

CREATING VALUE WITH LEAN THINKING AND VALUE ENGINEERING¹

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BIOGRAPHY



Mr. Cell is the Value Engineering Program Manager for the U.S. Army Joint Munitions Command. He has a Bachelor of Arts from Franklin and Marshall College, and a Master of Public Administration from the State University of New York. He has served in leadership positions in the Federal government in the fields of personnel, organization management, force management, commercial activities, and value engineering. Mr. Cell was the 1996 recipient of the U.S. Army Materiel Command Value Engineering Professional Award, and was a member of the team awarded the 1997 U.S. Department of Defense Special Value Engineering Achievement Award.



Mr. Arratia is the Lead for Lean Initiatives at the U.S. Army Joint Munitions Command. He has a Bachelor of Science in Industrial Engineering from the University of Iowa, and a Master of Business Administration from St. Ambrose University. Mr. Arratia, a former Certified Value Specialist, has considerable experience in Value Engineering, within both the Government and industry. He has also managed a number of Government/industry competition studies. His current assignment involves working with U.S. Army installations in the planning and execution of the Joint Munitions Command transformation towards a Lean enterprise.

ABSTRACT

Value Engineering can leverage, accelerate, and amplify efforts to implement Lean principles and practices in your organization, and vice-versa. Moreover, if you're already implementing Lean principles and practices, use of VE can significantly enhance your overall efforts to reduce cost and increase value by using VE to not only leverage your Lean efforts, but also address areas not within the normal methodological purview of Lean. VE is a vigorous and effective analytic methodology. Analysts have applied VE in a great variety of situations – VE is flexible. Lean, on the other hand, while not specifically an analytic approach, brings to bear a group of operating principles and practices that, in the right context, can transform an organization's culture, productivity, profitability, and customer relations. Separately, in their respective spheres, VE and Lean are approaches with much to offer. Taken together, they offer great synergy. There should be no conflict between the approaches, and there should be no need to compromise between the two approaches. With a good understanding of the respective strengths and weaknesses of both disciplines, managers and analysts should be able to construct an environment where the two approaches collaborate – where they are more than the sum of their separate parts. Organizations capable of this collaboration will benefit, and those organizations' customers will benefit.

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INTRODUCTION

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"The command is doing some good, unheralded work in value engineering. I am not persuaded that we are fully capitalizing on the benefits of VE ... as we try to develop and deploy improved manufacturing processes in lean manufacturing...". U.S. Army Lieutenant General, in an email to a Major General, April 2002.

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Value Engineering can leverage, accelerate, and amplify efforts to implement Lean principles and practices in an organization. In turn, Lean can enhance the effectiveness of VE efforts.

For readers who are VE practitioners, and are not familiar with "Lean" principles and practices, they should know that Lean principles and practices are transforming whole industries.

For "Lean" readers, they should be aware that VE analytic approaches and methods have quietly been saving millions of dollars a year, in companies and countries around the world. Use of the VE approach has been steadily growing for over 50 years. VE has no great corporate proponent, or hot best-selling book, to promote its use. Nevertheless, it continues to grow and evolve as a discipline for the simple reason that it works - it will reduce cost and increase value of items, systems, and processes, and it offers great flexibility.

For reference, we have provided a summary of both VE and Lean approaches at the end of this paper. Readers not familiar with one or either approach may want to review those summaries now. As an additional point of reference, we have provided a summary of Six-Sigma to round-out discussion.

Development of Lean was led by Toyota (some refer to the approach as the "Toyota Production System"), and later adapted by American companies, most notably car and truck manufacturers. Lean spread to the aerospace industry, which now uses Lean extensively. Use of Lean principles and practices continues to grow in other industries. In our home area of eastern Iowa, Hon Industries and Pella Windows lead the way in making Lean the predominant operational strategy of the company.

For those organizations that take the Lean approach seriously, Lean produces excellent results. Steady improvements in productivity of 40%-60% are common. Lean reduces cost, improves the efficiency of production, and focuses on customer wants and needs. Today, you can look at industries and find companies that practice Lean, and companies that don't practice Lean. In the not too distant future, you will look at those same industries and find only those companies that use Lean – the other companies will no longer be in business.

