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An Evaluation of Charles Babbage's Mathematical and Management Ideas

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ABSTRACT

Charles Babbage is widely known as the 'Father of Modern Computers', but his contributions to the field of management have not been given much recognition. He advocated for applying scientific and systematic techniques in industrialized age, which helped in lowering costs, enhancing production and improving the ways of managing. In the present study, Babbage's thoughts have been critically analysed in terms of their application and validity in the contemporary era. The evaluation of criticism faced by this mathematician has also been done. The paper concludes that Babbage's ideas were valid when proposed by him and majority of his ideas are valid even after nearly hundred years. In fact, he successfully laid foundation for many of Taylor's Scientific Management principles and Quantitative theory proposed in 19th century.

1. Introduction

World history narrates thousands of tales of people working together in formal as well as informal ways. Since the times people began forming groups to accomplish aims, they couldn't achieve as individuals and therefore, managing became essential to coordinate individual efforts[1]. As society progressed due to mechanization in 18th and 19th century, certain functions were recognized and a term called 'Management' became apparent for systematizing various activities to smoothly run the businesses. Different management thoughts kept on evolving due to varied environmental forces and new ideas kept on developing on the premise of old ones[2]. The voyage of management thought included Pre-Classical, Classical, Neo-Classical, Modern and Contemporary theories, where different ideas emerged to fulfill the needs of business environment.

Industrial Revolution in the late 18th century raised production rates, but the owners of factories couldn't protect their organisations from unforeseen challenges. Entrepreneurs handling the affairs in their factories tried to find solutions at their individual levels to cope up the emerging business pressures. It was during 1800s, that the foundation of various functions and principles of management thought started getting shape. Experts from multiple disciplines such as Economics, Engineering and Sociology etc. offered solutions to deal with challenges proposed by factory system, out of them one of the thinkers who directed the voyage of management towards Scientific Management era through his systematic and scientific thinking was a Mathematician Charles Babbage. Acknowledged as the 'Father of Modern Computing'[3], 'Patron Saint of Operations Research and Management Science'[4] and 'Father/Forerunner of Modern Computer', Babbage had a keen interest in solving the problems of production in an analytical way. He talked about scientific techniques to improve the ways to manage and advocated that application of scientific principles would help in lowering costs and enhancing production. This English Mathematician[5] and a Cambridge professor proposed two theoretical ideas of 'Division of tasks' on the basis of skill and necessity of 'Replacing manual work with machines'[6], which are valid even today (proposed in the 19th century). He emphasised that good machines and efficient workers didn't necessarily ensure success in business. Good management to direct and manage workers and machines was must[7].

2. Rationale Behind Babbage's Scientific Management Ideas

Babbage was a visionary, who foresaw the invention of modern day electronic computer. He was neither an industrialist nor a manger, but a professor and an inventor. He was a British advocate of systematic use of science and mathematics in the industry[8] and was actively involved in scientific inventions, most of which didn't turn into reality in his lifetime. Automatic mechanical calculator[9] with its own formatting printer (difference engine), versatile programmable computer (analytical engine in 1833) and contribution in the creation of a punch card machine were some of his eye opening inventions.

One of the major reasons that grounded Babbage's ideas was rise of factory system, which raised production rates and automation all around the industrial world in the latter half of eighteenth century. Cost reduction, higher rates of production, speedy work, efficient operations and increased output were the needs of this century. Babbage suggested mathematical and analytical ideas and his inventions (e.g. automatic calculator) were the need of that hour to deal with upcoming challenges of industrialized world.

While working in England and France, Babbage studied the condition of factories there and found that most of the organisations were working on imagination or tradition[10]. He sensed that a creative way of dealing with complex issues could be the idea of using scientific instead of traditional methods, which would improve the ways of working in the era of industrialization. The organisational environment of 18th century gave him an idea to apply rational and scientific methodology. Further, Babbage recognized the fact that

mechanization led to the problems in terms of labour relations, especially where the wages of workmen weren't directly linked with the profits of owners. He believed that rational society was always be just and equitable one. Therefore, he recommended profit sharing programs and employee bonus to foster harmonious management i.e. cordial labour relations[11].

Besides various environmental factors, Babbage's personal background also shaped his management ideas. He was born and brought up in a wealthy Protestant form of Christian family. His family imbibed in him an orthodox form of worship such as daily morning and night prayers, which he rejected as he grew young. He used to look at the things rationally. He was interested in the field of Mathematics. Since childhood he observed that he knew mathematics more than his instructors[12]. His mathematical, scientific and logical thinking helped him to look at management issues scientifically.

