The Manufacturing Education Dilemma: Operating Efficiency vs. Productivity

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by

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Abstract

Manufacturing engineering graduates are given the unenviable task of converting design intent into high quality products and services. Too often they are constrained by limited time and resources to complete the task effectively. Further exasperating the problem is the confusion surrounding the distinction between operating efficiency and productivity. Much clarification is needed in this regard if manufacturing engineers are to successfully argue for time and resources. The increasing number of defective products and recalls in all manufacturing areas is disturbing. A hallmark of American industry was pride in engineering excellence. The move away from engineering excellence to financial dominance now plagues the American economy. As upper level management have become increasingly dominated by financial personnel the results for some industries have been disastrous. Therefore, manufacturing engineering students must understand and clearly articulate the distinction between operating efficiency and true productivity which represents customer value. Only with the proper dialogue can real change be implemented. This paper outlines the various perspectives and confusion surrounding productivity. It will be argued that there is only one viewpoint that represents true productivity. Therefore, a definition of true productivity is provided. In addition, an instructional intervention is suggested to provide to provide faculty with a vehicle to elucidate the distinction between operating efficiency and productivity throughout the undergraduate experience.

1.0 Introduction

Students from manufacturing engineering programs have the formidable job of bringing new products and services into the marketplace. They must understand and interpret both design and functionality in order to provide the necessary expertise to ensure customer satisfaction. They are the arbiters between operating efficiency and productivity. Students must understand this difference from an ecosystem perspective. They must learn to realizing that any such system can be pushed beyond it natural limits in the name of increased efficiency.

All manufacturing engineering students learn that manufacturing operating efficiency is output divided by input where efficiency is simply doing more with less [1] [2] [3]. Monetarily, output is sales revenue while input consists of operating expenses both fixed and variable. Further still, operating efficiency can be measured by the amount of output – number of units for a specified time period associated with the cost of producing these units. A more inclusive definition involves multifactor measures the output generated by a combination of inputs, multifactor or total factor productivity [4]. Total factor productivity consists of capital, labor, energy, raw materials, and business services. The evolution of the Internet of Things (IoT) provides a comprehensive platform where students can assimilate and differentiate operating efficiency vs. productivity.

Engineering faculty are using a variety of immersive approaches to support student learning objectives via: Problem Based Learning (PBL), Case-Based Learning (CBL), Experiential learning (EL), Project Based Leaning, (PjB) and Learning Factories. As an immersive example the tension between operating efficiency and productivity is explored in a capstone manufacturing course. In this course management and engineering design and manufacturing students are challenged to design and develop product concepts. The tension between operating efficiency and productivity is deliberately emphasized, much to the dismay of the engineering design and manufacturing students. Management students deliberately press throughout the semester for increased efficiency in raw material utilization, design simplicity, manufacturability and increased functionality at progressively lower cost targets. Within this course the tension between operating efficiency and productivity emerges.

In an experimental learning environment, it is easier for students to understand the traditional and most widely used measure of operating efficiency, labor efficiency [5] [6]. Students are increasingly tasked with the need to introduce automation, robotics and other tools to reduce direct labor costs. As connectivity increases within manufacturing operations and throughout the supply chain the IoT plays an increasing role toward improve efficiency [7]. Labor reduction is an integral aspect of the IoT that has allowed for the biggest gains in reported productivity. Labor productivity is obtained by dividing value added by the numbers of hours worked or the number of workers [8]. Operating efficiency is where, according to researchers, the highest productivity level (efficient point) is achieved when maximum output is obtained for a particular level on input [3]. Regardless this concept of improved *productivity* particularly focused on labor input has been challenged by some researchers and business analyst. These researchers point to mixed reviews regarding competitive advantages of downsizings and rightsizing to achieve profit maximization [9] [10]. The potential distortion of these labor reduction efforts is having and has had disastrous effects on such organization as Boeing, General Motors, and General Electric and manufacturers in general [11] [12] [13]. The issues regarding the Boeing 737 Max are a powerful backdrop for faculty to highlight the distinction between perceived operating efficiency and true productivity.