LEAN REQUIREMENTS

Lean is effective, but it is not the answer to all problems. As with VE or any other discipline, Lean principles and practices are not effective in addressing all problems in all contexts. Some of these constraints stem from some of the conditions required to effectively implement Lean:

- Lean is most effective with processes that involve high dollar value (e.g., aircraft manufacturing) or high volume procedures and processes (high volume production lines, supply chains, commercial transaction processes).
- Lean works best with processes that have low variation and effective cost and method/standard controls.
- Lean implementation is a long-term process which requires strong and consistent management support.
- Lean implementation requires a large initial human and financial investment, albeit for a significantly larger return on that investment. (Lean implementation typically does not generate requirements for capital investments/acquisitions).

LEAN CHARACTERISTICS

Not every problem area or activity lends itself to efficacious application of Lean principles and practices. Saying this is not intended as a criticism of Lean principles and practices. Rather, by showing where Lean does not apply, and where VE does, an organization can apply the most effective tools appropriate for a situation.

For example, at our facilities, environmental impacts are often a significant cost element – remediating prior environmental impacts, ongoing disposal of waste, responding to and attenuating environmental incidents of varying kinds. In these costly areas, Lean can likely play little or no role, but these areas nonetheless have a major impact on overall facility costs, and therefore product cost and value. VE has experienced great success in addressing environmental costs and issues.

VE is not limited to areas of high volume or high dollar value (e.g., aircraft). VE can be used by organizations with great effect in a variety of situations, including VE analysis of product/item design, packaging, industrial and logistical processes, and other areas of high cost.

In another example, Lean principles and practices offer no direct method of addressing product design. As Jim Raines pointed out two years ago in his paper “Using Value Analysis to Implement Lean Engineering”, in the auto industry, approximately 80% of a vehicle’s final cost is set at the time of concept approval. This leaves Lean with only 20% of vehicle cost available for Lean to improve. Unlike VE, Lean has no analytical or methodological mechanism for analyzing the design of a product with the intent of reducing production cost or otherwise increasing customer value.

In contrast, as VE practitioners are well aware, VE offers analysts an effective analytic method for developing design changes to reduce cost and increase value. Developing value increasing design changes is VE’s bread and butter. Few approaches or methodologies can match VE’s ability to increase value in product design or attributes.

In a similar vein, just as Lean principles and practices do not speak to product design, neither do they speak to an organization’s management practices or policies, except as they directly impact flow or operator support. Often, management practice and policy can significantly and adversely affect product/process cost and effectiveness. It is possible to use Kaizen events (also known as

Rapid Improvement Events, typically week-long events to address/resolve waste identified in the Value Stream Map) to address and identify problem areas that may be generated in whole or part by management practice and policies, but Lean offers little guidance on how to address these areas except to change the management practice or policy to conform to Lean principles and practices. Beyond this general prescription, Lean provides little guidance on how to develop the new practice or policy. In contrast, VE offers a much more rigorous approach for identifying problems in this area, and the methodology provides an excellent analytic basis for developing cogent, effective changes.

VE/LEAN LEVERAGE

In addition to complementing each other by addressing different areas with respective effectiveness, analysts can use VE methods and Lean principles and practices to bolster some weak areas within the other discipline.

For example, organizations tend to consider VE as an event that is not part of the typical business of an organization. While it could be a regular part of an organization's operations, and VE proponents can make a compelling case that it should be, in reality it is usually not sold or practiced that way.

One reason it is not sold that way is that VE can work well as an isolated study event – it does not require the encompassing and pervasive level of support that an effective Lean effort requires.

In contrast, Lean is typically an all or nothing proposal – it can only be effectively used as part of an overall organization operational strategy. Another way of looking at it is to consider Lean a strategic decision, while organizations can choose to use VE successfully and effectively in a tactical manner.

This is a great strength of Lean – it provides an organization with a cohesive set of operating principles and practices, and a vigorous set of tools/events to implement and further those principles and practices on an on-going basis.

