

Integrating Lean with Value Engineering

Donald E. Parker, PE, CCE, CVS, FSAVE

Abstract

Lean thinking is a concept that has blossomed in the last decade to be a manufacturing savior. This paper outlines how value engineering is the complementary methodology to use with Lean programs for effective results.

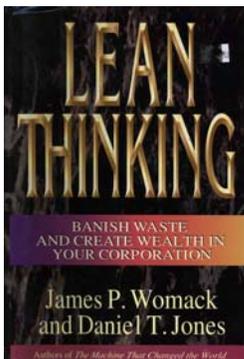


This paper is based on knowledge of Lean principles described in two books. Both books can be purchased from Amazon.com.

The first book is “Lean Thinking,” the latest technique in the last decade to influence the manufacturing segment of our nation. The book is an excellent read to learn the basics of ‘Lean’ and is commended to all. It is authored by James P. Womack and Daniel T. Jones ©1996, Simon and Schuster.

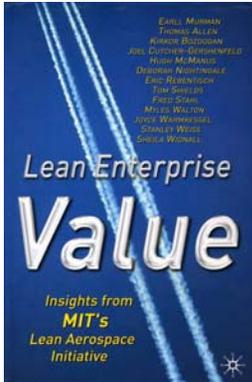
The second book is “Lean Enterprise Value,” © 2002, Palgrave. It was written by 13 authors based on insights from the 8-year Lean Aerospace Study being conducted at the Massachusetts Institute of Technology. Their credentials include: three members of the U.S. National Academy of Engineering; fellows and past presidents of the Institute of Industrial Engineers and the American Institute of Aeronautics and Astronautics; a fellow of the American Association for the Advancement of Science; a former secretary of the U.S. Air Force; a former head of MIT’s Department of Aeronautics and Astronautics, a former deputy dean of MIT’s Sloan School of Management; and significant careers in the aerospace industry and U.S. Navy.

Background



In the first book, the two authors began 4 years of research in 1990 into Lean, traveling throughout the United States, Europe and Japan to find out how Lean is practiced, who is doing it and whether or not it is universally applicable. Womack maintains a research affiliation with the Massachusetts Institute of Technology and Jones is Director of the Lean Enterprise Research Center at the Cardiff Business School in Wales.

These two authors wrote a landmark book, “The Machine That Changed the World” which explained how companies can dramatically improve their performance through the “Lean production” approach pioneered by Toyota. Lean Thinking extends these ideas to provide a rallying cry for today’s corporate leaders.



The authors found that after a decade of downsizing and reengineering, most companies are still stuck, searching for a formula for sustainable growth and success. The problem they found is that managers have lost sight of value for the customer and how to create it. By focusing on their existing organizations and outdated definitions of value, managers create waste, and their companies continue to stagnate.

The second book, redefines Lean production as a framework for enterprise transformation. It extends the prevailing view of 'Lean' to one of eliminating waste with the goal of creating value.

What better goal is there for The Value Society?

What is thinking Lean?

The essence of Lean thinking is to help managers clearly specify value, to line up all the value-creating activities for a specific product along a value stream, and to make value flow smoothly at the pull of the customer in pursuit of perfection. Thus, these five concepts constitute Lean thinking:

1. Specify value
2. Identify the value stream
3. Flow
4. Pull
5. Perfection

The book, Lean Thinking demonstrates these simple ideas can breathe new life into any company in any industry, routinely doubling both productivity and sales while stabilizing employment. Here is the essence of each of the five concepts:

1. Specify value – Both books define value similarly as a capability provided to a customer at the right time at an appropriate price, as defined in each case by the customer. Value methodology also teaches that value can only be determined by the user, not the designer or manufacturer even though they think they do so and they like to try to determine value.

It is hard for producers to correctly define value because they want to make what they are already making (like a beer manufacturer making beer instead of trying to make anything that will “quench thirst”) and partly because many customers only know how to ask for some variant of what they are already getting.

Much waste occurs when manufacturers try to outguess what value customers are seeking (rather than ask them) by producing products to place in inventory hoping someone will buy them.