2.0 Evolution of Operating Efficiency Measurement

It may interest manufacturing engineering students that the root of operating efficiency has its beginning largely with the industrial revolution which began in England. As early as 1791 Benjamin Franklin understood the need to contribute something of value to society each day with the question, “What good shall I do today?” This was but one of Franklin’s 13 virtues. His sentiment is reflected and shared by the Engineering Creed as well as the Fundamental Engineering Canons.

THE ENGINEERING CREED

> “To participate in none but honest enterprise; To live and work according to the laws of man and the highest standards of professional conduct; To place service before profit, the honor and

> standing of the profession before personal advantage, and the public welfare above all other considerations" [14].

THE FUNDAMENTAL ENGINEERING CANONS

> **1**. **Engineers** shall hold paramount the safety, health and welfare of the public in the performance of their professional duties.
> 2. **Engineers** shall perform services only in the areas of their competence [14].

Many companies and their employees seeking to provide value to their customers. Regardless, reviewing the evolution of the definitions of productivity it is easy to see how the terms efficiency and productivity became interchangeable in manufacturing. The history of the term productivity has its roots even earlier with subsequent definitions. These definitions are largely operations centric, and do not reflect a sense of commitment to society or the customer, please see Table 1 below.

Table 1 Productivity Definition Over Time

Time Scale	**Researchers**	**Definitions of productivity**
Eighteenth century	Quesnay (1766)	The word "productivity" appears for the first time
Nineteenth century	Littre (1883)	"Faculty to produce"
Twentieth century	Fabricant (1962)	"Relationship between output and the means employed to produce this output
		"Quotient obtained by dividing output by one of the factors of production"
	Kendrick and Creamer (1965)	"Change in product obtained for the resources expended"
		"Always a ratio of output to input"
		Functional definitions for partial, total factor and total productivity
	Siegel (1996)	"A family of ratios of output to input"
	Sumanth (1984)	Total productivity-the ratio of tangible output to tangible input

Entire textbook also emphasizing productivity but explore the dynamics of operating efficiency. Interestingly in some the term customer never appears [15]. Manufacturing students learn that from an operational viewpoint operating efficiency is quantified as percent utilization and yield for a given operation. Percent utilization is the actual amount of productive machine time (uptime) divided by the optimal amount time available for a given machine. This fundamental manufacturing concept can be more readily understood by students within a hands-on, active learning environment [16]. Students can easily understand the numerous reasons for lower than 100% utilization: preventative maintenance, machine set up and adjustments [17]. While other downtime issues are not planned such as unscheduled maintenance, lack of raw materials, staff and limited demand. The use of downtime codes which can be programmed at the machine help manufacturing students better understand problematic areas. They begin to understand changes needed to optimize machine utilization and is an integral aspect of IoT. Students also learn that percentage yield will also draw down output based on actual units shipped rather than a theoretical optimal number of units that the system is capable of producing. Yield reports outline problems with out of specification production in terms of form, function and fit. In many experimental learning environment students are placed in specific roles, such as quality control, to understand quality related issues. Students in this role learn to identify and resolve quality related problems which can be identified through the use of routine roving inspection, automated inspection, capability index analysis as well as destructive and non-destructive testing. Quality control concepts can also be taught in an applied laboratory or industry internship setting.

