# NEW AGE INDUSTRIAL ENGINEERING MANAGER, A REVIEW WITH A RETROSPECTIVE APPROACH

(To meet the challenges in Management of Technology, Innovations and R&D)

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## ABSTRACT

In this paper, we describe on the revolution of Industrial Engineering with a review on the new challenges to face in management of technology, innovations and R&D subject areas.

## Keywords

Industrial Engineering & Management, Management of Technology, Innovations and R&D.

## 1. INTRODUCTION

Industrial Engineer has come a long way from the time of the industrial revolution to the current era of information technology revolution. From the basic concept of work study, incentives and labour productivity improvement there is a quantum jump to researching, re-modeling and re-shaping the industry with high technology and the opportunity provided by computer aided tools and techniques and introducing innovative methods of motivation to become more competitive in the global market place. With the globalization of business, liberalized economy, trade policies and global competition for excellence and tremendous advances in technology, the role of industrial engineering has changed. This paper is based on the survey conducted with a set questionnaires on excepted role of industrial engineers today, suggestions for new syllabus and preparation of new age industrial engineers. The responses were collected across various industries, referring to syllabus of Universities. A review is made with a retrospective approach for new areas of focus for new age industrial engineers from perspective of broad based engineering and management.

## 2. ORIGIN OF INDUSTRIAL ENGINEERING

It is said that Industrial Engineering evolved around the industrial revolution in the 18th century. Engineering was then confined to 3 major disciplines, Civil, Mechanical and Electrical. Inventions such as steam engine, advances in metal cutting and production, machine tools and innovations in the textile industry stimulated fast growth of industry replacing human & animal power by machines especially in the manufacturing sector. The earliest work study to asses how much a worker could produce without excessive fatigue is attributed to Frederick W Taylor, who conducted experiments as early as in 1881 onwards. He proposed that jobs and work methods could be re-designed to realize more output in less time without fatiguing the worker. This was complimented by Frank Gilbreth, by his study of motion of the industrial worker. Taylor's time studies and Gilbreth motion studies, which later combined as Time and Motion study became one of the foundations of the industrial engineering discipline.

The Pennsylvania State University, USA was the first (1909) in the world to offer an Engineering graduate programme in Industrial Engineering. From simple time and motion study to enhance productivity, industrial engineering evolved from time to time and composed of manufacturing, operations research, human factors and ergonomics.

Role of the industrial engineering consisted of work study and work measurement, study and improvement of work methods, to avoid idle time and improvement in productivity as defined and measured as standard man hour output. They were stopwatch & clip bound supervisors. The tasks included designing and implementing methods of motivation through job measurement, incentives, job rotation etc. The industry looked up to the industrial engineering even for layout planning, requirement of men, machines, materials, designing and controlling the jobs, management of maintenance, safety and productivity. However, with the expansion of industries and the development of new organizational structures in the manufacturing with specialization such as production engineering, quality engineering, maintenance engineering, operation mangers, factory managers, etc., the role of industrial engineering gradually got reduced to one of Management Information Systems (MIS). This consisted only of preparing/ presenting reports, developing database, analysis and interpretation of information together with productivity measurements, incentive schemes etc. It also lost its glamour and responsibility as it was reduced to supporting the management through MIS rather than the earlier overall management responsibility.

## 3. INTEGRATION OF ENGINEERING & MANAGEMENT DISCIPLINES

With advancement in technologies, the basic small number of engineering disciplines, multiplied into several specializations. Some examples are Civil, Architecture, Irrigation & Agriculture, Town Planning, Tourism Road Engineering Mechanical, Automobile, Shipbuilding Aeronautics, Space Engineering, Mining, Metallurgy Chemical, Textile, Paper, Plastics Engineering, Medical Engineering, Bio-Technology, Industrial Engineering, Manufacturing, Electrical, Electronics, Medical Electronics, Photonics, Telecomm, Electrical & Electronics, Electronics & Telecom, Mobile Telecom, Computer Science, Information technology and the list can go on to over a hundred disciplines. The broad based engineering gave way to greater specialization in each field. Management consulting found more relevance with integration of people, money, knowledge, equipment, materials, processes and its development,

improvement, implementation and evaluation. With the IT revolution and its first application in MIS, industrial engineering, got a new thrust under the circumstances, for the industry it was also necessary to rely more on industrial engineering which has a broader base in basic engineering disciplines, manufacturing process and management. Engineering Management consulting brought principles and methods of engineering analysis as well as mathematical, physical and Humanities & Social Sciences together to design to specify, predict and evaluate such system. With the globalization of business and economy and the accompanying fierce competition and necessity for preparing Indian industries to meet the challenges, the industrial engineer has now a greater responsibility to take on and steer the management of the industries to become globally competitive and contribute in greater measure to the national economy.

