


# **COST** Management

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# DEBATING THE PRINCIPLES: ASKING QUESTIONS

This article is the second in a series that highlights questions and concerns with the principles that underlie some existing management accounting approaches.

## OF LEAN ACCOUNTING

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**T**his article is the second in the series that highlights questions and concerns with the principles that underlie some existing management accounting (MA) approaches. The focus of this series of articles is on foundational principles in MA conducive to effective decision support. As was pointed out in the MA Philosophy series of articles, decision science falls in that branch of the scientific method that deals with inferences of causes and their effects in different time frames i.e., origin/historical science.<sup>1</sup> The scientific method (whether operations science or origin science) has as its foundation inductive logic and causality as its guiding principle. In business, decisions are concerned with understanding cause and effect outcomes (causality) in the future. For managers, MA is an important source of causal insights and their corresponding monetary implications.<sup>2</sup> With that frame of reference this current series has a twofold purpose: 1) to point to limitations of other principles that MA approaches use in terms of what makes them unsuitable for use in the decision science domain, and 2) to highlight shortfalls and inconsistencies in approaches because they rely on inappropriate principles.

The first article in this series looked at the Theory of Constraints' (TOC) use of relevance as a guiding principle for operational modeling to support a range of optimization decisions. In this article, lean accounting (LA) is the approach under discussion. There have been questions raised as to claims from within the LA circuit with regard to support for external reporting and decision making.<sup>3</sup> The intent here is to examine the principle LA employs as the foundation for the monetary decision support information it provides.

Lean manufacturing has its origins in the automotive industry; specifically the automotive manufacturer Toyota. Lean thinking refers to a management philosophy that takes a systems view of operations with the objective of designing and operating that system (e.g., an entire automotive plant and its supply chain) in an optimal manner with an emphasis of customer pull through the system. Lean thinking has found application and demonstrated benefit in a variety of industries. Lean accounting in turn is an attempt to

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**LA ASSUMES  
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derive monetary management information based on lean manufacturing principles. The Toyota Production System (TPS), the showpiece of lean thinking, has one-piece flow (aka, the simple flow-path) as its core principle. LA assumes the flow-path as its guiding principle for the MA information it provides—proponents argue that to simplify the accounting system, one must “... use the same rules, guidelines, and underlying principles that guide the operation and development of TPS.”<sup>4</sup> They therefore conclude: “The concept of one-piece flow is a prerequisite for simplification—and for a lean accounting system.”<sup>5</sup>

### **The flow-path principle and decision science**

Lean thinking emphasizes an overall systems approach and LA, by adopting the flow-path as its guiding principle, places the systems view ahead of causality, the principle appropriate to the decision science domain. For example, LA claims: “The cost of the product is primarily related to the rate of flow through the value stream, not the amount of labor or machine time required to make the product.”<sup>6</sup> Thus, system flow trumps causal insights into individual resource usage or non-usage. LA’s disregard for decision support information based on the principle of causality is further illustrated by its practice of including excess/idle capacity costs in the value stream and associating those costs arbitrarily with the products produced. Such lack of support for the principle of causality in LA raises the question whether its guiding principle (flow-path) can satisfy the demands of the decision science domain.

Systems thinking—like so many of today’s leading edge ideas—has its roots in the late 19<sup>th</sup> and early 20<sup>th</sup> centuries.<sup>9</sup> This timeframe has been referred to as MA’s progressive era, in particular the years from 1890 to 1920. It is from this era that one can glean the evaluation criteria to answer the question posed about LA’s flow-path principle. It was recognized very early on that the factory floor and the decision science domain are two very different disciplines. Church expressed his view on the topic as follows:

The object of organization is to determine the ways and means of efficient production; the object of cost accounts is to register and record every stage and step of production as it actually happened. It is very necessary to insist strongly on this latter definition. Costing should be registration of production—events that actually happened—it should be nothing else. But when such facts have once been faithfully and accurately recorded, then they may be interpreted in several different ways, according to the need and the point of view of the person interpreting them.<sup>10</sup>