The use of Overall Equipment Efficiency (OEE) provides manufacturing students with a broader perspective both at the machine level as well as at the plant level in order to optimize output. Increasingly being coupled with IoT analytics, OEE, can be more easily assessed throughout the manufacturing operation [18]. Students learn that the strength of the OEE index is in making losses more transparent and in highlighting areas that need improvement [19]. The introduction of OEE helps to differentiate operating efficacy from productivity because of the inherent assessment of quality. This methodology was first proposed by Seiichi Nakajima to quantify performance of factory equipment [17]. Essentially OEE involves three aspects which together helps to quantify efficiency generally as an overall percentage.

$$\text{OEE} = \text{Availability} + \text{Performance} + \text{Quality}$$

Due to process variability it is nearly impossible to reach 100% OEE [19]. As pointed out by Bicheno [20] world class level of OEE is in the range of 85% to 92%. The average rate in manufacturing plants is 60% so there is a critical need for further improvement [21]. While on a plant wide basis Overall Factory Efficiency (OFE) can be used but, unfortunately, there are limited standard methods or matrices. However there has been increasing effort made to understand the nature of operations where machine processes are linked [22]. Numerous tools have been developed to support improved equipment efficiency, for example, moving from preventative to predictive maintenance. The use of close loop technologies, monitoring key process variable, design of experiment, process mapping has greatly improved manufacturing process efficiencies.

The OEE measurement is an important Key Performance Indicator (KPI) at both the operational and strategic level. A series of 34 KPIs have been developed by the International Standards to provide a fundamental framework for global manufacturing operations [23]. The use of KPI are critical to help prioritize and align various aspects of a manufacturing operation and continuous improvement systems. Basically, KPIs are defined as a set of quantifiable and strategic measurements in a Performance Measurement System representing the critical success factors for an organization [24]. The rapid evolution of information technology IoT, provides numerous tools for monitoring and controlling of manufacturing operations and equipment: radio-frequency identification, wireless sensors and networks, programmable logic control, automated inspection and robotics [7]. More specifically IoT analytics provides critical quantitative data that can be analyzed to study cause and effects based on a performance measurement system [25]. Regardless to encourage a broader perspective and understanding researches have proposed a hierarchical structure for KPI relationship investigation [24]. The use of these analytical tools is important for monitoring but to achieve world class manufacturing the introduction of lean concepts, waste elimination. Lean concepts have played a major role in improving operating efficiencies. In order to accurately measure manufacturing efficiency, we need to accurately measure inputs and outputs. In this regard we need to estimate the input substitution possibilities that various technologies allow as a potential source of competitive advantage. The evolution of IoT has made a significant contribution to measure operating efficiency helping companies to deal with the biggest challenge facing U.S. manufacturers, productivity improvement [26] [27]. Regardless from a historically perspective efficiency improvements have been driven largely by reduction in labor input.

3.0 Operating Efficiency - Labor centric

The use of labor as a means to improve operating efficiency has its root in early manufacturing where industry was labor intensive. The common definition of labor efficiency is, “the number of labors hours required to accomplish a given task, when compared with the standard in that industry or setting” [3]. There is always unrelenting pressure to reduce direct and indirect labor cost. Pragmatically labor force reduction is within easy reach of manufacturing managers seeking to be more efficient [28]. Manufacturing operations has become increasingly automated coupled with other efficiencies created by the integration of lean methodologies. In addition, other areas need careful assessment such as conservation of raw materials, energy and prudent capital expenditures to help ensure competitive advantage [29]. Much progress has been achieved in operating efficiency with regard to labor input. Historically this can be seen readily with agriculture, construction and manufacturing. Although labor is easilty quantified at the aggregate plant, national or international level it is more difficult to quantify individual worker efficiency [28] [30]. Despite the difficult of measuring individual productivity a number of studies bases on either quantity or quality- adjusted methodology have been conducted [31] [32].

Regardless pursuit of labor reduction, both blue- and white-collar workers, has had mixed benefits toward improving profitability and competitive advantage. For instance, there are some contradictory outcomes on the return on asset ratio (ROA) and return on equity (ROE). A number of research studies [33] [34] indicate that both employee and asset downsizers as well as employee ‘upsizers’ reduce ROA and ROE [35]. In addition, there is limited empirical evidence that downsizing consistently improves financial outcome [34]. Further exacerbating labor related issues is workers leaving manufacturing altogether [36].