3. Analysis of Babbage's Management Thoughts and Contemporary Business World

Babbage used his experiences and actual observations in British factories to propose and implement management ideas. Majority of his ideas are applicable in contemporary organisations. His ideas and their validity in contemporary times have been summed up under following heads.

Employees as Partners in Profits

Babbage observed the conflicts going on in the early nineteenth century organisations. He suggested that sharing of profits could prove to be one of the founding steps towards improving productivity and industrial relations. He further advocated for an employee bonus[13] and profit share for those who would recommend new ideas and offer useful suggestions. Babbage put forth his profit sharing idea to make the workers satisfied, while management could save profits by lowering down the average wage rate with the application of division of tasks. Babbage emphasised the importance of cordial relations among workers and managers[14]. His idea of profit sharing was meant to maintain healthy industrial relations. He foresaw that sharing of profits could prove to be step towards improving productivity and good industrial relations.

Contemporary organisations also apply balanced approaches. The participation of employees has been extended to many other areas besides profits. Employee Stock option schemes, their participation in important decisions, asking their suggestions for improvements, regular meetings and social programmes with their families etc. have been adopted as regular feature by almost every contemporary organisation.

Cordial relation between employer and employees is one of the major issues in the contemporary organisations. Organisations put in their best efforts to make their human resources satisfied in the long run. Besides taking care of employee's needs, the companies are stepping ahead for taking care of their families' needs. Keeping the employee contended and making their families happy assists in maintaining cordial relations between these two crucial groups of organisations.

Babbage also advocated for motivating employees by profit sharing method. His motivation methodology was excellent. He laid foundation for the motivational methods used in contemporary times. Today, the organisations use different motivational methods such as recognition, awards, financial incentives, best employee awards and perks etc. to motivate their people.

Analytical and Scientific Thinking

Babbage favoured analytical thinking and application of mathematical models. In the mechanized world of 19th century, Babbage foresaw that automatic machines and programmes were the need of industrial era. The idea of present day digital computer originated from Babbage's mind. He advocated that decisions in an organisation should be based upon investigation and accurate knowledge. He proposed the application of quantitative methods and industrial engineering techniques to maximize productivity[15]. He applied analytical thinking even in the designing of tools for factories and advocated that exact measurements should be the key to develop machine tools.

Babbage emphasised on dividing the tasks into activities. As the task would be divided into smaller activities, the work would become simpler. He performed fundamental research and invented first practical automatic mechanical calculator and analytical engine. His idea of punch card machine and programmed calculator were the examples of his intellectual insight. Besides scientific inventions, Babbage focused on analysing and controlling the production activities, process and costs[16]. He emphasised for low average wage rates for workers and dividing the tasks into activities, which would make the work simpler. It would enable more workmen to learn the task and organisations would have more people, and would ultimately lead to low average wage rates to be offered to labour. Babbage also observed that many principles (scientific and unscientific) were applied to physical work only to get more output. He advocated for maintaining a balance between physical and mental work, as intellectual/mental work was as important as physical work. He suggested for division of work into mental and physical efforts[17].

In the contemporary times, almost every decision, whether personal or official, requires systematic and rational thinking. In the organisational context, developments of various new ideas in Management Science, application of techniques of Operations Research, Management Accounting, Corporate Accounting and Cost Accounting etc. evident analytical and logical decision making. In fact, Babbage paved way for adopting scientific thinking in the organisations for every task.

Division of Labour and Specialisation

In 1832, Babbage realized that majority of workers in factories were unskilled or semi-skilled. He further observed that skilled labour was often involved in unskilled tasks[18] and workers were wasting time in many activities which were below their skill level. They carried the potential to produce more than what they were producing, through the application of division of tasks. Therefore, he advocated for the application of Division of Labour to mental tasks[19], which would lead to increase in general productivity and also in cutting wage cost[20]. Besides

that the workmen would get specialized in their tasks[21]. He advocated that high skilled tasks must be assigned to high cost workers (those who were paid high wages) and other tasks to lower paid workers. The success would depend upon the division of entire process (physical as well as mental). He pointed out the commercial outcomes of more careful division of labour in his work 'Economy of Machinery' which (later on) popularized as Babbage principle. His fundamental contribution to the field of management was to practice the idea of dividing the tasks among workers and making them specialized in their respective tasks. He argued (1835) that in the absence of specialization, each worker would be expected to do a number of tasks involving variety of skills and capabilities. Since the supply of skills and capabilities vary considerably in every society, the great virtue of division of labour was to unbundle them and to allow the workers to specialize in their tasks for which they were best suited[22]. Babbage's analytical concepts of division of work and specialization were aimed at efficiency. His ideology (in early nineteenth century) became the foundation for contemporary Operations Research and Cost minimization techniques. In fact, he laid founding stones for most of Taylor's scientific principles and Henry Ford's assembly lines.

