Applying Lean Manufacturing in Anodizing and Aluminum Extrusion Operations

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Prepared by: Jared Bringhurst
Futura Industries
USA
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Jared Bringhurst, Futura Industries 2015

This paper will detail a case study on Lean Manufacturing and the benefits achieved through the application of specific lean tools in a manufacturing environment including extrusion and anodizing operations.

An outline of the paper is as follows;

1. The pre-implementation state of our organization and processes prior to implementing lean principles. Real issues, problems, and challenges that consumed energy and time and detracted from the growth and productivity of our operation.
2. The introductory phase of lean manufacturing, including the education process of our organization, necessary research and analysis to advance to the implementation phase.
3. The implementation phase of lean manufacturing and the selection process of specific lean tools which would provide immediate results and long term sustainment.
4. The application of lean tools and methodologies in specific processes of the operation.
5. Successes realized as a result of lean.
6. The culture of continuous improvement and lean manufacturing sustainment.

1. Pre-Implementation of Lean Principles at Futura Industries

It was business as usual for our company in early 2003. We would meet as an Operation’s team for a daily production meeting where we discussed a “past due list”, which was a list of customer orders already late shipping, in some cases a few days late, but in many cases a week or longer later than our promised ship date. The part of our production meeting where we discussed this list included first – identifying where the order was in the operation, i.e – had it been extruded, was it being anodized, was it at a downstream operation, etc. Next, we needed to understand, “had pieces been scrapped, and if so how many were left – enough to fulfill the order?” Then we would assign a project manager, or better yet an expediter to go out and, for all intents and purposes, hold hands with the order and see it get packaged and delivered to our logistics group to be shipped as soon as possible. In the meantime every other order played second fiddle, and it was very likely the next day, there would be a completely different list of new candidates to find and chase through the plant, only to push them out for another late delivery. This was only one of several issues we struggled with on a daily basis.

We had constraints within the operation, orders for a particular finish or type of product would spike and within days we would have a bottleneck in our operation, big enough to create a large upstream ripple. We believed it was due to a lack of equipment or personnel, and our mentality was tough through it, throw as many resources at it as needed, but do not stop taking orders and promising good lead times. Our scheduling began at the extrusion presses and didn’t account for bottlenecks downstream, so orders continued to pile up in front of the bottlenecks and soon we would run out of
space, resources, and patience, only to compound our past due list and everyone’s frustration levels –
most of all and most importantly our customers.

Our operation was divided into departments as most businesses are, and we noted that if an issue with
an order arose, such as surface defects on the material, a scratch or abrasion, there wasn’t any one
single department responsible to take care of that order and our customer. Was it extrusions fault,
anodizing, fabrication, or packaging? Who’s responsibility was it? No one specific area or individual had
overall accountability for any specific order. On most occasions our Quality Assurance Manager would
assume responsibility. Basically he was the Fire Chief, when a quality issue arose or in other words a fire
broke out, the call went out to the QA Manager who quickly threw on his white lab coat and raced to
the production location where he would decide whether the material was acceptable or not, and in
essence the accountability landed on his shoulders. Meanwhile the departments continued processing
other orders, un-phased by the order on hold and the root cause or issue which forced the stoppage,
and eventually the late order to our customer.

Another challenge which was quite ironic was the fact our business was growing at a relatively high rate,
which of course compounded all of the issues already mentioned, this issue also caused logistical
constraints with our floor space. As our business grew it seemed natural that we would need to add
employees, add equipment, and we would require more floor space to store work in process, and
accommodate the new equipment.

It felt like ground hog’s day due in large part to our poor operational performance and compounded by
an insurmountable wave of orders and expectations. Our Executive team realized a drastic change
needed to take place to transform how we thought and executed our operation. We also recognized
this change needed to fundamentally start with our Executive Team. We had heard quite a bit about
lean manufacturing and in previous years had even attempted, on our own, what we thought was lean
manufacturing, but at this point we realized we needed real training and experience, so we began
looking for resources, help that could provide us with the education and tools to fundamentally change
how our operation functioned.

