Frederick W. Taylor's Presence in 21st Century Management Accounting Systems and Work Process Theories

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Frederick W. Taylor changed the way management looked at manufacturing by using a scientific methodology to study workers' motions, thus developing the foundation for management accounting. Modern management accounting systems such as standard costing, activity-based costing, theory of constraints, and lean manufacturing reflect numerous lessons learned from the Taylor era. This paper contains a review of the connections between Taylor's theories and modern management accounting systems. As management accounting systems evolve in the 21st century, some theorists predict a return to aspects of Taylorism, as adapted to accommodate the modern knowledgeable worker and highly mechanized production systems.

Discussions often revolve around Frederick W. Taylor's study of the movement of workers and this effort to maximize productivity. Taylor described this study as *task analysis* or *task management*, which later became known as *scientific management* (Drucker, 1999b). The use of a stopwatch to study the motions of production workers allowed Taylor to design a series of movements that promoted efficiency. In addition, the results of these studies drew attention to the importance of accurate measurement of resources consumed and standardization of workflows for effective management decision-making and control. While Taylor measured activities in terms of time, he also brought awareness to the fact that managing resources was not only about physical resources, but included intangible resources and processes (Verico & Williams, 2005).

Taylor's method of using a stopwatch and designing physical labor, thus standardizing the labor processes, provided a link with modern day management accounting and management control systems. The literature contains few articles written in the 21st century about the influence of Taylor on modern day management accounting systems. However, the modern approaches reflect numerous lessons learned from the Taylor era. In particular, standard costing, activity-based costing, theory of constraints, and lean manufacturing in the United States bear imprints of Taylor's work.

The first section of the paper considers the early development of management accounting methods and Taylor's contribution in facilitating the advancement of cost systems, standardized costing, and efficiencies in production processes. The second section provides evidence of Taylor's impact on lean manufacturing in the United States. The third section reflects upon the outlook of management accounting systems as the 21st century begins and the steadfastness of Frederick W. Taylor's theories and his scientific management methods.

The Development of Management Accounting

Management accounting was first defined as "...the process of identification, measurement, accumulation, analysis, preparation, interpretation, and communication of financial information used by management to plan, evaluate, and control an organization and to assure appropriate use of and accountability for its resources" (Institute of Management Accountants, 2008, p.1). Through the analysis of the historical development of management accounting, theorists could mark out methods and theories in support of this definition. Frederick W. Taylor's work was a core element to these developments as seen in his efforts to analyze processes, establish standards, create variance analysis, and measure and allocate overhead (Kanigel, 1997).

A formalized system of management accounting emerged during the industrial revolution in the textile, and iron and steel industries. Firms operating in these sectors used management accounting to monitor costs based on output from raw materials to finished product. Managers were concerned with controlling resources consumed in production, in particular, direct labor. During this era, prevailing market prices dictated the cost of labor, thus managers were compelled to control the rate of productivity by workers and used management accounting information to do so (Johnson & Kaplan, 1987). Comparisons of a worker's performance to other workers performing the same process over a period provided analysis for evaluation. All cost information provided by these comparisons aided management's evaluation of internal processes and encouraged workers to achieve company productivity goals (Johnson & Kaplan, 1987).

Later on, the complexity of operations and widespread geographical locations of organizations in the railroad industry led to the establishment of more detailed management accounting systems than had been utilized by manufacturing firms to date. Elaborate calculations generated from the management accounting system measured the cost per ton-mile for efficiency. The calculations allowed comparisons of several operating components including the evaluation of maintenance and overhead (Wren, 1994). The increasing volume of transactions warranted the need for a more sophisticated approach to systemizing the transactions. Managers divided operations into specialized processes or subunits (Johnson & Kaplan, 1987). Summary reports related the operating statistics for each specialized process or subunit for evaluation and control by management. Railroad operations such as Louisville & Nashville were the first to assign divisions of management to oversee subordinate managers of specialized processes (Johnson & Kaplan, 1987).