Babbage recognized potential in the 'Principle of Division of Labour'. Specialization concept suggested by him has further been comprehended and organisations are entering into the era of Super-specialization. It requires further fragmentation of tasks into sub tasks. The organisations believe that specialized people work more effectively, when they are given access to specialized technology. Specialization can be clearly seen in modern assembly line businesses and most of the functions of management. Babbage laid down the foundation for many techniques of contemporary 'Operations Research' for which, he is well known as the 'Forerunner of Contemporary Operations Research'.

4. Evaluation of Criticism of Babbage's ideas

Babbage was a unique practitioner of nineteenth century due to his innovative ideas, but his efforts were criticised on the premise that they lacked the central tenets of a theory of management. He couldn't propose any significant dimensions of management like Fayol and Taylor. In fact, Babbage couldn't add much towards management ideas during Pre-Classical era, because at that time there were no systematic management thoughts and management hadn't emerged as a separate discipline. Another fact is that Babbage was interested in Mathematics since his childhood. He was neither a manager nor an industrialist during his lifetime. Due to lack of practical industry experience, he couldn't develop a blueprint for his management ideology, which was the need of that time.

Another criticism emerged was that most of Babbage's ideas, related to management, were theoretical in nature. He could not develop any scientific base for his ideas in the field of management. His major thrust was on increasing productivity, but he had not conducted scientific experiments for raising productivity in the organisations. Babbage came up with his ideas in early nineteenth century, when industrial revolution was in its inception and industries were not systematically developed. The industries, machines and tools were not scientifically designed. Still, Babbage was able to leave a memorable impression due to his analytical ideas. His ideas were scientifically proved and further developed by F.W. Taylor (Scientific Management) in the Classical era and by Revisionists in the Modern management era. Babbage was one of the thinkers, who talked about using scientific methods prior to Taylor. It is generally quoted in the management literature 'what Arthur Young was to agriculture, Charles Babbage was to factory visits and machinery'[23].

Another group of critics argued that Babbage's ideas had not shown much discussion on human element of the organisations. His view on human capital was restricted to minimizing time period to recover the training cost that an organisation spends on its employees. Babbage's profit sharing plan was directed towards the betterment of human element working in the factories. No doubt, his thinking was more scientific and mathematical in nature; still his ideas had not ignored the human dimension.

Table: 1 Validity of Babbage's Management Ideas in the Contemporary Times

Management idea	Validity when proposed	Validity in today's times	Evident in practices of contemporary world
Basic Approach			
Analytical and Scientific Approach	Valid	Valid and widely applied	Tools of Management Science, Operations Research, Concepts of Reengineering, Restructuring, MBO, Goal Setting
Concepts and Ideas			
Employee's Partnership in Profits	Valid	Valid	Employees stock option schemes, participation in crucial decisions, Quality circles, Consideration to their personal and family needs
Division of Activities and Specialization	Valid	Valid and widely applied	Modern assembly lines businesses, Idea of Super-specialization
Motivation is Crucial	Valid	Valid and widely applied	Increments, Best employee awards, Gifts, Appreciation letters, Public posting of sales and production data to instill departmental pride among workers
Cordial Industrial Relations	Valid	Valid and widely applied	Organisations take care of their employees' development and social needs, employees put in their best to attain mission and vision

Table 2: Validity of Criticism Faced by Babbage

Criticism	Validity	Supporting facts
Lack of Theoretical Base	Partly Valid	Management as a discipline has not developed, when Babbage proposed his thoughts.
Lack of Scientific Experiments	Partly Valid	No scientifically designed experiments like F.W. Taylor and Elton Mayo
Lack of Formal Management Experience	Valid	Field of expertise was Mathematics rather than social science
Less Concern for Human Element	Partly Valid	Ideas of worker's bonus and participation in profits were worker centered

5. Conclusion

Most of Babbage's management ideas were not appreciated by his contemporaries, as he belonged to technical subject. He never worked as a manager or industrialist. Some of his ideas such as profit sharing were not based on any scientific experiments, but simply on his experience and observations. Still, majority of Babbage's inventions and ideas were revolutionary due to his analytical thinking. His ideas were unique and he was among few who thought about applying the mathematical models in management practices. Many other entrepreneurs and thinkers like Andrew Ure, Charles Dupin, Henry Robinson Towne, James Montgomery and Henry Varnum Poor thought on the similar lines with Babbage and paved the way for systematic developments. He laid foundation for many of Taylor's Scientific Management principles[24] and Quantitative theory proposed in 19th century.

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