## 4. IMPACT OF GLOBALIZATION

The liberalized Indian economy and its integration to global economy provide opportunity for growth of industry. However, it has to face stiff competition, especially from imports due to tariff reductions. Although India provide comparatively low cost labour, our low labour productivity and low operational efficiencies together with infrastructure problems will pose considerable challenge to meet the competition. If Indian industries can tackle this, through innovations, infusion of technology enhancing productivity and quality there is great potential for growth and enhancing of exports.

Manufacturing is the engine for growth and principal means for wealth creation. India is bestowed with one of the largest number of young work force, scientists, engineers and managers, as well as natural resources and raw agricultural products. Challenges and forces of globalization, if rightly managed, can stimulate industrial growth in the manufacturing and service sectors, making substantial contribution to the growth of GDP. Industrial Engineer should be prepared to apply the industrial engineering concepts towards service sectors. This will also provide productive jobs for the large work force entering the job market especially from the rural India knowledge. Enhancing competitiveness is the key to this growth and industrial engineer has a key role to play in this endeavor.

## 5. THE ROLE OF INDUSTRIAL ENGINEERING IN MAINTAINING THE COMPETITIVE EDGE AND LEADING TO GLOBAL EXCELLENCE

The world has evolved into a technological society. Innovations, technology development & applications have become essential for survival and growth of industries. The industrial engineer is actively involved in both manufacturing and service sector of industries. Both the sectors can contribute significantly for GDP growth and productive employment. Industrial engineer must play a major role for the induction of new technologies, high productivity machines, advanced productivity concepts and policies and management techniques. In the field of manufacturing the science and technology has lead to high speed and high productivity machines, flexible manufacturing systems, CNC machining centres automation, robotics and rapid prototyping etc, and computer integrated pipe bending, sheet metal / FRP cutting, routing, four and five axing milling, cutting, grinding, drilling etc. The lower operational efficiency and sub-optimal levels of operations and comparatively lower labour productivity and the current level of high cost of capital employed leading to poor competitiveness can be overcome only by technology and innovative HR practice.

Total productivity management should be technology driven and HRD driven. Innovations leading to new knowledge, products and processes need to be capitalized through intellectual property rights for the growth of the organisation. Application of information technology will have an important role in all disciplines and inter-disciplines for enhancing performance at all levels.

Human computer interactions is an important component of training and capability building for the new age industrial engineer. Information technology plays a critical role in modern management. Computer aided tools and techniques are significant for the design, development, manufacturing, marketing and maintenance of products with better performance and reliability. Product Life Cycle Management (PLCM) and Enterprises Resources Management and many such tools are examples. Computer aided design and computer aided manufacturing (CAD-CAM) are other examples. ERP incorporates various elements in the traditional MIS and focus sharply on decision support. Modern ERP based on IT is derived from manufacturing resources planning which followed material requirement planning. Through ERP the company's capacity planning and manufacturing planning, integrated materials planning have become part of a standard software activity handling inventory, production, quality management, human resources management, logistics, marketing, shipping, invoicing, sales, and strategic management all through software. Design to manufacture is handled by concurrent engineering through a network of computers. The ERP integrates all functional departments specialized and separately involved in specific operations, into one system, which synchronizes and integrates various systems, departments and operations. The new era industrial engineer is thus concerned with integration of all factors and processes of production into networked cohesive systems for effective & efficient production of quality goods or services meeting global quality standards at competitive prices.

Globalization has considerably increased the need for improved logistics and supply chain management. In order to enhance the market share and be globally competent, share the risks and gains of business, companies worldwide are networking and forming consortiums. The industrial engineer has to play particular attention to logistic and supply chain management and networking to meet the global challenges. Although we have a large domestic market in India, liberalization has made the market into a buyers' market from the earlier sellers' market and customers are more demanding on quality, cost, and timely deliveries. Industrial engineer must bench mark the industry against best international practices and endeavour to incorporate the best in manufacturing, quality, marketing and HR and all disciplines. In the present age of multiplicity of engineering disciplines and focus on specialization, industrial engineer with a broad based engineering background would be the best tool for the industry to achieve this objective. The inter-department and company wide approach of industrial engineering coupled with information technology solution will give excellent results in improving productivity of business processes. Industrial engineers can also contribute in service industry including IT industry.