As manufacturing firms progressed to more complex and larger operations, internal procedures to coordinate the multitude of processes were essential. Andrew Carnegie expanded the existing cost accounting system to accommodate the needs of mass production. The development of a voucher system used by the railroad became an integral part of the cost accounting system. Each department listed the amount and cost of materials and labor used on each order as it passed through the subunit on cost sheets (Johnson & Kaplan, 1987). The primary function of the cost sheets was to accumulate the direct labor cost and material usage. Management used these sheets as an instrument for control. Carnegie proposed that the additional effort involved in paying attention to costs resulted in increased profits (Johnson & Kaplan, 1987).

Advancements Lead to Scientific Management and Efficiency

The demand for more precise information regarding efficiency of workers became paramount in the view of management as mass production dominated the market. The labor structure was based on a contractual system in which underperformance was a prominent practice. Under this system, management provided facilities, machinery, raw materials, and selling channels, while contracted supervisors supplied the labor (Johnson & Kaplan, 1987). The income of the contracted supervisor was the difference between the wages paid to the laborers and sales to management, plus the day's pay received as an employee (Johnson & Kaplan, 1987). Management benefited from lower costs and the relief of responsibility of control of laborers, but they were unable to direct the productivity levels (Johnson & Kaplan, 1987).

The contracted supervisors or the workers themselves dictated the labor steps and process. On the job training from previous employees or from the contracted supervisors was the standard. The efficiency of the process employed was of little concern to the workers, as productivity level had little impact on compensation. Teams of engineers began intensive efforts to establish standards by which the manufacturing firms achieved optimal productivity through efficient use of resources. Frederick W. Taylor and the advent of scientific management were major contributors to this goal. Many manufacturing firms began to break down the contractual labor structure and build systems to track resources consumed during production (Johnson & Kaplan, 1987).

During his association with the Manufacturing Investment Company as a consulting engineer, Taylor immersed himself into the world of accounting and began to customize accounting systems to suit his clients (Kanigel, 1997). Taylor's systems provided detailed monthly statements of expenses by job along with time studies, piece rates, and standardization (Verico & Williams, 2005). Relying on the production planning system at Midvale, Taylor developed a cost accounting system that set up expense classifications, distributed overhead expenses, and improved materials handling and control systems (Wren, 1994).

Measurement and allocation of overhead costs became a significant focus of Taylor's work. In the industrial era, where labor and machine tools dominated production costs, the allocation of overhead costs was prorated based on time to produce. Taylor realized that other activities were utilizing resources and thus apportioned those resources as part of the cost of operations. Taylor's accounting system classified planning, industrial engineering, training, and tool management as overhead (Vercio & Williams, 2005).

In his book *Shop Management*, Taylor (1911a) outlined in detail the various departments manufacturing organizations should employ and their respective functions. One superintendent could manage the entire factory operations by strategically locating vital departments adjacent to production, in particular, the planning department (Taylor, 1911a). No longer would the factory perform operations under a rule-of-thumb method imposed by managers, but instead were planned and controlled in a very systematic fashion by the planning department.

The main responsibilities of the planning department included (a) the complete analysis of all orders for work, (b) time studies for all work by hand and all operations by machine, (c) inventory control, (d) establishing standards, (e) determining costs of all items manufactured, and (f) monitoring and setting improvements for the production line, as well as various administrative functions related to the operations (Taylor, 1911a). By placing the cost accounting function in the planning department, the accumulation and synchronization of all costs of production were reconciled with daily operations reports. Costs then became an integral part of daily planning and control, rather than a subject for analysis after a long passage of time (Wren, 1994). Taylor recognized that accounting information was vital to successful operations and effective management.

Contemporary Trends Trigger Innovative Practices

The manufacturing environment faced dramatic changes in the late 1970's due in part to severe economic problems in the United States. Facing strong global competition and emerging innovative technology, manufacturing firms had to realign their strategies. "The practice of focusing on direct-labor performance and overhead rates is gradually being replaced by throughput, machine utilization, quality, vendor performance, inventory level, and delivery-performance measures" (Seed, 1988, p.8). In addition, an inventory management approach receiving a significant amount of attention was just-in-time (JIT). Under this approach, often referred to as lean manufacturing, companies reorganized factories to manage and eliminate waste.