One rule of the Lean process is to define value in terms of the whole product. Firms find it hard to get value right when value creation flows through many firms, each one tending to define value in their own way to suit their own needs. For example, review the following results from a travel firm trying to determine the value of an overseas trip:

Total travel time – 13 hours
Total time actually going somewhere – 7 hours (54% of the time)
Queuing and wait time – 6 hours
Number of lines – 10
Number of times luggage was picked up and put down – 7
Number of inspections (all asking the same questions) – 8
Total processing steps – 23

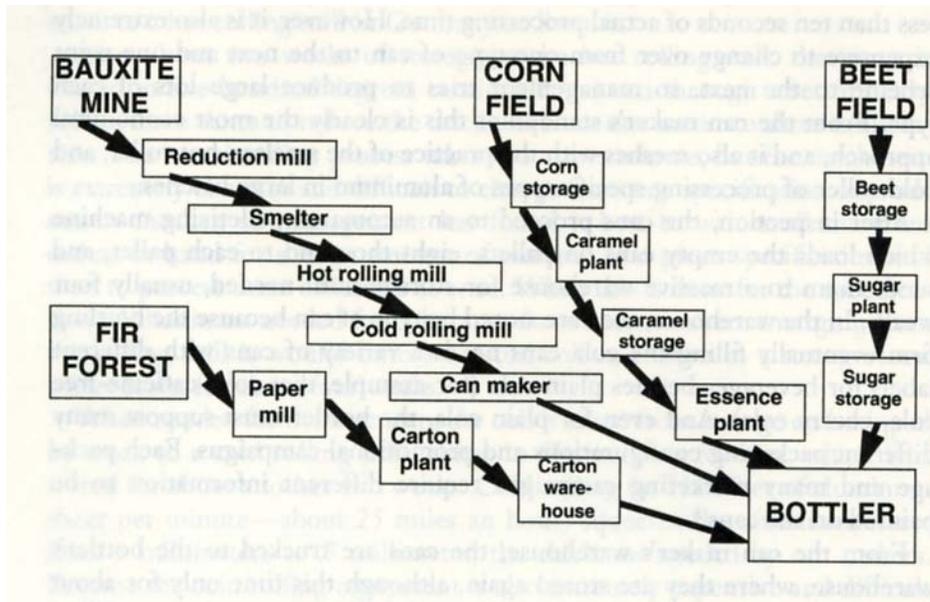
Everyone has experienced this problem – too many firms involved, each appropriately specialized for their task, each providing a partial product, often looking inward towards its own operational “efficiency” while no one was looking at the whole product through the eyes of the customer.

Value methodology using function analysis, with the customer participating, is a perfect tool to use to shift the focus to the whole product for value improvement.

2. Identify the value stream – The value stream is the set of all the specific actions required to bring a specific product through the three critical tasks of any business:

1. The problem solving task running from concept through detailed design and engineering to production launch,
2. The information management task running from order-taking through detailed scheduling to delivery, and
3. The physical transformation task proceeding from raw materials to a finished product in the hands of the customer.

From Lean Thinking here is the value stream for a bottle of cola:



Value

specialists know that the use of FAST diagramming with VE methodology is a wonderful way to identify the value stream in function terms by asking the questions HOW and WHY something is done.

The Lean study summary of the Coke value stream produced the following results:

	INCOMING STORAGE*	PROCESSING TIME	FINISHED STORAGE	PROCESS RATE	CUM. DAYS	CUM.† SCRAP
Mine	0	20 min	2 weeks	1000 t/hr	319	0
Reduction mill	2 weeks	30 min	2 weeks		305	0
Smelter	3 months	2 hrs	2 weeks		277	2
Hot rolling mill	2 weeks	1 min	4 weeks	10 ft/min	173	4
Cold rolling mill	2 weeks	<1 min	4 weeks	2100 ft/m	131	6
Can maker	2 weeks	1 min	4 weeks	2000/min	89	20
Bottler	4 days	1 min	5 weeks	1500/min	47	24
Tesco RDC	0	0	3 days	—	8	24
Tesco store	0	0	2 days	—	5	24
Home storage	3 days	5 min	—	—	3	[90]
Totals	5 months	3 hours	6 months		319	24

Once can see that the amount to time when value is actually being created (3 hours) is infinitesimal in relation to the total time (319 days) from bauxite to the recycling bin. More than 99 percent of the time the value stream is not flowing at all. Second, the can and the aluminum going into it are picked up and put down thirty times. From the customer's standpoint none of this adds any value.

The Lean study reports that the aluminum and cans are moved through fourteen storage lots and warehouses, and the cans are palletized and unpalletized four times. Finally,

fully 24-percent of the energy-intensive expensive aluminum coming out of the smelter never makes it to the customer.

As in a Lean study, producing the above data is the responsibility of the value team under the information phase of the Value Job Plan, a key ingredient of value methodology. Value methodology is certainly compatible so far!

3. Flow – Flow is defined as the progressive achievement of tasks along the value stream so that a product proceeds from design to launch, order to delivery, and raw materials into the hands of the customer with no stoppages, scrap or backflows.

Most products today are produced with interrupted flow in the value stream caused by batch processing and queuing before assembly. Good flow is uninterrupted continuous flow with no storage or waiting time between steps in the process. When you start to make one item do not stop working on it until it is finished and goes out the door.

The Lean experience is that the amount of human effort, time, space, tools, and inventories needed to design and provide a given service or good can typically be cut in half very quickly and steady progress can be maintained from this point onward to cut inputs in half again with a few years.