Industrial engineer should endeavour to shift the emphasis from labour productivity to total productivity, to change from push production system to pull production system, using innovation,

 

technology and people. The traditional industrial psychology Theory X needs to be replaced by Theory Y and the Japanese theory Z. Combination of Y and Z is in line with the Indian heritage values and ethics and is more conducive for team building and emotional motivation. Theory 'X' is negative in that it assumes that average person does not like to work and will avoid it and need to be coerced & controlled to work. Theory 'Y' is positive and assumes that employees may be ambitious and self-motivated and accept work if empowered. Industrial engineer can make use of this by providing opportunities and empowering employees, to become innovative and creative through schemes such as suggestion scheme, quality circles, lean management groups and suggest ideas / plans and implement to make their work easier, more interesting and productive, enhancing quality and productivity and reducing cost. Theory 'Y' assumes that work is natural and is a source of satisfaction and direct to achieve higher order of human psychological needs. Theory 'Z' is aimed that enhancing the employee loyalty to the organisation through long term relationship with focus on the well being of the employee. A combination of theory 'Y' and 'Z' to develop an innovative method of motivation is necessary for getting total commitment of the employee, motivation for excellent performance and to change from improving local efficiency to overall efficiency of the organizations.

With the infusion of new technologies and the IT assisted manufacturing and management processes, the Industrial Engineer must develop new methods of measuring performance and monitor by periodic assessment and set new goals for continuous improvement.

# 6. NEW AREAS OF FOCUS FOR INDUSTRIAL ENGINEERING AND MANAGEMENT

In the wake of multitude of specialized engineering disciplines, industry's need for a broad based engineering with added knowledge in management could be filled by the Industrial Engineer. The academic curriculum can be designed for responsible roles in their chosen professions whose experience is in industrial research, scientific production, engineering and the general sciences. The new areas of focus for industrial engineering and management is given below :

## 6.1 Analytics and Statistics :

Analytics is a multidisciplinary subject which extensively uses mathematics & statistics using predictive computer models to gain valuable knowledge from data analysis. It is used for investigation of technologies by research methodologies in the area of data science to drive business value to improve decision making understanding human relationships and transform data into knowledge. Current challenge has emerged in solving through analysis of complex data sets often when such data is in constant state of change which is commonly referred to as Big Data. Another usage is found by researching and mining of large industrial databases for discovering root causes of poor quality. i2 is one the software used in analytics industry. SPSS is a statistical package used for data mining and statistical analysis.

## 6.2 Financial Engineering and Management

Financial Engineering and Management is a part of Industrial Engineering and Management which is essential to identify and quantify the risk with the application of financial engineering instruments, re-engineering, business processes adapting firm's strategy, switching customers / suppliers or taking alternative investment decisions. These benefits mainly to apply strategic skills to manage the firm's innovation and technology. Financial Engineering involves applied mathematics, computer science, statistics, economic theory, operation research etc. Current research is done by Industrial Engineering professionals to create, price & hedge (reducing risks) complex derivatives, financial risk management, portfolio optimization (investment strategy that best suits a decision makers objectives) and derivative securities (to know the value of underlying assets) etc.

## 6.3 Management of Technology, Innovations and R&D

Management of technology and innovations comprises of hardware as well as technical know-how, skills and knowledge related to techniques and operations of using hardware / software for production, the competencies related to commercial-scale production and the knowledge generated through incremental innovations towards efficiency and the improvement of technology. It incorporates R&D, design, process and production engineering, maintenance, management, and the demands of marketing. The information sources need to be identified that provides information for new innovation projects, contributed to the completion of existing innovation projects, or provide information for the commercialisation of innovation. Management of these technologies to create new product / process is done through innovation management by carrying out new combinations. This effort is achieved through application of scientific knowledge which is referred as Research & Development (R&D). R&D management causes significant impact to spur technology innovations in industries. The measurement of R&D is based on R&D tendency and R&D intensity. R&D tendency is the amount invested, organisation's support & communication and organization decision making & authorization. R&D intensity is the ratio of expenditure made for R&D by the firm and firm's sales. Measuring the R&D Management by customer participation, level of technology collaboration, R&D investment, participation of all departments with a multifunctional team and level of top management involvement. R&D indicators are (i) Ratio of R&D spending on organisation's output, (ii) the speed of technology innovation and (iii) the relative significance of R&D development staff.