As product lines increased and markets expanded globally, the need for a more sophisticated system of tracking and allocating costs to production was essential. The advancements in information technology allowed managers access to critical cost data more quickly than in Taylor's era. As a result, managers saw the benefit of scientific management theories as a vital management tool for control and for decision-making. This fundamental association of resources to activities recognized by Taylor came into sharper view with the development of activity-based costing (ABC) systems.

In the early 1980's, manufacturing operations began to evolve into processes that were more complex. Labor costs represented a smaller percentage of production costs than was seen in decades prior (Albright & Lam, 2006). This evolution made the traditional method of allocating overhead costs based on volume (direct labor hours or machine hours) archaic because it resulted in imprecise product costs. Management recognized the compelling need to change approaches and once again turned to Taylor.

In his book *Shop Management*, Taylor (1911a) emphasized task analysis and managerial control of the whole production process. Taylor outlined a succession of tasks or *activities* carried out in each department to heighten individual work efficiencies and productivity. The major focus was on direct labor as the main activity. The evolution of automated production directed management's attention to all activities involved in production, not just direct labor. Management once again drew on scientific methodologies to study and analyze all activities directly involved in and supporting the production process.

An ABC system characterizes an activity as a process or operation performed in the production cycle. The activity may involve preproduction tasks, such as material procurement or product reengineering, as well as actual production tasks. The ABC system captures the cost of these activities whether it is labor, material, or factory overheard consumed by products and assigns those costs in proportion to activities consumed (Albright & Lam, 2006). This assignment of cost was a major advancement in management accounting by providing relevant financial data for cost control and process redesign.

ABC methods consider that overhead costs may not only arise as units are produced, but by varying production processes. "The ABC process is able to incorporate both physical measures and causal principles in the costing system" (Popesko, 2010, p. 103). The three main elements of ABC are (a) identification of the activities in the production processes, (b) determination of the costs related to the identified activities, and (c) assignment of activity costs through *cost drivers* (Tardivo & Di Montezemolo, 2009). An analysis of identified activities provides a measurement of the related costs or resources consumed in the performance of the activity. Once the costs are associated with an activity, an appropriate allocation of these costs is applied to production and then to the finished product. The application of costs on a cause and effect relationship provides the basis for allocation of costs.

Identification of cost drivers or activities closely correlated with the incurrence of costs within a process or operation is a key component of ABC. This approach of cost analysis eliminates the distortion of allocated overhead as seen under traditional costing systems (Albright & Lam, 2006). Using more reliable information, management is able to implement appropriate efficiency measures to improve production. Understanding processes and managing the flow of resources under ABC is a manifestation of the ideas in scientific management reflective of the current manufacturing environment.

Process Improvement Strategies

To supplement the ABC system, management often employs additional process improvement strategies. The theory of constraints (TOC) and material requirement planning (MRP) are process improvement strategies that emphasize throughput as a means of maximizing efficiency and the flow of value through the system. A thorough understanding of the entire production process and managing inventory flow are the underlining aspects to TOC. The function of MRP is to determine the quantity and time of the release of inventory into production to ensure a continuous flow (Kumar & Suresh, 2008). To achieve optimal efficiency through continuous improvement, management should apply a measure of synchronization to these strategies. The flow of value through the system is therefore a measure of lead-time from system input to system output (Anderson, 2004).

The TOC draws from Taylor's mechanisms to identify and quantify the constraints impeding the production process. Where Taylor focused on time and motion studies of individual workers, TOC studies processes as a whole to identify inefficiencies. The basic tenet applied under TOC, as in Taylor's scientific management, is that of establishing the best possible production flow and increasing profits (Albright & Lam, 2006).

To achieve greater throughput levels, management had to begin thinking about the impact of constraints on efficiencies, productivities, and setups (Reimer, 1991). In place of stopwatches and slide rules, industrial engineers used information technology to develop models that simulated production flow (Albright & Lam, 2006). Applying scientific methods, management was able to identify constraints and guide production scheduling to minimize delays. Time, not labor, is the critical aspect of TOC. The scheduling of inventory into and through production was integral to production efficiency.

