

**SIGNIFICANT OPPORTUNITIES
FOR LEAN PRODUCTION
IN SMALL TO MEDIUM US MANUFACTURERS**

**EXPERIENCE COLLECTED IN
LMU INDUSTRIAL ASSESSMENT CENTER**

ABSTRACT

The paper assesses the degree of implementation of Lean Production in 25 small and medium manufacturing plants in the Los Angeles area. Thirteen of the 25 plants are third and fourth-tier suppliers to the aerospace industry. The paper demonstrates an appalling level of Lean, and points to significant opportunities to benefit from implementing Lean in this industry. The results have been selected from the work performed by the DoE-sponsored Industrial Assessment Center at Loyola Marymount University during the year 2001.

**Bohdan "Bo" W.Oppenheim¹
January 2, 2002**

**Loyola Marymount University
Los Angeles**

¹ Professor of Mechanical Engineering and Director of LMU Industrial Assessment Center, boppenhe@lmu.edu

1. INTRODUCTION

In 1985 the US Department of Energy, Office of Industrial Technology, introduced an innovative national program called Industrial Assessment Center (IAC). Over the years, 30 accredited universities joined the program. In year 2000, the program was rebid competitively, granting program privileges to six new and 20 continuing universities. The main program goals are to expose students to hands-on industrial environment, and to assist qualified small and medium US manufacturers in saving money by energy conservation, waste reduction, and productivity improvements.

In order to qualify for the extensive free assessment, the manufacturer must belong to one or more of the nine categories of the DoE "Industries of the Future", that is manufacturers of steel, aluminum, petroleum, chemical, agricultural, glass, and forestry products, as well as their suppliers and the industries using these products. There are additional criteria, as follows: fewer than 500 employees, annual sales under \$100,000,000, total annual utility bill between \$100,000 and \$2,000,000, and no energy expert on the payroll.

Until year 2000, the program completed over 7000 assessments in almost all states, finding opportunities for savings of \$50,000 per plant, on the average.

Together with five other new universities, Loyola Marymount University (LMU) joined the program in Oct. 2000. While all IACs must address all three assessment components: energy, waste and productivity, the strength of LMU IAC is in the productivity component due to the academic program in the Lean area at that school. The present paper deals with productivity alone.

2. SCOPE OF COMPANIES

During the year 2001, LMU IAC assessed 28 companies, of which 25 are analyzed in the present paper. 13 of the 25 companies are small suppliers to, among others, various aerospace companies. Others have been included for comparison. The mix of companies is random. Some were referred for assessment by a local utility company, some by word of mouth, some by direct marketing (by far the most frustrating part of the program).

The companies represent a mix of ownership types. Most are family owned, and others are owned by a single, sometimes remote investor. The company names are confidential.

Table 1 lists the companies grouped by product type.

Table 1. Types of Manufacturers Analyzed

13 SUPPLIERS TO AEROSPACE FIRMS	12 OTHER COMMERCIAL MANUFACTURERS
Electronic elements and systems (2)	Sewer cleaning equipment (1)
Composites (1)	Water and gas valves (2)
Die, sand, and centrifugal castings (3)	Axels (1)
Overnight heat treatment job shops (2)	Large tubes (1)
Pumps (1)	Fiberglass (1)
Fasteners and metal stamping (2)	Fire hydrants (1)
Magnets (1)	Gas cylinders (1)
Fuel ducting (1)	Fabrics (1)
	Envelopes (2)
	Tire recapping products (1)

Section 3 describes the various manufacturers and their Lean or mostly non-Lean characteristics.

3. LEAN CHARACTERISTICS

IAC assessments tend to look at all aspects of Lean/TPS² manufacturing. However, as will be shown, most companies have no Lean elements at all. Therefore, listing all aspects would be a waste of paper and only 11 characteristics, judged important, are addressed in this paper. The characteristics are listed in Table 2, organized randomly for the 25 companies³. Nine columns are shaded in the Table. They show nine characteristics which are assessed using a common grading scale from 1 = (worst, absent, not implemented, not known) to 5 = (best, fully implemented), following the TPS grading scale.

The numerical values quoted represent estimates performed by an experienced productivity/Lean auditor, and nothing more than that. The values are meant only to signal a message rather than to pretend to be accurate.

The characteristics and the results are discussed in order.

Ratio of Lead Time to Touch-Labor Time

Lead time is the time from order to delivery. The term "touch labor", popular among manufacturers, represents total of all process times, including *muda* type I. Theoretically, in a well run company, the ratio should be just over 1, signaling a well organized manufacturing, a prerequisite to competitiveness.