## 6.4 Stochastic Modeling and Simulation

Due to uncertainty caused in production and service systems, a methodology of probability theory and stochastic processes need to be designed by Industrial Engineer to analyze such problems to develop models to improve decision making. A stochastic model is a tool for estimating probability outcomes by allowing random variation in one or more inputs overtime. Simulation research derives new methods for design, analysis and optimization. Recent research ensures quantifying uncertainty measuring and controlling risk etc. and applicable to product development, production, capacity planning inventory control, system reliability & maintainability, logistics, supply chain management and financial engineering domains.

## 6.5 Flexible Manufacturing System

Now a day's industries need some amount of flexibility that allows its manufacturing system to react quickly in case of changes which may be predicted or unpredicted. Firstly, the machines should be flexible and have ability to be changed to produce new product types and to change the order of operations executed on it. Secondly, routing flexibility which consists of ability to use multiple machines to change a production schedule, to modify a part, or to handle multiple parts. Flexible Manufacturing System (FMS) consists of main systems such as industrial automation, automated CNC machines, Robotics – which are connected with effective material handling system, advanced manufacturing processes, Agile Production System – by applying terms that can create processes / tools which enable it to respond quickly to customer needs and market changes, FMS Communication – which consists of large files and short messages transmitted and received with almost instantaneous response. With adoption of Flexible manufacturing industrial engineers will become managers of technology not just users of technology. IGRIP – Interactive Graphics Robotics Instructions Program is one of the software used to suite tools to optimize their design and manufacturing processes.

## 6.6 Managing Performance through Management Challenges and Opportunities

Managing performance is a continuous process of improvement with involvement of all employees in the organization that contributes to archive goals by management challenges and opportunities. Achieving goals or excellence depends on change Change management for Competitiveness, Risk Management, Cost reduction through value engineering, Customer Relationship Management, Engineering Ethics, Factories Act, Environment & Safety Management, Integrated Materials Management (Purchase, Stores, and Supply Chain Management), Project Management, and Production Planning & Control, industrial safety, pollution control and environment management, prevention of industrial sickness & managing recovery, Entrepreneurship development and Corporate Social Responsibility. Synergy of these management concepts, skills and procedures are on one side based on technology and on the other side it depends on the quality of mind based on ethics and moral values.

# 7. CONCLUSION

The new age industrial engineer has to assume more of a management role and need to have a broad based engineering knowledge and skills, business acumen, entrepreneurial spirit and capability and should be fully IT Savvy. The mission of Industrial Engineer should be "to become master of change and decision maker of tomorrow" in order to keep pace with competition. New areas evolve employs multidisciplinary research methodologies. The new age industrial engineering is concerned with knowledge management, technology, innovation, R&D, and logistic management using IT techniques and new methods of motivation and team building and total productivity management with continuous monitoring assessment and improvement of the organizational performance with multi-disciplined approach.

# REFERENCES

[1] Survey Conducted: Based on the survey conducted at industries with a questionnaire format seeking some of the current role of Industrial Engineering and suggestions for new areas to focus & develop.

[2] Chawan, Anup N. and Hari Vasudevan. 2013. 'Modeling Knowledge Management Barriers in the Indian Manufacturing SMEs Using ISM Approach'. The IUP Journal of Knowledge Management. Vol. XI, No. 4.

[3] Chidambaram, R. 2011. 'Research and Innovation : An Indian Perspective', Industrial Research Institute, Inc. Invited Paper.

[4] Dasari, Sudhakar, Nasina Jigeesh and A. Prabhukumar. 2015. 'Analysis of Project Success Issues: The Case of a Manufacturing SME'. The IUP Journal of Operations Management. Vol. XIV, No. 1.

[5] Gupta, Priya Dhamija, Samapti Guha and Shiva Subramanian Krishnaswami. 2013. 'Firm growth and its determinants', Journal of Innovation and Entrepreneurship. 2:15.

[6] Rastogi, P.N. 2009. Management of Technology and Innovation: Competing Through Technological Excellence. Second Edition. Sage Publications Pvt. Ltd.

[7] Ray, Amit S. & Saradindu Bhaduri. 2001. 'R&D and Technological Learning in Indian Industry: Econometric Estimation of the Research Production Function', Oxford Development Studies. Vol. 29, No. 2.

[8] Srivastava, Mukesh. 2011. 'A Case Study and Survey-Based Assessment of the Management of Innovation and Technology', Journal of Technology Management & Innovation. Vol 6:1.

[9] Reviewing Curriculum: Referred syllabus contents offered in some of the major Universities from India and abroad.

 