It is this need for information that provides causal insights and their use in extrapolations and inferences (in, for example, planning and decision-making) to which Church alludes are at the core of the difference between the two disciplines. As discussed in the management accounting philosophy series, causality as one of the cornerstones behind rational inference is indispensable to effective decision making. In this regard there are four universal aspects of decision support information with which any MA approach must comply. The first aspect is scope, which signals the boundaries or breadth for rational inferences in a decision. The second is focus and it emphasizes the subject of the decision analysis for which the decision support information must be provided, i.e., the business entity(s) or object(s) such as a resource, a product group, a plant, or one or more market segments. The third aspect, causal insights, is a cornerstone of the scientific method recognized as indispensable ever since Francis Bacon penned *Novum Organum* in 1620.<sup>11</sup> Causal insights guide managers’ inferences concerning alternate outcomes in the future. The fourth aspect, cost behavior insights, is an essential part of business decisions; money is the common denominator that allows for the weighing of disparate decision alternatives. This fourth aspect LA seems to acknowledge in its own efforts to provide monetary decision support information.

### **An assessment of the flow-path principle for decision support**

The flow-path principle by its very nature deals with only those consumption relationships physically touching the product and this results in compromises in LA’s decision support capabilities. This sec-

tion discusses these compromises using the four aspects of decision support information identified above. The effects of these compromises on LA's decision support capabilities will be discussed in more detail below after considering potential objections to the assessment.

**Scope.** The scope of LA decision support information is confined to the *production process* because that is the flow-path's singular concern. In this regard LA has been criticized for its view that the shop floor is the center of the universe.<sup>12</sup> This criticism is underscored by LA's own claims that its "plain English" value stream income statement is intended for, and finds universal acceptance on, the shop floor. What about the information needs of those that look beyond or across value streams? Flow-path as a production/manufacturing principle tolerates no other view. One of LA's key selling points is that lean thinking simplifies things and eliminates the complexity that mires down traditional MA. Here again, LA's proposed cure is entirely local and it is oblivious to complexity factors and related information needs, e.g., global tiered complexity (see the business scenario below) beyond the flow-path's narrow view of the world.

**Focus.** A *product only focus* results because LA's guiding principle is singularly concerned with the flow of product through the value chain. Decisions that depend on information more detailed than a product's flow (e.g., for individual resources) are not supported. LA provides very limited insight into resource related costs; it pools resources in the value stream regardless of unique and/or peculiar cost characteristics.

**Causal insights.** The flow-path principle limits causal insights to *only some product-related insights*. Moreover, arbitrary allocations to the value stream dilute the value of even these causal insights. For example, support services that do not touch the product directly are associated with the value stream in an inconsistent manner, i.e., plant maintenance and floor space are allocated but not any other support costs.<sup>13</sup> The treatment of common fixed costs mentioned earlier further exacerbates the inconsistency.

**Cost behavior insights.** A view of cost behavior appropriate for decision support does not exist in LA. In defining cost concepts LA aligns with TOC (i.e., it defines material costs as variable and the costs of all resources embedded in the value stream as fixed).<sup>14</sup> This limits cost behavior insights to *direct inputs sourced externally* such as material, outside services, and consumables. Moreover, the value stream can only have product volume as an output measure. LA therefore cannot accommodate resource output measures and their associated cost behavioral characteristics. This leads to very limited insight into bottom line dollar impacts when attempting to understand the effects of resource related decisions.

In the decision science domain, LA's flow-path principle is in at least one sense worse than TOC's use of relevance as a principle. TOC is very specific as to the decision it targets to support (throughput). LA on the other hand cannot lay claim to such targeted relevance in the information it provides because of its arbitrary allocation of support and common fixed costs. Value stream information is therefore neither specifically relevant for a particular decision nor accurate or causally representative enough for broader decision support application.