What is most unfortunate is the current manufacturing skills shortage and the legacy these downsizing efforts have toward recruiting the next generation of manufacturing personnel. Although the headlines are often portrayed as sensational the reality is stark for employees and their communities who are or have been laid off. Sadly, it would seem that some CEOs relish the process only adding to the reluctance of individuals to pursue a manufacturing career [37]. Jack Welch, for example, former CEO of General Electric (GE) was known as “Neutron Jack”. He would annually purged 10% of his workforce [37]. Further fuel resentment is the 42% increase in pay for the CEO's for the 50 firms that laid off the most workers since the Great Recession. As mentioned previously both practitioners and academic literature indicates that many downsizing efforts did not meet their objectives. The current situation with Boeing, 737 Max ground and loss of market share, is a stark reminder of this mentality. Former GE senior managers have and now hold CEO positions at Boeing. Even in the midst of Boeing's quality related issues, management still pursues layoffs even in areas such as inspection [38]. The negative implication of downsizing for remaining employees (survivors) is but one of the key reasons' organization fail to meet their objectives [39]. Regardless if downsizing is well managed it can help mitigate the impact on survivors and help ensure core objectives are realized [40].

4.0 Operating Efficiency - Lean Centric

The application of lean has enabled many companies to flourish making significant gains in operating efficiency [41]. The direct application of lean concepts rests, beyond labor, with the critical assessment of how a manufacturing operation makes every effort to reduce waste on an ongoing basis – continuous improvement. This requires continuous improvement in three areas: waste reduction, value enhancement and people involvement [20]. This in terms of operating efficiency directly impacts the total factor perspective. The ultimate goal is to minimize and eliminate waste with regard to raw materials, energy, labor and capital. These efforts impact the denominator, inputs, of the efficiency ratio. From an operations viewpoint lean implementation involves: just in time delivery, work flow balancing, spaghetti diagrams as well as optimizing work in progress while minimizing off spec production and scrap [42]. To continue to improve effectiveness the concept of lean enhances operating efficiency for many manufacturers that embraces an operations centric definition of efficiency. Reduction in inventory based on Just in Time (JIT) delivery is also noteworthy but requires highly reliable quality suppliers [43] [41]. Regardless lean can sometimes be taken too far to the point where there is limited flexibility and resources to further develop operational competitiveness and innovation [44] [45] [46]. In terms of competitiveness publicly traded companies look to Wall Street for validation. The Wall Street mentality has tremendous influence on manufacturing operations with its emphasis on profit maximization to enhance the company's valuation, dividends and stock prices.

5.0 Wall Street Influence – Profit Maximization

The influence of Wall Street on manufacturing operations is enormous with the underlying goal of not just of profit but, profit maximization. Every effort is made to maximize profits and increase market share. As mentioned previously General Electric's Jim Walsh and his staff use every means at their disposal to raise dividends as well as the company's stock. From a labor perspective, downsizing, and rightsizing personnel has been a major tool in this effort. Mergers have also played a significant role in increasing a company's valuation. Another effort is the use of stock buyback which has been radically increasing in recent years [47]. The relentless effort toward growth and profit maximization impacts all aspects of manufacturing production: research and development, procurement, supply chain management, marketing, sales and human resource management. Further, from a financial perspective, CEOs embracing the concept of return on net equity (RONE) has played a major role in large companies divesting themselves of an array of competitive assets.

The influence of Wall Street and the need to satisfy investors need for almost immediate gratification has been a daunting task of US manufacturers. The reward system, especially for senior level managers tends to prioritizes short term thinking over long term strategic planning is well known [48] [3]. This short-term thinking translates into efforts to maximize profits, boost stock prices often is operationalized by mergers, layoff and stock buybacks. Many industry and economic analyst have warned of the consequences of this mode of operation. Regardless, this mindset continues in some major industries unabated. Unfortunately, the legacy of this short-term thinking has and can lead to filings under Chapter 11, or bankruptcy and in some cases criminality [13].