The Lean books are replete with techniques necessary to achieve continuous product flow in the factory. Two of the most critical techniques for Lean in the workplace requires creating a workplace suitable for visual control and Lean production. They call it the five Ss based on the Japanese language:

Seiri (organization) – means to straighten or simplify, organize tools, parts, and instructions

Seiton (neatness) – means to sort, remove unnecessary items from the work area.

Seiso (cleaning) – means to scrub or shine, repair, clean and keep clean the work area.

Seiketsu (standardization) – means to standardize or stabilize, establish and maintain controls and standards.

Shitsuke (discipline) – means to sustain or self-discipline, strive for continuous improvement.

Visual control is essential to a Lean manufacturing environment. It means the placement in plain view of all tools, parts, production activities, and indicators of production system performance, so that the status of the system can be understood at a glance by everyone involved. Visual control is a term used synonymously with transparency.

Another component of Lean in the workplace is to recognize the 7 muda or, the 7 wastes commonly found in physical production. These are:

1. Overproduction ahead of demand,
2. Waiting for the next processing step,
3. Unnecessary transport of materials,
4. Overprocessing of parts due to poor tool and product design,
5. Inventories more than the absolute minimum
6. Unnecessary movement by employees during the course of their work, and
7. Production of defective parts.

Value methodology is ideal to use to identify all process flow functions and create function flow charts that illuminate redundant functions, steps, waiting time, idle time, storage time and the above wastes.

4. Pull – This is defined as a system of cascading production and delivery instructions from downstream to upstream activities in which nothing is produced by the upstream supplier until the downstream customer signals a need.

The concept of pull is that you never again manufacture products to put on display and hope that they sell. You manufacture only what the customer orders at the time of the order and deliver it to the customer in a short period of time. The customer pulls the products from you. You do not build up a large inventory of products that may or may not sell.

The books cover a lot of concepts on how to achieve pull with topics such as: level selling, level scheduling, material requirements planning, multi-machine working in cells, single minute exchange of dies, single-piece flow, and takt time to name a few.

5. Perfection – In this last step, after performing the above four, is the performance of repeated studies on each product with the customer to improve value. A minimum of 5 repeated studies is recommended for a Lean environment “because you can never find everything all at once and technology keeps changing.”

Shown below are the results of implementation of ideas from repeated Lean study of a gasket and seal manufactured by the same company over a period of years.

	FEBRUARY 1992*	APRIL 1992	MAY 1992	NOVEMBER 1992	JANUARY 1993	JANUARY 1994	AUGUST 1995
Number of associates	21	18	15	12	6	3	3
Pieces made per associate	55	86	112	140	225	450	600
Space utilized (square feet)	2,300	2,000	1,850	1,662	1,360	1,200	1,200

Notice that the last study did not result in savings in labor or space but did result in a 33% increase in productivity without an increase in labor or space.

This is what one would expect from classic VE using the Value Job Plan. Most VE activity appears to be already working in this area, trying to achieve perfection without performing the first 4 steps of the Lean process.

Examples of Lean benefit application

1. **Simple case** – The case illustrated below was used to demonstrate that Lean techniques, adopted from the Japanese, would work in the U.S.A. LanTech, a manufacturer of one product – shrink wrapping machines for pallets – was selected for the demonstration.

LanTech was thought to use simple process technologies, have a 20-year history, a relatively small workforce of 200 employees, and a modest \$70 million in annual sales.

	BATCH-AND-QUEUE/1991	FLOW/1995
Development time for a New Product		
Family	3–4 years	1 year
Employee hours per machine	160	80
Manufacturing space per machine	100 square feet	55 square feet
Delivered defects per machine	8	.8
Dollar value of in-process and finished goods inventory*	\$2.6 million	\$1.9 million
Production throughput time	16 weeks	14 hours–5 days
Product delivery lead time†	4–20 weeks	1–4 weeks

As can be seen from the chart above, through implementation of Lean practice they cut their new product development time by 75%, improved their productivity by 100%, nearly halved their requirement for manufacturing space, cut 1/3 out of their required inventory, and reduced their production time from weeks to a few days.

2. **Harder case** – Lean was then tested on a harder case at the Wiremold Company. This case was deemed harder because Wiremold was considered an original USA “smokestack” type company born at the turn of the 20th century, with entrenched management, an older highly unionized workforce, a stagnate core market, and making low tech products with low tech tools. Look what happened:

	1990	1995
Sales per employee (\$000s)*	90	190
Throughput time to produce average product	4–6 weeks	1–2 days
Product development time	3 years	3–6 months
Suppliers	320	73
Inventory turns	3.4	15.0
Space required (index)	100	50
Sales (index)	100	250
Operating profit (index)	100	600
Profit sharing (% of straight wage)	1.2	7.8

3. **The acid test** – The next test was an industry using complex technologies, large in size with 29,000 employees, rich in tradition with 129 years in business, with an annual sales of \$5.8 billion. The test was Pratt & Whitney, manufacturer of aircraft engines.