### Objections to the assessment

LA proponents oppose an evaluation of the approach and its principles using traditional measures because, they maintain, such measures are not relevant. They assert that LA has a very different foundation.<sup>15</sup> Systems thinking serves as the basis for lean thinking and not traditional mechanistic thinking.<sup>16</sup>

This objection to the assessment however has questionable merit; LA as a MA approach *must* comply with the demands of the decision science domain. The four aspects used in the assessment are not traditional accounting relics to be discarded as some LA proponents will no doubt claim. On the contrary, as highlighted above they are aspects of decision support information rooted in the scientific method and its application in business. Compliance with these four



**IN THE DECISION SCIENCE DOMAIN, LA'S FLOW-PATH PRINCIPLE IS IN AT LEAST ONE SENSE WORSE THAN TOC'S USE OF RELEVANCE AS A PRINCIPLE.**

aspects of decision support information is obligatory.

There is another objection to the assessment to consider. Optimization context refers to the environment within which optimization decisions occur. One can glean the preconditions that define a lean company's optimization context from the Toyota business model:

- *Long product life cycles* are key to be able to invest in a plant, facilities and infrastructure that conform to lean's ideal right-design, right-size, and right-fit objectives and the elimination of monuments;<sup>17</sup>
- *Price elasticity of demand* enables the manipulation of volumes to maximize the units produced for the investment made;<sup>18</sup>
- *Product differentiation* goes hand in hand with growing and sustaining product volumes at an optimum level;<sup>19</sup>
- *Proportionately large direct product costs*—if the value stream contains only a small portion of total cost its usefulness is greatly diminished; and
- *A single tier value chain* where all activities relate to the value stream output, which is in turn highly correlated with customer pull.

Toyota's business model is familiar; it focuses heavily on leveraging fixed costs. Some in the LA community claim that lean thinking does away with economies of scale. However, such claims are likely based on differences between economies of scale and economies of capacity. Toyota as one of the two largest automotive manufacturers in the world will always enjoy economies of scale due to its price influence on suppliers throughout the extended supply chain and because of the volume discounts it gets.

Lean thinking does change the traditional view of economies of capacity. By designing a plant as an optimized unit where each plant is a single megamachine, Toyota has elevated economies of capacity from the individual machine level to the plant level. A primary objective of Toyota's business model is clearly to achieve economies of capacity for its megamachines. It achieves economies of capacity not by running large batches over the

biggest and most expensive machines in the factory but by manufacturing only one or two car models (essentially a perpetual batch approach) through each optimized mega-machine.

The economics is simple: right-design, right-size, and right-fit the entire plant to limit fixed costs, be lean in execution, and manipulate volumes to reach maximum output: thus leveraging your investment to the hilt. This insight into lean's model environment allows for putting the assessment in perspective on two fronts: 1) within the context of a model lean environment, and 2) when going outside the box (i.e., when companies cannot or will not meet one or more of the lean preconditions).

Within the context of the model lean environment, the structure imposed by the preconditions simplifies the optimization challenge for Toyota. For example, it is unlikely that capacity adjustment, product mix, and resource allocation decisions would be commonplace; the plant as a single optimized mega-machine is difficult and prohibitively costly to expand, and it produces a limited number of model vehicles in an optimally designed process. One can therefore argue that the level of decision sophistication inherent in the assessment does not apply because for such an optimized mega-machine, incisive decisions are seldom or never taken. However, there is one central question in this line of reasoning that justifies the use of the flow-path principle in decision science: In such a highly structured environment, is LA a decision support system at all or does it merely serve to measure and motivate the shop floor? Its "accounting" function is reduced to providing an average unit cost. In fact, lean purists go so far as to point out that, "... accounting control systems play no role in Toyota operations,"—this includes LA.<sup>20</sup> Small wonder that with regard to LA's usefulness in model lean environments, lean purists scold LA as muda—and rightfully so.<sup>21</sup> The objection to the assessment within the optimization context of model lean

**LEAN THINKING DOES CHANGE THE TRADITIONAL VIEW OF ECONOMIES OF CAPACITY.**

environments has merit. However, optimization context is a double edged sword because it highlights the fact that LA is redundant in model lean environments.