2. The Introductory Phase of Lean Manufacturing

We identified and attended a number of off-site training camps such as the Lean Institute in
Massachusetts and a TPS (Toyota Production Systems) course in Kentucky. The IW (Industryweek) Best
Plants Conference shared a variety of lean tools used by the Best Plants winners which provided
additional detail and help for our organization. We also interviewed a number of consulting agencies
and settled on a local consulting group, well versed and experienced at both training and implementing
lean principles. What we quickly realized was that we needed not only to educate our senior executive
team, but we needed to educate every individual team member within our organization. It took time,
money, and energy – certainly while we were training and learning, there were parts of our business
that needed our help and input. It was a very difficult and challenging process – but in the end there
was no question it was the right thing to do and well worth the investment. The training was excellent,
the concepts and lean principles became clear, and the root cause of our problems and issues began to manifest themselves in ways that seemed extremely obvious, almost embarrassingly obvious.

After nearly 6 months of training our senior executive team, our sales force, finance, purchasing, production, maintenance, engineering, and logistics teams, we then began to look at the underlying structure of our business systems and processes. We looked at every item produced and its specific routing or sequence of process steps. There were hundreds of iterations or sequences by which all of our products were made. We laid each item out in an Excel formatted table and the end result looked exactly like a plate of spaghetti (Image 2-1). There were so many variations to the items we make, they really needed to be grouped and organized into a much better group of part families.

As we began to sort 11,000 different SKU’s, we were able to narrow down 8 different high volume paths which we later named value streams, there were literally hundreds of smaller path sequences which we named value creeks, and there were two large shared resources within the majority of routings which we named Monuments.

Monuments; Extrusion, Anodizing

Value Streams; IMF, Precision Parts (PP), Small Bent Parts (SBP), Buff, Anoplus, Commercial, TSLOTS, and Hypercells. A few years later we combined the Hypercells and SBP Value Streams leaving our current structure of 2 Monuments and 7 Value streams.

A Monument was defined as a solid shared resource spanning multiple Value Streams
A Value Stream was defined as a specific path or sequence of operations where value is added to the material in a specific way. It was also the intent to try and group customers into Value Streams rather than items.

3. The Implementation Phase of Lean Manufacturing

Now with our entire organization educated and trained on Lean Manufacturing and with Monuments and Value Streams identified and defined we were ready to implement and trial a variety of the tools available in lean manufacturing.

a. With our Value Streams defined, we modified our personnel structure to accommodate the new layout of our Value Streams. Each Value Stream would have a Facilitator and a Value Stream Engineer—in some cases an engineer or facilitator would have responsibilities for multiple value streams.

b. The Value Stream Engineer developed a value stream map both current state (Image 3-1), and future state based on goals set for what we wanted to accomplish, and then we identified Kaizen blitz’ or areas of opportunity to help us accomplish our value stream goals. The majority of these goals centered around; meeting promise dates, improving quality, increasing capacity, improving productivity, reducing cost, and occupying less physical floor space.

c. The goals for each area were displayed and prioritized based on priority. Our desire was to start out with a Kaizen Event that would lead to a trophy area, or an area that would
stand as an example of what the lean process can achieve. We set dates and identified individuals who should be invited to attend the different respective Kaizen Events (Images 3-2 to 3-5).

Image 3-2

Image 3-3

Image 3-4

Image 3-5

i. Small Bent Parts value stream layout and flow
ii. The birth of the Water Strider
iii. SMED for Commercial value stream to name a few.