Manufacturing engineering students need to understand how to develop long term strategic advantage using a holistic approach to achieve true productivity. The Balanced Score Card (BSC) provides faculty and their students with such a context. The use of the BSC perspective provides an all-inclusive viewpoint to help stakeholders differentiate between operating efficiency and productivity. The BSC consists of four areas: customer, financial, internal business processes as well as learning and growth. Review of operating efficiency measurement and methodologies directly impacts internal business processes. The financial element in the BSC can be highly influence by Wall Street. The realm of customer value and learning and growth seemed to be orphaned after reviewing the research literature. The tension between operating efficiency and productivity has been places in stark contrast due to the dominance of the financial perspective. The result has let to the formation of large oligarchies and failed industries that need to be bailed out by taxpayers [49].

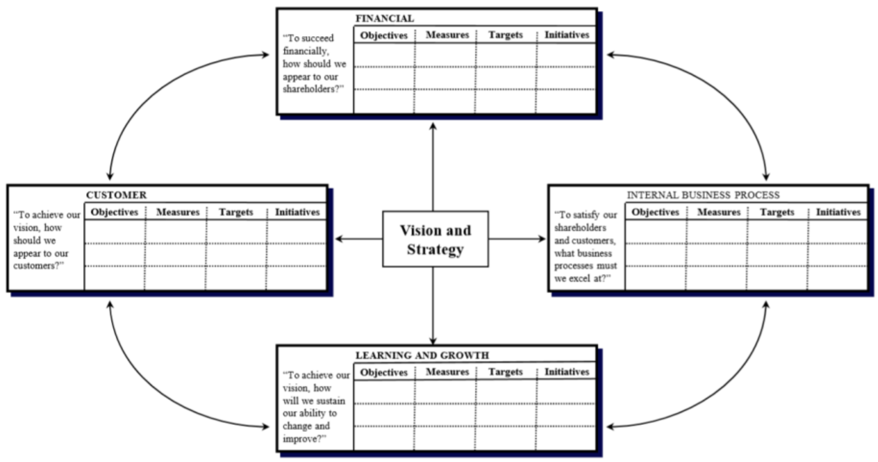
6.0 Holistic Perspective – Balanced Score Card

What is needed is a unifying definition of productivity. A definition that can be applied to all levels of a manufacturing organization as well as along the supply chain. There are excellent working model to analyze key production efficiencies such as percent utilization and yield aggregated and enhanced by OEE, KPIs and OFE. Regardless, stakeholders need to understand that all efficiencies do not necessarily translate into productivity. It is an illusion, sometimes a dangerous illusion, to assume all efficiency gains translate into productivity [3]. Any organization can be efficient at producing products and services that customers do not want or that can annoy or harm them. Despite some successful acquisitions, mergers, downsizing and rightsizing have and will plague U.S. manufacturers over the long terms [50]. Effort to boost operational efficiency have seen noticeable improvement but may leave some operations too lean to be flexible and innovative. Wall Street has played a major role in rewarding CEO who *appear* to provide short term benefit to their stakeholder while sacrificing long term stability and competitive advantage [51] [52]. Each approach to improve operating efficiency may tend to evolve into myopic groupthink. Such a mindset leaving blind spots that can and will be detrimental to the long-term stability of an organization. What is needed is a balanced approach that integrates all stakeholders toward focusing on customer value [12] [13].

The BSC provides the needed framework for managers, engineers and their staff to help align an entire organization and their supply chain to achieve customer satisfaction while remaining competitive globally. An enhanced approach is for OEM managers to understand and treat their supply chain as an ecosystem. Viewing a supply chain as an ecosystem has the potential to empower all stakeholders. The ecosystem can be viewed in its entirety using BSC.

Balances is achieve in four area of focus: customer, learning and growing, financial and internal business processes to actualize both a vision and strategy, see Figure 1 below.