### Going outside the box

Lean thinking has gained acceptance with manufacturers and service providers in a variety of other industries. The number of cases where companies cannot meet the list of lean preconditions are likely large and for them LA claims to support a range of decisions.<sup>22</sup> However, what happens if a company's optimization context requires global scope (not local), a broader focus (not just product) and related causal and cost behavior insights? Below, the effects of the decision support compromises that results from LA's flow-path principle are discussed in more detail using three business scenarios: 1) excess/idle capacity, 2) low volume, high mix businesses, and 3) global tiered complexity in optimization. For each scenario an indication is provided of the four decision support aspects required for the particular decision. These should be contrasted with the decision support aspects LA is able to provide namely, scope (manufacturing process only), focus (product only), causal insights (limited to some product related insights), and cost behavior insights (limited to direct inputs sourced externally).

**Scenario one: Excess/idle capacity.** Lean proponents promote an increase in excess/idle capacity as a key benefit of the approach.<sup>23</sup> Lean's efficiency gains materialize as excess/idle capacity for companies not able to right-design, right-size, and right-fit their resources in the short or long term. In these cases, companies must attempt to reduce or market available capacity. How does LA support capacity adjustment and rationing decisions for individual resources using value stream information? The LA response is that these types of decisions require special studies. Due to flow-path principle limitations LA cannot provide the needed information.<sup>24</sup> Based on the reasoning that adopting lean invariably leads to capacity adjustment and/or rationing decisions leaves managers in a bind; decisions result from lean thinking and are commonly

taken, but LA provides no information to support them.

Aspects of decision support information for scenario one:

- Scope—resources in the production process
- Focus—is on specific idle resources
- Causal insights—understanding the effects of capacity adjustment and/or capacity rationing
- Cost behavior—resources' fixed and variable cost, which costs are avoidable

**Scenario two: A low volume high mix business.** Low volume and high mix is another scenario that falls outside the model lean environment and is a reality faced by many companies. Take the example of Hamilton Sunstrand where product complexity and labor specialization forced a mixed model value stream implementation in which diverse products must be manufactured in one lean flow-line.<sup>25</sup> The products' takt times (in hours) vary from the low teens to over eighty hours for the most complex.<sup>26</sup> Resource allocation and product mix decisions are the order of the day, and in the case of Hamilton Sunstrand necessitated adding capacity management and resource allocation tools to supplement quantitative value stream information. Decision makers however are still dependent on the value stream for relevant monetary information. How does LA support optimization when it lacks all the requisite insights into individual resource capacity, resource costs, and related cause and effect insights?

Aspects of decision support information for scenario two:

- Scope—certain resources in the production process
- Focus—individual resources and their capacity to satisfy diverse product demands
- Causal insights—the effects of committing a resource to one course of action as opposed to another
- Cost behavior—the opportunity cost of a resource such as its variable cost

**Scenario three: A business with global tiered complexity.** The third scenario, global tiered complexity, exists in companies where the value chain is not a single highly correlated series of activities; instead



**LEAN THINKING HAS GAINED ACCEPTANCE WITH MANUFACTURERS AND SERVICE PROVIDERS IN A VARIETY OF INDUSTRIES.**



**THERE HAVE BEEN CASES WHERE COMPANIES ADOPTED LEAN THINKING BUT WERE UNABLE TO REALIZE BENEFITS.**

independent value streams with little or no interlinking have different pull dynamics (customers), but an overarching decision maker is required to optimize across value streams. Consider two typical airline value streams: 1) passenger handling and 2) freight handling. Flow-path information in each value stream achieves local optimization. How is the information needs for optimization across value streams supported? For example, due to headwinds the flight manager must reduce a long-haul flight's payload. Should he turn away five standby passengers or remove 500 kilograms of freight? This is another opportunity cost scenario but here it spans value streams.

Aspects of decision support information for scenario three:

- Scope—is global, across market segments
- Focus—is on multiple value streams
- Causal insights—understanding the effects of deferring the fulfillment of a particular service
- Cost behavior—understanding the opportunity cost of deferring a service

As these examples demonstrate, the globalization of lean thinking, or its adoption in other than model environments, significantly heightens the need for LA decision support sophistication. Decisions that are more incisive become commonplace and make providing global scope, focus beyond just product, causal insights, and cost behavior insights essential; when the lean preconditions cannot be met, optimization context demands sophisticated decision support.

