Learning to see True Cost

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"*One of the main fundamentals of the Toyota System*," writes Taiichi Ohno, "*is to make "what you need, in the amount you need, by the time you need it" but to tell the truth there is another part to this and that is "at a lower cost*."[2] Obviously, every industrial company tries to reduce the cost of the product it makes. On paper it sounds simple. One calculates the unit cost of each part and does what it takes to minimize it. The unitary cost is made of:

- Cost of materials and components
- Cost of fabrication (e.g. milling, grinding, molding, etc.)
- Cost of human labor in assembly
- The cost to correct defects (i.e. re-work)
- Cost of storing the part
- Cost of moving the part
- Company overhead attributed to the part (cost of design, management, etc.), and ultimately, the
- Cost of disposing of obsolete units

To minimize this unit cost, companies make a number of "strategic" decisions (which are not strategic at all, but a number of disconnected tactical decisions):

Cost of materials and components	▪ Design each component uniquely to minimize the cost of components ▪ Pick the "lowest cost", as measured by purchase price, supplier to keep the material and component cost down
Cost of fabrication	▪ Invest in the speediest machines so that the cost of the machine and its upkeep is divided over many, many parts, and a single part's cost is comparatively low ▪ Make the parts in specialized shops organized around technologies so that the part cost is best controlled
Cost of human assembly	▪ Replace human work by automated work wherever possible to reduce the cost of human labor ▪ Locate production in low-cost areas ▪ Produce one reference as quick as possible, then another for the shift length so as to maximize the use of human labor
Cost of storing the part	▪ Use sophisticated IT systems to minimize the cost of storage
Cost of moving the part	▪ Organize large batch transport to minimize the unit cost of moving per part
Overhead cost	▪ Use small suppliers without design functions or large management costs to keep the overhead contribution down

[2] Ohno, T., Workplace Management, 2007, Gemba Press : Mukilteo

In terms of real expenditure (cash out of the box), this reasoning has also some unfortunate drawbacks. Dan Jones, one of the key architects of the lean movement, tells of how he was recently with a group of senior executives puzzling over an end-to-end map of how a product was assembled. In this case it happened to be for an automotive component, stretching from raw materials to the car assembly line, but it could equally have been for many other products, such as medical devices supplied into a hospital. Surprisingly this was the first time these executives had looked at all the end-to-end flows involved in making this product. They were shocked at what it revealed.

It apparently took between 26 and 97 weeks – or between six months and nearly two years - to perform a total of 156 production steps in 21 plants spread across four continents. They estimated that it took no more than 200 minutes – or just under three and half hours - to carry out the forging, machining and assembly steps. Moreover these parts travel literally tens of thousands of miles across the globe before the final six assembly steps are performed close to the final customer, in this case in the USA. Calculating the total inventory cost in this long pipeline is a dramatic wake up call. (By the way, traditional accounting systems don't even attempt to calculate this total costs because the cost of holding inventory is treated as a period expense and the cost of moving, and overhead in general, is spread over all parts ratably, usually based on labor or machine hours.) But this is just the tip of the iceberg of unnecessary costs in this supply chain. Does it really need to take nearly two years to perform three and a half hours of value creating work? While these senior executives may have been shocked, in Dan Jones' experience, this situation is unfortunately very common. There are, in fact, systematic drawbacks to unit cost calculations.

In fact, many of Taiichi Ohno's original experiments with lean techniques started from a determination of understanding *true* cost, which is the cost of making parts taking into account the systemic cost of the manufacturing environment. In his terms, this meant looking for the "nut" at the center of the plum – the real cost of making parts stripped of the necessary and unnecessary wastes of over-production, waiting, conveyance, overprocessing, inventory, motion and correction. In trying to understand the true cost of production, Ohno reached a number of conclusions.

First, accounting calculations and reasoning are often misleading. For instance, he observed that the notion that it is cheaper to set up and run a batch of 10,000 parts rather than 1,000 on a press is misleading if the parts are not immediately needed: it only leads to expend value on parts which cannot be sold. Strangely enough, "minimum economic quantities" are still generally practiced half a century later. In another case, he realized that a company claiming to have "reduced inventory" had in fact produced ahead of schedule, and indeed reduced the raw materials inventory, by inflating work in process. A modern version of such shifting of the cost burden from an accounting point of view is

consignment stock – inventory owned by the supplier at the customer's premises. It appears cheaper, but the true cost of this inventory is still existing in the system.