There are organizations and disciplines that use VE extensively, almost as a strategic operating principle. Highway engineers and construction engineers in particular have found great success with VE, and in many other organizations VE is an integral part of their operations, but we are aware of no organizations that use VE as pervasively as those organizations that use Lean.

VE is, at core, an analytic technique – it is not an operational philosophy. Lean operating principles and practices are simply that – operating principles and practices. If you use VE analytic tools, you will greatly benefit. If you use Lean principles and practices, you will also benefit.

In an organization practicing Lean, given the Lean approach of repeated Kaizen events, Lean will eventually address all areas of waste, sometimes repeatedly. This dogged pursuit of eliminating waste requires resources and management determination/support, but it does work –

Lean will reduce waste over time. VE, on the other hand, will find and fix wasteful effort very quickly, but it will generally (not necessarily) do so on an episodic basis, not a continuous or systematic basis.

In addition, VE can also produce excellent results in the areas where Lean focuses – identification and reduction of non-value added effort.

Lean also does not rigorously speak to what to study first – where to get the most “bang for the buck.” Lean does an outstanding job in laying out a process and identifying problem areas, and Lean principles and practices call for dogged and determined pursuit of eliminating waste. However, in larger processes, and particularly in the early stages of Lean implementation, one could face what the Army would call a “target-rich environment,” and face dozens of areas that need attention. VE’s value approach and tools help teams focus on the high payoff areas first and will generate larger savings sooner than you might otherwise get in Lean. Lean makes up for this with persistence (repeated Kaizen events) and determination (top management support), so both approaches will address problems eventually. Nonetheless, use of VE methods will likely save more money faster.

SHARED ATTRIBUTES

Lean and VE further complement each other because they share many important attributes.

Customer Focus

For example, both approaches focus on the customer – what does the customer value? What does the customer want, and when and where does he want it?

Lean’s customer focus initially takes the form of “Takt Time”, which is the rate of production required to satisfy the customer quantity and delivery dates. This establishes the customer “pull” that drives the analysis of your processes to identify and eliminate waste.

VE’s customer focus is apparent in the form of the definition of value. In VE, Value = performance divided by cost (performance to cost ratio). In turn, performance = customer wants and customer needs, and customer wants and needs = functions, and function analysis is the heart of VE. VE works to increase the value (performance/cost ratio) of functions that customers want/need, and reduces the cost of (or entirely eliminates) functions customers don’t want/need. VE uses a series of analytic processes to accomplish this.

Note the value equation allows increases in value without reduction in cost. If you increase performance, and hold cost steady, or even increase cost, but at a lower rate than you increase performance, you have increased value. As a case in point, makers of performance luxury cars are familiar with this dynamic.

Other similarities between VE and Lean are not as readily apparent, but are equally interesting and revealing.

Visual Analytic Tools

To facilitate analysis, both VE and Lean rely extensively on transforming operations into alternative forms of visual information.

In Lean, a Kaizen team will consider using a variety of visual analytical tools to identify waste. Spaghetti diagrams, flow diagrams, bar charts, standard work sheets, and production control boards, are all part of the Lean analytical lexicon. All serve the same purpose – to allow Kaizen team members to “see” processes and procedures in a different way, and in doing so perhaps see waste where they didn’t see it before.

In VE, the second step of the VE study process instructs the study team to conduct a function analysis. Typically, this involves the team building a Function Analysis System Technique (FAST) diagram. This diagram captures the “How-Why” (and sometime When) relationship between the functions of an item, system, or process. By breaking an item, system, or process down into functions, and then analyzing functions, and not what the item, system, or process “look like”, the study team will inevitably “see” things it did not see before.

Creating alternatives to functions, and not trying to create alternatives to the actual item/process, is called “creating by function”. Creating by function is the high-octane fuel generating VE performance and success. The FAST diagram is a powerful, visual tool for analyzing function and functional relationships, which mentally equips and enables the team to think “outside the box.”

Operator Support

Another common feature of VE and Lean not readily apparent is that much of the success both approaches enjoy stems from the fact both approaches short-circuit the hierarchical relationships and practices of many, if not most, western organizations.

Western organizations typically practice hierarchical management that extends to the point where some managers (less today than in the past, but still too many today) believe the employees exist to do only what they’re told to do, and managers exist for the purpose of telling employees what to do.