### **Red lights that point to the compromises identified**

There have been cases where companies adopted lean thinking but were unable to realize benefits.<sup>27</sup> The lean community provides reasons why benefits are sometimes hidden as when they penalize or do not show up in financial statements.<sup>28</sup> Some of the reasons given such as the effects of reducing inventory are legitimate. Others justify further examination here because they relate to the flow-path's decision support compromises. "Claimed-

but-unrealizable" benefits and the apparent need to "account-to-benefits" are two examples. A third point worth highlighting is the role LA's go-to-market strategy plays in the hidden benefits dilemma.

The flow-path's local focus has the inherent potential for *claimed-but-unrealizable benefits* i.e., unavoidable excess/idle capacity costs or available capacity that is unmarketable simply produces no incremental gain to the enterprise's bottom line. The machine's depreciation is what it is and people still get paid. The view of cost behavior adopted for LA also contributes to this problem. Instead of using recognized decision cost concepts (avoidable and unavoidable, which have the sole purpose of expressing gain) LA commits the blended cost concept error by using operational cost concepts (fixed and variable) exclusively in decision making.<sup>29</sup> In contrast, the proper use of the concept of avoidable cost would unambiguously highlight lean benefits.

More disconcerting is an apparent need to *account-to-benefits*—changing the way of doing accounting to better showcase lean benefits. One proposal is for value stream information to be based on cash flow and not accrual accounting.<sup>30</sup> Another reason for doing away with traditional MA is simply that value stream costing better demonstrates lean benefits.<sup>31</sup> These proposals have potential for circular reasoning and self-vindication for more of the same, when "demonstrated" benefits might in fact be unrealizable. Moreover, from an accounting perspective such proposals could signal desperation to prop up the flow-path principle. Either way, one is left wondering whether LA claims one thing (a major change to the accounting paradigm<sup>32</sup>) but is so rooted in a narrow production design principle that it is unable to function in the demanding decision science domain—from there the need for a more pliable yardstick.

The *LA go-to-market* approach, similar to TOC, is another relentless simplicity sell. In this regard, it is important to note that LA mandates compliance with a list of preconditions far beyond any other management accounting approach. A veritable laundry list of prerequisites

confronts a potential adopter. The list includes the items discussed above under the Toyota business model plus the need, among others, for a new organizational culture, a different management model, lifetime employment, and other people-related must-have's (coordinators, mentors, coaches, and advisors).<sup>33</sup> This insight into lean's model environment sheds new light on its claims of simplicity; an adopter is by no stretch of the imagination facing a simple endeavor. LA per se might be simple, but it clearly has no merit without a fully-fledged lean initiative.

Moreover, in instances where adopters cannot meet some or all of the lean preconditions, their optimization challenge exceeds the simple world that LA puts forward. With each precondition that a company cannot meet, the complexity of realizing lean benefits increases exponentially. Do these adopters understand the nature of the challenge—the chasm between the optimization equation they will face and the limited decision support information the flow-path principle is able to provide? In lean's globalization, the simplicity mantra is a liability to the larger lean movement; LA's simple solution oversell contributes to the unrealized benefits dilemma.

### Is LA at odds with "The Toyota Way?"

Toyota has made a name for itself with its culture of continuous improvement and being a learning organization; a way of operating that has become known as "The Toyota Way." Five principles laid down by the company's founder in 1935 serve as the foundation for The Toyota Way. One of these principles is "Genchi Genbutsu" (Go and see for yourself).<sup>34</sup> This principle relates specifically to how Toyota makes decisions: "We go to the source to find the facts to make correct decisions."<sup>35</sup> The Genchi Genbutsu principle stresses the fact that decision making in The Toyota Way is entirely predicated on the scientific method and in particular that branch of science that deals with empirical observation or empirical/operations science. Therefore, cause and effect insights like causality are at the heart of Toyota's continuous improvement cul-

ture and decision making in the company; causality is rightfully indispensable to the poster child of systems management thinking.<sup>36</sup>