Ohno's second conclusion is that the only way to figure out the true cost of production is to go to the *gemba* and see for oneself. By example, he experimented systematically with one-piece-flow and invariably found that productivity increased considerably, surprising the very operators who thought it was more effective to make batches. Indeed, many lean techniques are fairly counter-intuitive, so one has to try out by oneself to learn the true nature of cost. I recently visited a plant, which has carried on doggedly with the lean approach for a decade, and is now one of the best manufacturing sites I know. When asked what was the most important aspect of their lean success they answered: "leveling." This is indeed one of Ohno's original insights, but not necessarily the first thing that comes to mind when lean is discussed amongst less experienced practitioners. The importance of leveling production schedules to absorb the impact of external variations can only be discovered by direct experience.

By following in Ohno's footsteps, one discovers that the true cost of production cannot be calculated – it can only be discovered through experiment, much like shooting in the dark and listening for the "ping" of bullets hitting the target. However, experience also shows that the true cost of operations, its "systemic" aspect can best be evaluated by simply looking at operations at one given moment, like taking a photograph:

- How many people are working at adding value? Moving crates around? Talking or walking about?
- How many parts are being processed? Are being moved around or waiting to be processed? Are being stored in the warehouse?
- How many machines are producing at takt time? Are idle because of breakdowns, change-overs or any other technical reasons? Are simply not loaded?
- And so on…

Ultimately, the search for the understanding of true cost, and going to see true cost now! is a key part of understanding lean thinking, which can lead to very different conclusions from the usual "accounting" understanding of costs:

Cost of materials and components	▪ Design each component uniquely to minimize the cost of components ▪ Pick the lowest cost supplier to keep the material and component cost down	▪ Creates significant systemic costs in design and sourcing as opposed to using components from a standard list ▪ Disruption cost of either selecting out or assembling non-conform parts from faulty materials or components
Cost of fabrication	▪ Invest in the speediest machines so that the cost of the machine and its upkeep is divided over many, many parts, and a single part's cost is comparatively low ▪ Make the parts in specialized shops organized around technologies so that the part cost is best controlled	▪ Making 120 parts when you need 100 increases the processing cost by 20 unneeded parts. The cost of "a" part maybe low on paper, but the cost of only the parts you need could be very high if the number is much lower than the machine's capacity ▪ Specialized shops are also often inflexible (designed to produce high volumes), and the mix of parts routed through them causes many problems resulting in low overall utilization of the equipment – defeating the purpose
Cost of human assembly	▪ Replace human work by automated work wherever possible to reduce the cost of human labor ▪ Locate production in low-cost areas ▪ ▪ ▪ ▪ ▪ ▪ ▪ ▪ ▪ ▪ Produce one reference as quick as possible, then another for the shift	▪ Robots are less tolerant of component variations, and can often stop frequently. Furthermore the equipment still needs to be "fed" and maintained, and the remaining human labor around the machine is rarely looked at ▪ Localization can carry high exceptional costs (expat wages, plant start-up, etc.) as well as causing under capacity in existing high-cost area plants – which means carrying the cost of either shutting them down or run them underloaded. The savings achieved by achieving a lower labor rate per hour may be partially, of fully, offset by lower productivity (more hours per part), more movement (transportation from low cost areas), more inventory carrying costs (longer pipeline), more overhead (higher cost of maintaining relationship far away), higher "cost of quality" (scrap defects rather than return for re-work), etc.

	length so as to maximize the use of human labor	▪ This apparent "efficient" use of operators'time creates a lot of overproduction and hence unnecessary processing of parts
Cost of storing the part	▪ Use sophisticated IT systems to minimize the cost of storage	▪ Storing parts is both a waste of cash in inventory and storage cost (often in rented outside platforms) – optimizing the storage cost and inventory through IT often feed-backs large disruptions in production
Cost of moving the part	▪ Organize large batch transport to minimize the unit cost of moving per part	▪ Large batch transport in low frequency often means moving parts that are not needed now whilst running out of parts that are – and disrupts production considerably because of missing components – which leads to rescheduling, etc. It also means having heavy duty equipment available to physically move the parts.
Overhead cost	▪ Use small suppliers without design functions or large management costs to keep the overhead contribution down	▪ Relying on "job shops" cuts away the innovative capacity of suppliers, as well as limits your own flexibility and product design changes ability