Inventory management is an element of production that Taylor appreciated and incorporated in his design as a means of timing and controlling the cost of manufacturing. "MRP is a technique for determining the quantity and timing for the acquisition of dependent demand items needed to satisfy master production schedule requirements" (Kumar & Suresh, 2008, p.133). Under TOC, the release of inventory is in accordance with the constraint. MRP technique exploits this dependent relationship to avoid excess build up of inventory (Kumar & Suresh, 2008).

In the era of mass production, Taylor's development of production standards and work efficiency studies were instrumental in changing management accounting systems and work processes. As production shifted towards lean manufacturing, advancements in technology expanded management's capability for detailed analysis regarding the flow of production in an effort to eliminate waste. The development of more refined costing systems provided more accurate cost data on which to base management decisions. Globalization, decreased product life cycles, and compressed lead-time required a shift in management accounting systems and work processes.

Lead into Lean Manufacturing

Taylor developed cost systems to monitor production, measure labor and material efficiencies, and to link data to profits. Taylor's standard cost methods, material and handling controls, floor shop layout, and creation of management departments enhanced cost accounting systems. The flow of cost data and centralized information points improved management's ability to design production processes, set productivity levels, and address bottlenecks in the process.

The later part of the 20th century experienced extreme changes in the manufacturing environment. Technological advancements, improvements in engineering, and global competition led to shifts in business operations. No longer were companies mass-producing standard products, but rather customizing products to a mass market. With product life cycles decreasing and the rapid demand for products increasing, the need for strong communication across operations and the need for more reliable cost information became crucial. Businesses saw the need to develop and implement accounting methods and work processes to contend with the realities of this changing market place.

Taylor's Influence on Lean Manufacturing in the United States

A review of management accounting concepts would be incomplete without a discussion of lean manufacturing. Lean manufacturing involves the elimination of waste throughout the value chain. Waste, also known by the Japanese term *muda*, is "any human activity which absorbs resources but creates no *value*" (Womack & Jones, 2003, p. 15). In studying the practices followed by companies implementing lean manufacturing in the United States, several represent a logical evolution of various aspects of Taylor's theories. In particular, Taylor's work on time and motion studies, as well as his focus on the worker, appears to have formed the basis of several lean manufacturing principles employed years later.

Taylor (1911b, p. 5) began the introduction of his book, *The Principles of Scientific Management*, with the following quote from President Roosevelt regarding the societal concern about waste: "The conservation of our national resources is only preliminary to the larger question of national efficiency." Taylor (1911b, p. 5) discussed the concept of waste of both material things and the "awkward, inefficient, or ill-directed movements of men." Although Taylor's theory of scientific management and lean manufacturing employ markedly different approaches, the elimination of waste through improved worker efficiency was the underlying theme of both theories.

Time and Motion Studies and Changes to Compensation Structure

The manufacturing environment in the late 1800's and early 1900's was plagued with a variety of problems related to efficient worker production and resource management. Taylor began to study worker movements and the most efficient use of equipment and materials using a scientific methodology (Wren, 1994). Taylor's objective was the maximization of profitability for both the company and the employees (Taylor, 1911b). Rather than requiring a group of extraordinary employees to meet this goal, Taylor (1911b) postulated that a systematic approach to management using detailed instructions for the employees would allow ordinary employees to achieve maximum performance.

The empirical study of job activities led to the development of performance standards for each job (Wren, 1994). Once the standards were in place, management had to take a more active role in employee supervision and the development of an appropriate compensation system (Taylor, 1911a; Wren, 1994). Taylor proposed a dual compensation system. Workers who were not able to meet the standard earned a lower rate of pay, while those workers who made the effort to meet the standard received higher compensation (Taylor, 1911a; Wren, 1994). Taylor (1911b) proposed the concept of the *first-class man* to describe the person who was capable and able to produce at the highest level. To maximize the performance of the first-class man, management had to match the capabilities of the worker with the requirements of the job (Wren, 1994). Taylor advocated the concept of the *functional foreman*, where a worker had authority over a task or series of tasks because of the foreman's knowledge about the task rather than authority based on the foreman's position within the organization (Wren, 1994). Many of these concepts continue for companies implementing lean manufacturing.