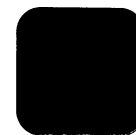
Lean accounting, however, spurns causality as a guiding principle for the decision support information it provides. The fact that LA and The Toyota Way are at odds on the principle appropriate for decision support seems like a peculiar development, but there is a likely explanation for this. Lean's own globalization and the accompanying demand for decision support sophistication, forces LA's hand as an "accounting" system. It is compelled to break with the narrow shop floor measurement and motivation role and must provide real monetary information.

In the U.S., therefore, LA is marketed as able to provide monetary information to support a range of decisions using the flow-path principle; the TPS design principle is imported lock, stock, and barrel into the decision science domain. However, as the assessment and the business scenarios showed, more demanding environments unmask the flow-path principle as inappropriate for decision support. LA, if it claims to be a decision support system and still holds to the flow-path principle, is at odds with The Toyota Way, which unambiguously holds to the principle of causality for decision support.

### Conclusion

Lean thinking is on a road, in the production/manufacturing domain, which for years to come will drastically transform shop floors everywhere. In operations design for manufacturing and services the flow-path principle will find application far beyond its automotive roots. It is however also in this process—lean's own globalization—that its proponents will increasingly be pressed to come to terms with the principles and practices of a close ally—the decision science domain.

As Church alluded to almost a century ago, sound decision support starts with the recognition of fundamental differences between decision science and production/manufacturing—and one can add—even lean ones. Lacking this dis-



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inction, lean's foray into the decision science domain—in the form of LA with the flow-path principle—is an underwhelming step in the wrong direction. In the lean thinking movement, one is dealing with a paradigm shift in shop floor design and execution. However, for LA to ride the flow-path coattails and accolades into the decision science domain is unrealistic. The flow-path principle is:

- Unable to provide requisite information for the four decision support aspects; and
- Incapable of making the transition in lean's own globalization to support the resultant decision support sophistication.

Self-praises are best set aside until LA demonstrates an ability to meet decision science demands in a broad spectrum of enterprise optimization scenarios. As The Toyota Way clearly affirms the types of decision-related intricacies highlighted in this article is without peer on the playground of the principle of causality. ■

#### NOTES

- <sup>1</sup> Van der Merwe, A. "The Management Accounting Philosophy Series," *Cost Management*. May/June, Sept./Oct. and Nov./Dec. 2007 Editions. Thomson Reuters. New York, NY.
- <sup>2</sup> The terms monetary and monetary information as used in this series refers to the dollars a MA approach associates with operational input and output quantities for managers to use in decision support.
- <sup>3</sup> Thomson, J. and Van der Merwe, A. "The Lowdown on Lean Accounting," *Strategic Finance*. Feb. 2007 issue. IMA Montvale, NJ. p. 26–33.
- <sup>4</sup> Kennedy F. & Huntzinger J. 2005. "Lean Accounting for Operations," *Target—Innovation at Work*. The periodical of the Association of Manufacturing Excellence. Vol. 21. No. 4. p. 8.
- <sup>5</sup> Ibid.
- <sup>6</sup> "Accounting For The Lean Enterprise: Major Changes To The Accounting Paradigm," 2006. A Statement on Management Accounting. The Institute of Management Accountants. Montvale, NJ. p. 24.
- <sup>7</sup> The irony of this LA practice should not escape the reader. The unit cost of the products through the value stream gets smaller with larger volumes only because LA unitizes common fixed costs (e.g., excess/idle capacity costs). Thus, LA practices the very same thing for which it berates traditional full absorption accounting.
- <sup>8</sup> Yates, J. 1989. *Control Through Communication: The Rise of System in American Management*. Baltimore: The Johns Hopkins University Press. p. 15.
- <sup>9</sup> See note 8 above.
- <sup>10</sup> Church, A.H. 1910. "Production Factors in Cost Accounting and Works Management," *The Engineering Magazine*. Republished by Arno Press. The History of Accounting Series. 1976. New York, NY. p. 36. Emphasis is the current author's.
- <sup>11</sup> Bacon is considered the father of the scientific method. In *Novum Organum* (The New Organon) he

argued for inductive principles (searching for causes) in making inferences to understand the world around us.