The lean approach to producing at lower cost is all about improving processes to reduce the systemic costs in the second hand column. Strategies designed to reduce *system costs* are therefore radically different to the traditional unit-cost focus:

- Localize production as close as possible to customers to be responsive to market pressure;
- Co-localize as many steps of the production process as possible (without making silly extreme decisions, of course – a large press is unlikely to work at the same cycle as assembly) by flowing when you can and pulling when you can't. Certainly, some equipment can be slowed up to *takt time* it can work at the same rate as assembly, which has the side benefit of less wear and tear on the machine and less maintenance – but only in the case where this machine is not flexible enough to produce another needed component.
- Design with standard processes and from standard parts lists as much as possible to keep the systemic cost of producing new products low.
- Design with minimal technical solutions in mind: not over-clever machines that can do everything at the same time, but simple machine which can be converted to work from one product to the next, to use machines beyond their depreciation period – at low real cost. Utilize existing equipment as much as possible by making it flexible and allowing it to run frequently very small batches.

- Locating next to customers can lead to having production facilities in high labor cost areas, so work fervently at kaizen to make the smartest use of people's time.
- Store as few parts as possible by producing just-in-time "what is needed when is needed in the amount needed," with flexible equipment and running very small batches – which will take down both the cash outlay of inventories and the cost of storage platforms.
- Move small quantities of all parts frequently, rather than large batches of a few parts infrequently. The same truck volume can either contain all of one component, or many containers of all different components – it's just a matter of organization.

There is no longer any debate that the lean approach to production produces better quality products at a lower overall (out-of-pocket) cost. But obtaining these lean processes does present two large difficulties:

1. Most of the real costs lean processes take out are "systemic" costs. This is real money, but which doesn't show up clearly in financial calculations – whereas the traditional "unit cost" financial calculation is easier to do from one's office, but will lead into devastatingly wrong choices. Understanding the "true cost" underlying lean strategies can only happen on the shop floor, having constantly in mind Ohno's three basic insights: produce only good parts, when they're needed, in the amount they're needed; remind yourself that you are wrong at least half of the time; look at the cost of production *now!* in this very minute.

2. Obtaining the systemic benefits from lean strategies in real money (in the pocket) means achieving a degree of leanness in the processes, such as actually getting better quality, delivery and cost from high labor cost areas, actually reintegrating knowledge in the product and process design, and actually producing with high delivery rates and low inventories in the overall supply chain. If the company does not feel it is able to lean its processes in order to obtain these systemic benefits for real, it might as well continue to work with traditional unit price reasoning – and pray none of its competitors are working on a real lean transformation.

Ultimately, the search for the "true cost" through going and seeing for oneself and conducting shop floor experiments with frontline staff can lead to a complete transformation of industrial reasoning:

Learning to improve quality, productivity and lead-time challenge assumptions about the true cost of production from improving product assembly, workstations and process flow

Learning about the true cost of production challenges assumptions about manufacturing localization

Improving factory systems with kaizen challenges assumptions about process and product engineering

Re-examining product engineering challenges assumptions about customer usage and the very nature of the service products deliver to customers

Learning how to improve both the perceived quality of products (or services) on the markets and the true cost of delivery channels of these products (or services) challenges strategic assumptions

On the whole, business is about opinions. Some opinions work for a while on a market niche, and the people who hold them make money. Some opinions are wrong and their believers lose money. However, since the world is complex, confusing and constantly changing, it's hard to know which opinions will save you, and which will kill you. Furthermore, because of the stickyness of opinions and the difficulty we all have in changing our minds, individuals tend to be associated with a set of opinions. Hence the political fights in companies between people who hold one set of opinions against another. Most people are eager to "learn" something new – to write on the blank slate. This is not learning. Real learning occurs when one has challenged one's own true beliefs. Taiichi Ohno hits the nail right on the head. Learning occurs when misconceptions are confronted and "wise men change their ways". In that sense, most of the training we do generates very little learning. In the case of lean, it is not about acquiring a new vocabulary or experimenting with new tools and techniques for their own sake, but using these techniques to surface our own and others' key misconceptions. Lean is truly a scientific approach if it's seen as a way to distinguish the right opinions from the wrong. So let's find out the true cost operations *now!*