The Essence of Lean Manufacturing in the United States

The concepts of lean manufacturing began at the Toyota Motor Corporation in Japan as early as the 1950s, in response to concerns about scarce resources and competition in the Japanese automobile market (Hines et al., 2004). In the 1970s, Toyota representatives began to share the concepts with companies outside of Japan (Hines et al., 2004). Intrigued by the superior performance of Toyota, western manufacturing companies introduced modified shop floor aspects of lean manufacturing, while ignoring many of the human elements relating to organizational culture (Hines et al., 2004).

The shop floor or structural aspects of lean manufacturing include the just-in-time production system, the *kaban* method of pull production, and employee problem-solving (Hines et al., 2004). Just-in-time production involves organizing the shop floor so that the product flows quickly and efficiently through the processes, as opposed to the traditional batch and queue models (Womack & Jones, 2003). Workers produce product quickly and in response to customer orders, eliminate the need for inventory (Womack & Jones, 2003). In pull production, the manufacturing of a product begins only when a customer orders it and involves all the downstream steps required to deliver the product to the customer (Womack & Jones, 2003). Trained and cross-trained employees are responsible for solving problems and empowered to stop production to solve mistakes (Womack & Jones, 2003). The desired outcome of all three aspects is the reduction of waste, and thus the reduction of costs (Hines et al., 2004).

In 1983, General Motors and Toyota announced a joint venture called New United Motor Manufacturing Inc. (NUMMI) as a successor to the General Motors plant in Fremont, California. NUMMI represented a theoretical example of lean manufacturing in the United States. The management at NUMMI used a time and motion concept based on Taylor's principles with a goal of superior productivity and quality combined with increased worker motivation and satisfaction (Alder, 1993). Unlike Taylor's concept of time and motion analysis performed and controlled by management, workers at NUMMI learned how to analyze the work and achieve continuous improvement in both process and quality (Alder, 1993). NUMMI is a good example of adapting Taylor's theory to reflect the changing times and avoiding some of the negative effects Taylor experienced, such as resentment from the workers.

Levin (2006) argued that worker participation in meaningful decision-making and sharing of benefits led to higher worker productivity. As an example, Levin (2006) cited the NUMMI plant and its practice of employing teams of five to eight workers who determined their work task assignments and discussed how to improve both products and processes. The teams solved their own problems and workers were significantly involved in the work management (Levin, 2006). Workers also had input into balancing workload and establishing job rotation schedules to reduce worker strain (Strauss, 2006). The productivity in the NUMMI plant was 50% higher than the plant achieved under previous GM management, absences were significantly reduced, and quality was improved (Levin, 2006).

In a study regarding the successful management of resource use, waste, and environmental pollution, Rothenberg (2003) found that worker involvement at the NUMMI plant created an atmosphere of improved knowledge and responsibility regarding pollution issues. Strauss (2006) concluded that management was more likely to adopt worker participation structures when management believed such structures would benefit the company. For companies like NUMMI who were striving for high levels of production, the focus on worker participation and empowerment appears to have helped the company reach its goals.

The Relationship Between Taylor and Lean Manufacturing

Taichi Ohno, creator of Toyota's production system, credits Henry Ford as the originator of the concept of lean manufacturing (Peterson, 2002). One of Ford's subordinates, Ernest Kanzler, played a major role in developing just-in-time production methods (Peterson 2002). Ford's assembly line method used quality parts and proper assembly, with an emphasis on continuous improvement (Peterson, 2002). Ford also emphasized efficiency along the value chain by using local component shops to minimize transportation (Peterson, 2002).

Peterson (2002) noted that although there is no evidence of a direct relationship between Ford and Taylor, Ford's subordinates were well versed in Taylor's philosophy, and both men were aware of each other's approaches. Peterson (2002) concluded that Ford developed his methods on his own in response to the unique needs presented by the automobile industry. The fact that the leaders at Toyota turned to Ford for advice was logical given Ford's success in the auto industry.