<sup>12</sup> See note 3 above, page 30.

<sup>13</sup> Kennedy, F. & Brewer, P. "Lean Accounting: What's it all About?" *Strategic Finance*, November 2005 Edition. Vol. 87 No. 5. IMA Montvale, NJ. p. 26–34.

<sup>14</sup> Solomons, J. "Why Successful Lean Implementations Can Punish the P&L and Why Results are Often Invisible," A presentation at the LA Summit. 21 Sept. 2006. Orlando, FL. Slide 39. It should be noted that this is one view of cost behavior in LA. In interaction with some in the LA community the author was provided a different view, that of variable costs and period expenses.

<sup>15</sup> "Lean Enterprise Fundamentals," 2006. A Statement on Management Accounting. The Institute of Management Accountants. Montvale, NJ. pp. 25–27.

<sup>16</sup> Johnson, T. "Lean Accounting: To Become Lean Shed Accounting." *Cost Management*, January/February 2006 Edition. Thomson Reuters. New York, NY pp. 6–17.

<sup>17</sup> Monuments are large indivisible resources, usually machines in the lean flow path that cannot be subjected to the "right" objectives.

<sup>18</sup> See for example: <http://www.bloomberg.com/apps/news?pid=newsarchive&sid=azKuau9Hvvhk>. Reporting on an interview with Jim Lantz, executive vice president of Toyota's U.S. sales unit concerning incentives on the Toyota Tundra truck: "We're spending the incentives necessary, given the economics, given a down market, to sell that 200,000 vehicles." Site viewed on Sept. 7<sup>th</sup> 2007.

<sup>19</sup> Steward, T & Raman, A. "Lessons from Toyota's Long Drive: HBR Interview with Katsuaki Watanabe (Toyota's CEO)," *Harvard Business Review*. Vol. 85, No 7/8. Jul./Aug. 2007. Boston, MA. p. 77. Product quality is a key differentiator for Toyota.

<sup>20</sup> See note 16 above, p. 7.

<sup>21</sup> See note 20 above, page 17. Muda: A Japanese word meaning waste, in particular wasteful activities. Eliminating muda (waste) is an integral part of lean thinking.

<sup>22</sup> See note 6 above, page 10.

<sup>23</sup> See note 6 above, page 18. "One significant impact of these changes on the value stream is the reduction in nonproductive capacity and the increase in available capacity."

<sup>24</sup> Grasso L. "Response to a Letter to the Editors," *Cost Management*. Nov./Dec. 2006 Edition. Thomson Reuters. New York, NY. p. 7.

<sup>25</sup> McKenney, K. "Development and Application of Management Tools within a High-Mix, Low-Volume Lean Aerospace Manufacturing Environment." *MS Diss.* 2005, MIT.

<sup>26</sup> Takt times is a lean metric indicative of the rhythm of the flow line; usually reflective of customer demand. A takt time of forty minutes means a new finished product will roll off the line at this interval.

<sup>27</sup> See note 15 above, page 25.

<sup>28</sup> See note 14 above.

<sup>29</sup> Maskell, B. "Value Stream Costing: Solving the Standard Costing Problem," A presentation at the LA Summit, 21 September 2006, Orlando, FL. Slide 4.

<sup>30</sup> See note 29, Slide 38.

<sup>31</sup> See note 29, Slides 32–51.

<sup>32</sup> See note 6 above, title page.

<sup>33</sup> See note 19 above, page 81.

<sup>34</sup> See note 19 above, page 76.

<sup>35</sup> See note 19 above, page 76 quoting Toyota's CEO.

<sup>36</sup> Not recognizing the centrality of the principle of causality particularly in systems management thinking borders on the absurd; the equivalent of denying all of what the scientific method has achieved in helping us understand our own natural world system over the last four centuries.