(load – load cell)

	AUTOMATED BLOHM GRINDER	CHAKU-CHAKU CELL
Space/product cell (sq. ft.)	6,430	2,480
Part travel (ft.)	2,500	80
Inventory (average per cell)	1,640	15
Batch size (number of blades)	250	1
Throughput time (sum of cycle time)	10 days	75 min.
Environmental	Acid cleaning & X-ray	No acid, no X-ray
Changeover downtime	480 min.	100 sec.
Grinding cost per blade	1.0 X*	0.49 X*
New blade type tooling cost	1.0 X*	0.3 X

It was thought that if Lean could work at an industry like Pratt & Whitney it could work anywhere. Shown above is the result of applying Lean to the grinding operation for turbine blades. The final costs are marked X* because they are proprietary data but the factor shows a 51% cost improvement in grinding and a 70% cost improvement in tooling. Not a bad result without even applying VE to the product!

The pillars of value creation

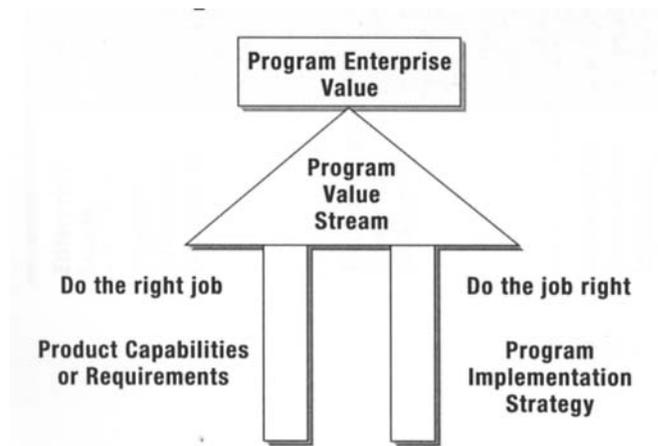
Research by MIT into Lean has led to their development of a value-creation framework for three levels of enterprise. The first level of enterprise is really the one most frequently discussed. It is the program level which usually revolves around one product at a time.

The other two levels of enterprise are the multi-program and national enterprises. Even though the levels are referred to separately they are described like the layers of an onion; programs are usually embedded in one or more larger, multi-program enterprises which are embedded in a yet larger national structure that imposes policies, constraints, and expectations.

Regardless of the type of enterprise, value identification occurs at all three levels though “the focus becomes broader and less precise as the levels progress. Value propositions also become less explicit and more complex. And value delivery shifts from narrow implementation activities to broad transformation initiatives.”

Illustrated below are the pillars of program value creation. The left pillar of Lean is “do the right job” using with the right product capabilities and requirements. Value methodology with its function analysis is the perfect tool to use to ensure this happens.

The right pillar of “do the job right” which involves program implementation strategy. This is where Lean focuses on the manufacturing process with its emphasis on flow and workforce techniques. Most of the VE application as we know it has been concentrated in doing the job right. VE needs to make a stronger contribution working in the area of the left pillar!



Necessary for an effective program

The Lean programs referred to in the two books reviewed for this paper all have the same essential ingredients as are necessary for an effective value program as shown to the left from an old slide used by value practitioners for years.



Nothing is new about this. If Lean programs now have the interest of top management and the investment is going in that direction, then value methodology can make these programs even more successful.

All Lean programs in companies need dramatic top management support to succeed (as do value programs). Initiation of a Lean enterprise requires the appointment of a sensei. This is a personal teacher with a mastery of a body of knowledge, in this case Lean thinking and techniques. One cannot help to believe that an experienced VE Program Manager, a CVS, would not be a wonderful sensei to apply VE methodology in all the areas mentioned above.

It was clear from reading both books that Lean, like Value Methodology, requires a climate conducive to rocking the boat which is what happens when dramatic change is to take place to make the magnitude of improvements possible from either program – not to say what even more might be possible if the two programs were actually joined!

Of course, really top management support is necessary and needs to be visibly demonstrated. In all three Lean cases mentioned above the sensei were initially escorted

**VM
&
Lean**

Requires a climate conducive to:

- Identifying waste
- Challenging tradition
- Suggesting change
- Individual growth
- Rewarding results

on a plant tour by the “white collar” senior management. And, during that tour, the sensei demonstrated his power (and management’s commitment) in front of the employee workforce by having the managers physically relocate (push) a machine across the plant floor to improve its production layout.

This is even better than having top management show up at the start of a VE study!