In contrast, a core principle of Lean is that a core responsibility of a manager/supervisor is to provide all support necessary for employees/operators to do their jobs with minimal waste. In this sense, under Lean, you could make a case that managers in effect work for operators.

For its’ part, VE works around a rigid hierarchy simply by placing the creation of value for customers as a priority function of an organization. This does not, in itself, short-circuit a hierarchy. However, as VE practitioners well know, the people best equipped to increase value – to make material contributions to and participate in a VE effort – are the people who do the work – not managers.

VE Study Teams are almost always composed of operational personnel. Operators know the problems, and the opportunities. They are best equipped to evaluate alternatives. To be sure, management needs to participate in the approval process, perhaps even sending the VE Study Team back to the drawing board to refine or amend recommendations. But, in the end, the people who do the work are the best equipped to increase value.

Anyone with a red pencil and sufficient authority can cut cost. Reducing cost while retaining or increasing performance takes someone who knows what they're doing – typically, someone with direct, in-depth knowledge of the process under review. This is typically the operator. If an organization truly wants to improve value for their customers/users, one of the best things management can do is simply provide the operators with the time, opportunity, support, and resources to conduct VE studies on a regular basis, and then implement the results.

Give operators the tool (VE) and get out of the way. “Support the operator” – just as in Lean.

Team Dynamics

Kaizen event teams will normally include, as a standard practice, individuals from outside the work area under study. This provides for new points of view and ideas, as well as a better understanding of how this area impacts other portions of the value stream.

Similarly, a standard practice of VE is to have VE Study Teams with team members from diverse backgrounds. Just as in Lean, the team will need subject matter experts/specialists who can speak to the area at hand. However, the truly original ideas may come from someone in an unrelated discipline who can make a connection between a method/practice from his/her speciality, and the problem the study team is addressing. For example, if you have a problem area or a high cost area in an oil refinery, and your study team is composed exclusively of petroleum engineers, your chances of developing a truly original solution will not be as great compared to a study team (or Kaizen event team) that includes petroleum engineers, chemical engineers, materials engineers, petroleum refinery workers, and representative from a customer's organization.

Both VE and Lean derive great strength from the use multidisciplined teams. VE practioners have the added advantage of using function analysis, which greatly facilitates communication by diverse team member backgrounds.

VE IN LEAN

As we take a closer look at the specific steps in the Leaning process, we can begin to see specific opportunities for VE tools and techniques in the Lean process.

For example, a typical factory floor Kaizen event would involve converting an inefficient work area into a Lean production cell within a week. To accomplish this, a multi-disciplined team (including the area workers/process owners) would follow a day-by-day plan like this:

Day 1 – Define current conditions (cycle time, layout, travel, productivity, etc.)

- Day 2 – Create the Lean cell (eliminate waste identified in day 1)
- Day 3 – Run/test/improve cell (adjust cell as you begin to see results)
- Day 4 – Create standard work (as cell improves, document, display and begin to visually control std. work sequence)
- Day 5 – Review progress, adjust as needed, and present results (must have a follow-up plan in place to sustain improvements).

Notice “Day 2 - Create the Lean cell” – this is one phase of the Kaizen event in which VE practitioners have an opportunity to use function analysis/creating by function to rapidly and systematically generate changes/alternatives/new methods needed to develop a Lean cell. There are no Lean tools that enable a team to systematically explore the functional/work relationships of an area with the purpose of creating breakthrough improvements.

In another example, Lean makes ample use of visual tools such as production control boards and workplace organization (“5-S”) to logically/conveniently locate all resources the cell workers need to accomplish their job and to visualize what is going on in the cell. However, Lean does not have a mechanism such as VE’s Job Plan to systematically and creatively improve the cell – i.e. eliminate unnecessary tools, modify cell layout, address ergonomic concerns, etc. The improvements generated in a Kaizen event tend to arise from common sense, operator experience, trial and error, and other approaches, which may not quickly or efficiently generate an optimal course of action.