The only manufacturers that approach this ideal are simple heat treating, plating and painting job shops which receive customer orders in the evening, process them overnight and deliver them back in the morning.

The firms producing to inventory rather than to order, e.g., 25 and 26, do not even understand the concept of lead time. Their ratio value is listed as "huge".

All together, only 9 companies have the ratio below 100. Five firms are in the range of 1000-2000. Aerospace suppliers tend to be the worst.

Changeover Time (hours)

A few companies never perform any changeover, producing the same catalog products as long as they are able to push them to the market. The author estimates that the changeover time could be reduced by a factor of 2-4 without any investment, just by proper training, and by an additional factor of 2-8 with additional affordable hardware in the vast majority of the companies assessed.

Familiarity with Lean

Eight of the 25 firms listed recently hired a Lean professional (a full-time manager rather than a *sensai*), who try to spread the Lean knowledge. These companies deserve grades of 1 and 2.

Two firms, a tube maker and a tire tread maker operate machines that do the entire production automatically, with easy electronic adjustments, and JIT delivery of raw material (but not quite the finished goods). Thus, the grade of 4.

The other firms listed appears to have no idea about Lean. Many are operated by former workers who were promoted to "Manager of Production" or a similar title, and do not possess any formal manufacturing education. They manage strictly by experience and instinct. Interestingly, when asked in a preliminary conversation whether they have implemented a Lean production, most answer in affirmative. This shows that the incorrect meaning of word Lean is still very popular.

Batch and Queue (B&Q) versus Lean Flow

If the familiarity with Lean/TPS is low, it is not surprising that most of the companies operate in the traditional Batch-and-Queue mode. A few, driven by their newly hired Lean managers have

² Toyota Production System

³ Company # 23 is omitted intentionally

started the transition, thus earning the marks of 2 and 3.

Interestingly, the two heat treating job-shop companies are quite Lean, without even knowing it, because they are strictly customer pulled, single piece (basket of parts) flow, and Kanban driven. Their *muda* type 1 is low because they use only 1 or 2 processes.

Implementation of Total Preventive Maintenance (TPM)

Seven companies understand the profitability gain from TPM and practice it fully or almost fully, gaining the grades of 5 or 4. They often retain external mechanics.

One third of the companies say that they "cannot afford" TPM, or can afford it for only the most expensive CNC machines. Of course, in the long term, this philosophy forces them into having to afford a much more expensive reactive repairs that cause unscheduled downtime and havoc in production schedule.

Andon (Visual Controls) on the Shop Floor

TPS has shown the world the benefit of having all relevant information displayed next to a given workstation or production area, including production status, future changes, status of training, progress in quality characteristics or cycle time, safety progress, messages about all abnormalities, and any other information that makes the work more productive, of better quality and more pleasant. Andon can take the form of paper boards, blackboards, electronic displays, screen savers, and many others.

Among the 25 manufacturers discussed only two companies earned a 3. All others follow the traditional philosophy of only managers being privileged to know such data.

Point of Use (POU) Carts

Carts or similar devices are used in almost all firms audited. However, only a few use them as Point-of-Use Carts in the TPS style, where the tools, parts and excellent Standard Instructions are laid out ergonomically, in the order of use, and usually prepared by an inexpensive warehouse worker, to be used by an expensive mechanic, so that he should not waste his time looking for these items or trying to figure out how to do his job. The Point-of -Use carts seen in the audited companies had major elements of a proper POU cart missing. Thus, the generally low grades on this score.

Inventory versus Just-in-Time (JIT), of Raw Materials, Work in Progress and Finished Goods

Again, only the two heat treat shops earned a perfect score of 5 here, for the reasons mentioned above. Most firms have large inventory. The companies with the managers of a "salesman mentality" tend to have exceptionally high inventories, motivated by thinking "let us not ever miss a sale because of a missing item on the shelf".

Many companies practice the profit-destructive "overage" habit of "just finishing the sheet, roll, box..." of raw materials, "just in case", intending to end up with "just a few extra pieces into the Finished Goods Inventory" and hoping for their subsequent sale. This practice inevitably leads to huge inventories of unsold and unsealable goods that have consumed a serious chunk of company profits. The overage factor alone is responsible for bringing two companies on our list to near bankruptcy, in spite of good products and good market for them.