Figure 1 Vision and Strategy Development: The Four Perspectives [53]



After reviewing the BSC and trends in industry it is easy to see managers have tended to emphasize financial and internal business process gains. What is almost entirely excluded is the customer as well as learning and growing, continuous improvement. This fiscal prioritization has led to some of the most flawed business decisions prior to Boeing. A case in point was the Ford Pinto, "Ford's beancounters hadn't figured out a way to calculate the cost of a happy customer" [13]. In addition, beancounters did not consider lost market share which would have a long-term detrimental effect on market share. Ford executives had lost sight of customer safety and value. Executives at General Motors (GM) also had similar problems by emphasizing internal business process related to supply chain management.

In the early 90s J. Ignacio Lopez was hired as Vice President of Purchasing for GM. Mr. Lopez's policy involved ravaging GM's supply chain for untenable cost reductions. Mr. Lopez's policy involved creating multiple rounds of bidding using the lowest bid as the next base price to being the next round of bidding. This bidding process continued until the absolute lowest price was obtained. Editors at the time predicted the problems and demise of GM stating, "The Lopez approach has the capability of destroying not only companies but also industries and perhaps the economies of entire nations" [51] [52]. In 2009 both GM and Chrysler would declare bankruptcy and protection under Chapter 11. The federal government would eventually bail out both automotive companies [54].

The case of Boeing and the 737 Max follows the same eerie pattern of supply chain mismanagement with emphasis on relentless cost reduction with similar consequence. In Boeing's case, CEO Dennis Muilenburg pressures his supply chain via, "Partnering for Success

2.0, demands additional price cuts of about 10%. "Frankly, this feels like walking down the street and being mugged, Nigel Stein, then CEO of the U.K. aircraft parts maker GKN Plc." [55]. Industry observers predicted problems similar to GM and Chrysler orchestrated by Boeing previous CEO, Jim McNerney [12]. Further still, as industry analyst point out how McNerney would turn to employees as another option to boost profits. McNerney either gutted or eliminated pensions, cut wages, and shifted some production to new facilities in South Carolina with the intent to break its unions [56]. In addition, Boeing moved its headquarters away from its manufacturing centers to Chicago far removed from any manufacturing operation [12] [49] [56]. Jim McNerney's legacy has left a toxic culture throughout Boeing that is still prevalent today. This a culture that lead to two fatal crashes killing 346 passengers and crew member. These incidences resulted in the Boeing 737 Max eventually being grounded. There have been numerous calls by policy makers, practitioners and customers to return Boeing to its engineering roots. Unfortunately, the recent replacement of Dennis Muilenburg with David Calhoun as CEO, who does not have an engineering degree, does not bode well. Further there remains no engineering expertise on Boeing's board of directors so little has changed. These decisions provide object lessons for manufacturing engineering students.

7.0 Instructional Implementation

Manufacturing engineering students are tasked to effectively transition customer focused design intent into high quality products and services. In order to effective implement the proposed definition of true productivity, described in the following Discussion and Conclusion section. It is suggested that faculty consider providing a thematic setting in each course. This thematic framework, product failures, should be provided throughout the entire manufacturing engineering undergraduate experience. Students should be tasked in their Introduction to Engineering course to research and carefully document product recalls. These recalls should relate to form - aesthetics, function and fit - assembly. Recalls related to function should involve various areas such as mechanical, thermal, vibrational, and acoustical malfunctions. Students, with these recalls in hand, will begin to understand the interdisciplinary expertise needed to solve manufacturing engineering problems. The IoT provides the computer integrated platform, with a common database, to successfully capture the requisite data. Students will also begin to understand how their various manufacturing courses are applicable and interrelated.