Although the debate continued of whether Taylor influenced the origins of lean manufacturing at the Toyota plant in Japan, there is ample reflection of Taylor's theories in the evolution of lean manufacturing in the United States. Rather than simply a production technique, lean manufacturing was a pervasive philosophy focused on eliminating waste in the manufacturing process (Parks, 2003). Workers in a company using lean manufacturing relied on specific instructions for standardized work methods (Parks, 2003). The standardized work methods used engineering techniques promoting efficiency and reducing waste similar to those developed by Taylor (Parks, 2003). Parks (2003, p. 42) concluded "...lean manufacturing is a natural extension of the classical industrial engineering tools such as plant design and layout, workplace design, methods analysis, and time study".

Waddell (2005) expanded the concept of the relationship between Taylor and lean manufacturing by suggesting that lean manufacturing took Taylor's principle of scientific management as it related to labor and extended the principle to the entire factory. Workers searched for waste in any aspect of production, including indirect costs (Waddell, 2005). Ultimately, in lean manufacturing, workers optimized direct labor and minimized manufacturing support costs (Waddell, 2005).

From the perspective of operations management, Voss (1995) drew a direct connection between Taylor's work regarding the development of mass production processes and lean manufacturing. Critical to lean manufacturing and the reduction of batch sizes are the single minute exchange of dies (SMED) developed using industrial engineering concepts stemming from Taylor's concepts (Voss, 1995). Additionally, Taylor's focus on the organizational aspect of the factory and the role of the individual has been a key element in the development of lean manufacturing (Voss, 1995). As lean manufacturing evolves in the future, Taylorism will continue to be an important aspect of lean manufacturing theory.

An Extension of Taylorism into the 21st Century

Just as Taylor dissected each manufacturing process into its component parts for modification, improvement, or elimination to promote efficiency (Gabor, 2000), managers in the 21st century must have thorough knowledge of all activities in the production process including automated activities. Advances in information technology systems afford managers a comprehensive series of methods to gather and analyze data in order to institute timely changes in the production flow. In the competitive environment of the 21st century, the ability to respond quickly to constraints is essential to sustaining the economic viability of the company.

Effectiveness and Efficiency in the 21st Century

Activity-based costing, theory of constraint, and material requirement planning arose as a reflection of the current manufacturing environment and the advent of advanced information technology. Each provides management with tools to monitor production flow, control costs, evaluate performance, measure outcomes, and ensure efficiency in operations. The successful employment of these tools requires management to have a complete understanding of all activities in the production process, which in turn, enables effective management of the process.

With the pressures of global competition, the demand for high quality products, and timely delivery expected by customers, Taylor's theories continue to have relevance. However, with a greater reliance on artificial intelligence, the mechanism by which managers obtain and analyze relevant information will continue to change (Seed, 1988). Due to the automation of production process and process control systems, managers have more timely access to accurate cost information (Seed, 1988). The modernization of Taylor's methods provides a more predictable throughput allowing efficiency in process performance with minimal waste (Seed, 1988). The progression from stopwatches to information technology when gauging efficiency has modernized Taylor's original theory of scientific management.

Corporate Sustainability and Reverse Logistics

The focus on waste reduction in the manufacturing process evolved into the corporate sustainability aspect of corporate social responsibility. Beginning in the late 20th and early 21st century, companies began to consider the environmental impact of corporate actions on present and future generations (Aras & Crowther, 2008). As part of the application of social responsibility, companies began to monitor the usage of scarce resources (Aras & Crowther, 2008).

In its simplest form, sustainability limits the use of a resource to an amount that can be adequately regenerated (Aras & Crowther, 2008). In a global economy, the concept of corporate sustainability places the company within a broad social and economic system where the company must attempt to balance economic growth and environmental protection on a global basis (Aras & Crowther, 2008). The quantification of the resultant social, environmental, economic, and ecological costs requires new or adapted systems of managerial accounting to provide decision-makers with needed information (Schaltegger & Burritt, 2006). In addition to external sustainability reporting to communicate the general management strategy regarding sustainability, a bottom-up, decision-focused model can help the company reduce costs and increase competitiveness by incorporating sustainability concepts throughout the organization (Joshi & Krishnam, 2010).