Quality Control

Most companies on the list have serious defect and reject rates. Most of defects are caught in time before going to customers, but at extraordinary cost: In one firm 30% of the labor worked in QA. In another, 50% worked in "finishing jobs" - meaning correcting previous defects.

The humbling lesson from Toyota is that an error-free production is possible, so the best QC is no control at all. Only a sample of items then needs to be checked periodically. This is level 5. At the other extreme is 100% final inspection, a grade of 1. A sampled local inspection

deserves the middle grades.

Only two envelope makers earned a 5. This is because their production is automatically perfect. If not, a paper jams occurs and the machine stops, which happens rarely with these machines.

One fastener maker earned a 4. The rest are at 2 or 3. SPC has been misused in all three companies where it was used: as a contractual tool rather than a real-time process optimization tool.

5 S Workplace Organization

Generally low grades. The decent grades earned by some companies on the list are mostly due to decent cleanliness of the shop floor and some signage. The more advanced aspects of 5S: hygienic cleanliness, designated floor places marked with tape, designated visible places for hand tools and parts preventing loss and theft, easy to follow directions to various parts of the factory, excellent organization of storage spaces, clean desks, no obsolete parts around, etc. were absent from all companies.

Management - Labor Relations

Finally the most important aspect: open, trusting, pleasant, motivating and empowering human relations at work - an absolute prerequisite for Lean. The companies listed follow the general trend of US industry of improving this aspect of work. But there are exceptions.

The authors frequently observe a situation where all managers are Caucasian, all laborers Latino paid the minimum wage with legally minimum benefits, or hired per job from a job shopper at minimum wage, performing brutal work at furnaces, ovens, in the presence of ammonia or other unhealthy gases, and so on, (yes, it does happen). In such places, managers frequently complain about the low quality of workmanship, but do not understand how to improve the situation. Most if not all small manufacturing plants in Southern California employ mostly Latinos who do not know English well enough to communicate on the job.

Very few companies offer any formal training to the newly hired laborers, except the 3-minute on the job "training". Some of it is rationalized by language difficulties. Only few firms offered on-the-job training for managers. Very few have job rotations. No firm has established Standard Work. There is no sharing of knowledge, except by friendship. Larger plants tend to have unions, smaller do not. Many smaller plants in the group are family owned and operated.

4. CONCLUSIONS

Based on the 25 companies studied in this paper (and consistent with author's consulting experience in about 50 other plants), the general conclusion is obvious: Lean is totally unknown in the vast majority of the small US manufacturers, and is in infancy in the remaining plants. Most plants are traditional. Most are struggling to avoid losing their jobs to overseas. This is a heart breaking result, knowing that the companies could cut costs by 50% or more, double their profits, vastly improve quality, improve labor relations, reduce inventories, become more responsive to the market, more competitive and keep jobs at home, if only they would implement Lean.

Almost all these plants satisfy the preconditions for introducing Lean: steady and mostly repetitive production; solid market (in spite of the fact that the audits were performed during the recession year of 2000), easy availability of raw materials and labor, decent infrastructure, and the location where all educational resources are readily available. They are just ignorant about that wonderful method of production. Most managers probably would not even read James Womack's et al, *Lean Thinking*.

The LMU IAC attempts to signal the potential huge benefits of Lean to the managers of all companies audited, however, this interaction is too short and superficial for Lean to take hold. It is often taken as an impractical recommendation from the ivory tower. Based on author's

experience, a one-day informational seminar on Lean makes all the difference: listeners become "converted". It is well known that the main contractors and larger subcontractors in the aerospace industry are attempting to implement Lean⁴ and to demand a transition to Lean from their immediate suppliers as a part of the qualification process⁵. This is, however, where the Lean chain ends. The knowledge does not trickle down to the last tier of suppliers.

5. RECOMMENDATIONS

1. Help disseminate the knowledge about Lean among small and medium manufacturers
2. Do not kill small suppliers with demands for brutal price cutting. Expose them to Lean first.
3. Force all suppliers seeking qualification to learn about Lean in at least a short seminar
4. Satisfy the huge need for easy training materials about Lean in Spanish.
5. The number of universities with Lean expertise is growing. Assist them with dissemination of Lean knowledge in their regions, using small grants. In particular, facilitate contacts between suppliers and universities.

⁴ - often with very mixed and shallow results, according to the present author

⁵ The author has seen a number of nonsensical demands made on small suppliers by their large aerospace clients to immediately and dramatically lower their prices as a condition of qualifying. This is unrealistic. In consequence, many small companies have disappeared or went overseas (which often is the source of gigantic troubles to the buyers).