One must note however, that much of Lean’s success comes from continuously eliminating waste and improving the flow of the operation through action – moving machines, modifying layout, changing materials handling tools, etc. VE can significantly improve the effectiveness of this iterative process by focusing on the actions that will yield the most value for the customer.

Additionally, as discussed earlier in this paper, not all areas of the Value Stream needing improvement lend themselves to a Kaizen event approach. There is a broad range of issues, which can come out of a Value Stream analysis that are better suited to the VE job plan. For example, the Value Stream Map may reveal a need for product redesign, equipment modifications/replacement, facilities improvements, etc. All of these are classic VE applications with a large body of knowledge/lessons learned available to VE practitioners.

LEAN IN VE

Given that Lean is not primarily an analytic technique, Lean does not offer VE many analytic mechanisms. It does offer two elements that VE can use.

First, one of the central principles of Lean is to work toward eliminating the “Seven Types of Waste”. They are:

1. Overproduction – Excessive quantities and/or speed.
2. Correction – Inspection and repair.

3. Movement – Of material/information, for no added value.
4. Processing – Effort which adds no value.
5. Inventory – Supply in excess of requirements.
6. Waiting – Human or machine idle time.
7. Motion – Human or machine movement with no added value.

Experienced VE practitioners will go down that list and likely say to themselves “Yep, we’ve found and fixed a lot of Type 1 waste in VE Studies I’ve worked on, and the same with Type 2 waste, and the same with Type 3....”.

VE practitioners identify and eliminate waste as a regular part of VE studies. They do not, however, typically consider waste elimination as a separate, distinct, category of analytic activity. VE practitioners should reconsider this. Waste is a drag on both performance and cost. When conducting a VE Study, VE practitioners should keep the “Seven Types of Waste” in mind. If you conduct your VE analysis, and don’t specifically look for waste as a separate effort, you may miss significant areas of value reducing waste for the simple reason that if you’re not specifically looking for something, you may not see it. Generally, a good VE analysis will find the waste. Nonetheless, it will take little time to scrub the analysis specifically for waste, and could result in identification of some noteworthy elements.

Second, and of far greater significance, given Lean can be reasonably characterized as an organizing and operating strategy that organizations implement using specific principles and practices, VE practitioners should be aware that in the process of implementing the Lean organizing and operating strategy, organization staff will likely become much more cost, waste, and value conscious. Heightened awareness of these factors is an important part of the culture change Lean brings to an organization.

When organizations implementing Lean become more aware of cost, waste, and value, and look for ways to reduce cost and waste, and increase value, that can only be good news for proponents of VE. VE proponents know, and can readily demonstrate, that use of VE can be very effective in reducing cost, eliminating waste, and increasing value, both within the Lean process (as discussed above), and in areas not wholly suited to application of Lean principles and practices (also as discussed above, such as product design). In short, increased awareness of cost, waste, and value, should result in more opportunities to use VE, and the more VE (and Lean) is used by an organization, the more that organization will create value for their customers/users.

SUMMARY

The integration of VE and Lean Thinking offers an organization the ability to see the “big picture” and take on the continuous improvement Lean journey, while focusing the power of VE on enhancing value creation as the enterprise becomes “Lean.”

Still, while opportunities for synergy abound with concurrent and integrated VE and Lean efforts, the integration and synergy will not happen without focused and supportive management. Reducing cost and increasing value on a long-term and continuous basis is a challenging and

strenuous undertaking. The effort to create value will always require focus and determination, regardless of which strategy or methodological tools you choose to use.

In a globally competitive environment, those organizations that leverage and amplify their Lean implementation efforts with other, historically successful, value creating disciplines such as VE will have a big advantage over those organizations which don't have the vision or capability to use more than one tool.

Those organizations who use both disciplines effectively will reap the benefits of both disciplines.

There should be no basis for conflict between VE and Lean. Moreover, there should be no reason or incentive to compromise between VE and Lean on the use of either approach. Organizations should choose a third path and work toward collaboration, where their respective strengths of VE and Lean will cover respective weakness, and the respective strengths amplify and leverage the other, and produce results where the total significantly exceeds the sum of the parts.

VE and Six-Sigma

Lean and VE aren't the only options available to reduce cost and increase value. Six-Sigma is an effective, proven, analytic approach to increasing quality and solving production problems.