Course concepts can be applied to prevent recalls in order to assure high quality products - customer value. Student recalls provide the necessary proactive arena to identify and prevent such problems in the future. The use of project-based learning and its variants, mentioned previously, provide the needed pedagogical structure within which these recalls can be accessed and solutions generated. Capstones courses can be somewhat limited and late in the course sequence. What is needed is continuous exposure to support consumer value – true productivity to make the needed pedagogical impact. Sadly, recalls abound annually and there is no lack of examples.

Recalls provide the needed context to engage and enhance a student's intellectual interest; the need to identify and solve a problem(s). As students enters individual courses these recalls, within the balanced scorecard milieu, girded by IoT can help to engage student's intellectual curiosity. They can see the direct application of course content throughout their program of study. In addition, the dialogue will also shift within each course encouraging students to become active participants in the specific subject matter.

8.0 Discussion and Conclusion

It is imperative that manufacturing engineering faculty help their students understand the difference between operating efficiency and *true* productivity. Without this understanding students will be unable to fully implementing the voice of the customer. Continuous improvement cannot be realized without fully understanding this distinction. Continuous improvement initiatives do necessarily translate into productivity. If cycle times are reduced, for example, it may only mean you are being more efficient at making unacceptable products or services [57]. If poorly executed IoT analytics are based on faulty sensor data or algorithms may tend to hamper the enormous benefits of this technology [58]. Further manufacturing students, upon graduation, will not be able to effectively argue their case with management, for increased resources and time. This is true especially with changes needed to prevent harm to customers. The BSC provide an all-encompassing framework to help students understand the four critical areas that need to be in balance. If properly executed the vision and mission of a manufacturing company can and will be realized by consistently providing customer value.

Manufacturing engineering faculty and their students are keenly focused on how to make companies more profitable. Understandably companies must focus on speed, efficiency and quality to provide value to the customer, to remain globally competitive [59]. The fundamental distinction between operating efficiency and *true* productivity is often the difference between quantity and quality. Sarri's ratio stands out for its straight forward simplicity [60].

Total Productivity = Output quality and quantity/Input quality and quantity

Despite major efforts to monitor and measure operating efficiency it has been suggested that a balanced perspective is need to ensure long term stability of any manufacturing firm. There are numerous tools that exist to define and measure the critical parameters for the various aspects of operating efficiencies. The prioritization of labor reduction to increase efficiency has and continues to dominate managerial thinking [3]. This is unfortunate, since from a total factor standpoint there remains many untapped areas for potential growth and profitability [19].

Unfortunately, the relentless downward pressure on price has come at a cost to many stakeholders along the supply chain as well as to customers. Unrealistic pressure to reduce cost encourages manufactures in the supply chain to often compromise the quality of their products resulting, ultimately, in loss of market share for Original Equipment Manufacturers (OEM). Many industry analysts and policy makers, for years, have called on OEMs to improve their working relationship with their suppliers but with limited success [61] [62] . Unfortunately, poor relationships with suppliers has and will cost OEMs billions of dollars. Boeing currently estimates its loss, due to the 737-max grounding, at 19 billion to date [63]. In an attempt to correct for past financial centric mistakes Boeing appears to be moving to re-empower their engineers [64].

A competitive manufacturing capstone course could consist of both management and engineering design students. The management students, representing finance, could constantly request cost reduction after every design iteration. Initially cost reduction can easily achieved but as the project progresses cost reductions becomes increasingly difficult and real tension could arises between students. Regardless faculty should intervene to guide students to seek solutions and decisions with an emphasis placed on assessing efficiency versus productivity.

The use of a Balance Score Card encourages an all-encompassing perspective in strategic areas: the customer - value, finance - fiduciary responsibility, learning and growing – staff development and internal business processes – operations/supply chain management. In conclusion this holistic perspective is fundamental and a pragmatic quantifiable definition of true productivity is proposed.

> *Productivity is the number of units sold and paid for with a high level of customer satisfaction divided by optimal fixed and variable costs consistently informed by the Balanced Score Card.*

This definition reflects the indisputable fact that the customer is the ultimate arbiter of productivity.

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