Mounting pressures to increase production efficiency while minimizing operating costs have fueled demand for new and innovative technologies. Automation and robotics (an area in which mechanical engineering is crucial) continue to be essential in helping manufacturing industries keep up with consumer demand while maximizing profit.

VI. CONCLUSION

In this paper, the origin, history, progress, paradigm shift, trends and future of Mechanical Engineering have been dealt with briefly. New developments in Mechanical Engineering in all its subset specializations are incessantly pouring in. Manufacturing, Design, Thermo-Fluid Applications, are continuously crossing their boundaries. These days, all science and technological and even humanities and social sciences including management are inter-disciplinary and innovative, sharp minded young and experienced mechanical engineers are ever more demanded.

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