Like VE and Lean, Six-Sigma has strengths and weaknesses, which for the sake of thoroughness we will very briefly summarize here.

Six-Sigma is an approach to improving quality by reducing process/product variation using statistical/empirical data.

Unlike VE and Lean, it does not rely on extensive operator involvement. Rather, a specially trained Six-Sigma "Green Belt" or "Black Belt" will address a problem area in the role of an outside consultant, and perform much or all analysis on his/her own (or with a Six-Sigma team), obtaining support and information as he/she requires. As such, it is not an operator driven process, and it will do little to change an organization's culture at the operator level. What it will do, with a record of great success, is analyze quantitative data to identify sources of process variation that result in defective products.

Since Six-Sigma was originally developed, it has grown from primarily a quality control process, to also encompass studies of how to make products or processes generally work better, faster, and at lower cost.

Like VE, it is an analytic process. It is not an organizational strategy like Lean, but (like Lean) it works best in processes with high volume or high value. Like Lean, it is not equipped to directly address product design, where VE is so equipped.

As with VE and Lean, the issue management should consider is not which approach to use to the exclusion of another, but how to effectively integrate Six-Sigma capabilities with VE and Lean. They all have strengths and weaknesses – the challenge to management is to minimize the weaknesses, and capture and use the strengths.

Summary Description of Lean

Lean thinking provides a way to specify value (from the customer's perspective), lineup value creating actions in the best sequence, conduct these activities without interruption whenever someone requests them, and perform them more and more effectively. Lean requires a long-term, enterprise-wide cultural change.

Lean's roots are in the Toyota Production System. Taiichi Ohno (1912-1990), the Toyota executive credited with developing the Toyota Production System, evolved the Lean concept through his frustration with waste – (*muda* in Japanese). He defined *muda* as any human activity, which absorbs resources but creates no value for the customer.

Lean's power lies in its ability to view a "Value Stream" from the customer's perspective. Lean then improves processes to optimize the value stream by removing non-value added work. At the heart of this continuous improvement approach is the Kaizen event. This is typically a week-long event, and targets a specific area within the Value Stream. Lean employs a systematic approach through a cycle - an approach generally like this:

1. Determine scope of the target Value Stream
2. Train Value Stream staff on Lean tools
3. Map and analyze the Value Stream (current, ideal, and future states) and plan improvements
4. Conduct Kaizen and other improvement actions
5. Track progress through visual controls and metrics reporting
6. Continuously improve the same Value Stream through alignment reviews, customer feedback, and additional Leaning cycles
7. Expand the Leaning process to all Value Streams in the enterprise

Kaizan events are repeated on a regular basis, and involve teams composed of employees from all parts of the organization, including top management. Waste-eliminating actions which may have been missed in one event, future events will eventually address, in addition to addressing changing work conditions, customer requirements, or adjusting to impacts from other Kaizen events. ◇

Summary Description of VE

Value Engineering is a systematic and creative effort that analyzes the function of items or systems to ensure required functions are achieved at the lowest possible overall cost.

Function analysis is the heart of VE. When a team successfully undertakes the process of identifying an item's or system's component functions, it is then prepared to conduct a range of analytic and creative actions, the most important of which is creating alternatives by function. In addition, a good function analysis will help a team identify value mismatches, which are instances where a disproportionate amount of cost is allocated to an area of low customer interest.

VE will follow a multi-step Job Plan. There are many versions of the Job Plan, but one widely-used version has six steps:

1. Information Gathering
2. Function Analysis
3. Speculation/Creativity
4. Development
5. Evaluation
6. Presentation

Study Teams can use the VE Job Plan to improve the value of items (analyze and change designs), systems (large scale or small), processes (production lines, logistic procedures), transportation practices, packaging, construction processes, architectural design, quality assurance, etc.

What makes VE work in such a variety of areas is the unique analytical leverage, stemming from a number of factors, that function analysis provides to any analytic endeavor.

VE has been increasing value for over 50 years in companies and countries around the world. As a discipline, it continues to grow in use and technical/methodological capacity to increase value. ◇