Additionally, in the late 20th century, companies began to examine the notion of reverse logistics, which, in addition to the return and disposal of unwanted products, included the recycling of packaging materials (Schwartz, 2000). Traditionally, the market or the shipper's requirements dictated the packaging design without regard to disposal (Chan, 2007). Concern for the environment, as well as sustainability, resulted in the development of returnable and reusable packaging to both save costs and environmental resources (Chan, 2007).

A Possible Return to Modified Taylorism

Vidal (2004) proposed that the increased stress on the workers due to making decisions and taking responsibility might result in a return to traditional Taylorism. Workers who had job security and acceptable wages, especially those working in companies where the empowerment was not significant, often became disenchanted with lean manufacturing methods (Vidal, 2007). Vidal (2007) also found that workers motivated by a broad range of factors were satisfied when working under traditional methods. Some companies began to employ a variety of structures ranging from traditional batch and queue methods to a lean cellular model in an effort to improve worker satisfaction and performance.

In his review of management through history and projection into the 21st century, Drucker (1999b) reported that in the late 20th century, a focus on teams replaced the top down structure of Taylor's theory. For the 21st century, Drucker (1999b) advocated a new focus on the leader, not to manage people as Taylor conceived, but rather to lead people to maximize their productivity. This maximization of productivity required obtaining and applying significant technical knowledge when performing manual tasks (Drucker, 1999b). Unlike the untrained worker from Taylor's time who depended upon the technical skills of management, the knowledge worker applied their own learned skills when performing tasks (Drucker, 1999b).

The maximization of productivity required workers to employ knowledge rather than simply working hard and efficiently (Helper, 2009). Strict standardized procedures, such as those employed by Taylor, stifled the creativity needed for continuous improvement and learning (Alder, 1993). The achievement of high productivity or productive output in the 21st century may require management to continue to focus on standards and efficiency, while also learning important lessons from the NUMMI plant in regards to adapting Taylor's methods to involve the workers in the process. Continuous improvement, so vital to the modern manufacturing process, requires workers to manage themselves and take responsibility for learning new skills (Drucker, 1999b).

Conclusion

Work process theories and management accounting methods often change as the economy, manufacturing processes, and other social dynamics change. Traditional Taylorism, as proposed by Taylor in 1911, may not exist in the modern manufacturing climate, but multiple aspects of Taylor's theories and practices continue to have relevance. New methods and theories will continue to evolve from the lessons learned throughout history.

Taylor (1911b, p. 140) concluded his book *The Principles of Scientific Management* with the following passage:

> It is no single element, but rather this whole combination, that constitutes scientific management, which may be summarized as: Science, not rule of thumb. Harmony, not discord. Cooperation, not individualism. Maximum output, in place of restricted output. The development of each man to his greatest efficiency and prosperity.

These words continue to guide operations management and the related management accounting systems today.

The globalization of the world's economies, the rapid change in technology, and the demands of an increasingly complex world continue to challenge our manufacturing processes. Today, more than ever, companies are increasingly reliant on knowledge workers (Drucker, 1999a; Drucker, 1999b). However, while maximizing manual worker productivity continues to have an important role in the growth of developing countries, knowledge worker productivity in developed countries has expanded to non-manufacturing industries such as medicine, education, and research (Drucker, 1999a). Because the tasks completed by the workers from non-manufacturing industries often involve both knowledge work and manual labor, the ability to attract and motivate high producing workers through sound management can result in improved performance for the organization (Drucker, 1999a).

The workers of the 21st century are better educated and rely on more mechanized systems than in Taylor's time. These developments allow management to fine tune production processes in the search for greater efficiency and productivity. In June 2008, the Institute of Management Accountants presented the following new definition of management accounting: "Management accounting is a profession that involves partnering in management decision making, devising planning and performance management systems, and providing expertise in financial reporting and control to assist management in the formulation and implementation of an organization's strategy" (p. 1). This new definition is an adaptation of Taylor's original theory recognizing the value of the knowledge worker and the worker's contribution to the maximization of the prosperity of the worker.

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