4. **The Application of Lean Tools and Methodologies**

Once we had identified and defined value streams, and setup and carried out our first group of Kaizen Events, we realized how to use other lean tools (Image 4-1) which facilitated a variety of lean improvements both large and small throughout all areas of our operation.
Specifically in Anodizing, we utilized 5S, POUS (Point of use Storage), Kaizen, Standardized Work, Kanbans, and Cellular/Flow improvements. Our teams developed shadow boards (Image 4-2) for our housekeeping supplies, labeled and organized our racking stations, moved chemicals, inspection tools such as our isoscope, seal testing, and color meters right to the point of use. Visual controls and Kanbans were added so that we replenished racks, clamps, rags, PPE, chemicals, etc. The culture shifted very much to a continuous improvement minded culture and evolves every day. Today work is staged on a cart. The carts are identified with flags, and a cone is sat on each cart showing the finish of that order and how many hoods that order contains. Our mix is scheduled to optimize our anodizing capacity. The work is delivered to
the anodizing operators along with clamps, racks, and everything that operator will need. When the anodizing line is lacking its next order a light turns on and a buzzer sounds. The chemistry, where applicable, contains sensors which identify whether rinsing and inclined holding for dripping was properly achieved. While our anodizing line is not fully automated, there have been several additions allowing semi-automation of chemical adds, and statistical feedback for chemistry of the tanks, amperage pulled during an anodizing cycle. Where we have been space constrained we have added spray nozzles for improved rinsing and visual controls to aid our crane operators process control. When supplies reach a point of replenishment there is a visual control for our water striders to replenish, in the event other supplies are needed, operators have a touch screen where they can order supplies by name and the order will immediately appear on the water striders iPad, along with a timer showing the length of time it takes until delivery of that item. All process time is measured from the time the product is racked, anodized, and then unracked. Each step is measured and recorded. Visual controls have been added to rectifiers. A green light will indicate the rectifier is supplying electricity, when the cycle nears completion there is a two minute warning where the green light begins to flash, at the conclusion of the cycle the light stops flashing, light turns red and a buzzer sounds notifying the operator it is time to advance this batch of material. Various improvements to racking have been made over the years as a result of our waste stopper program. Waste Stoppers are suggestions or ideas submitted by team members listing a problem which is wasteful, and a solution to eliminate the waste. (Image 4-3)
In other areas of our facility we have implemented several SMED (Single Minute Exchange of Die) Kaizens. “Flow is King” you’ll hear over and over again from any lean guru. We can attest to huge savings based on flow as we’ve held several area layout and a few plant layout Kaizens to establish a clear linear or cellular path of flow for those areas.

5. **Successes Realized through Lean Improvements**

Our initial Kaizen event included a complete revision to the layout of our SBP Valuetsream area and included 2 new “U-Shaped” workcells; iteration one (Image 5-1) and 12 months later iteration two. (Image 5-2)

And a new packaging and inspection area;

- a. 24% increase in productivity
- b. 33% savings of floor space
- c. Elimination of all work in process (WIP). Yes all of it!
- d. Reduced team size from 11 operators to 6 operators. The 5 other operators moved to other value streams where they championed improvements in those value streams.

We experienced very little push back from our team on the changes and philosophy of lean manufacturing, and we attribute that success to the upfront training and patience on the implementation of lean. In image 5-1 you can see the design of iteration one “u-shaped” work cell. These machines had originally been setup in batch formation. Each machine typically required one operator, and that operator would fabricate parts on the machine for an entire shift. Parts would be produced in batches often times taken from a cart and returned to the same cart.

The “u-shaped” work cell was designed to eliminate batch flow, moving to one-piece or two-piece flow, and eliminating all work in process. Raw material enters the work cell and leaves as a finished product. At the end of the day there are only raw stock and finished parts possible in the work cell. Also the cell was designed to use a maximum two operators, where prior to our Kaizen the machines would have used four to five operators.
In image 5-2 you can see the “u-shaped” cell was condensed further to eliminate wasted extra steps. A new 10’ brake press was replaced by a small used 3’ brake press which shaved 7’ of unnecessary space within the cell. Shadow boards were retrofitted with less tools and better point of use location.

In our anodizing area we have held several Kaizen events, two already in 2015. The Kaizen events have included; flow of racked product through the area, moving storage locations of racks and chemicals to closer proximity of where they will be used (POUS), 5S or 6S improvements to enhance lighting, cleanliness, and to identify proper placement and location of items within the area. A variety of visual controls have been added to eliminate wasted time searching for information. “Keeping the surgeon at the table” has been another large priority; anything that takes the operator away from his/her workstation should be analyzed and if possible delivered to them, at the time it’s needed. This year our focus has been to modify our process to a single order flow and to improve our staging of inbound orders to ultimately improve throughput by optimal mix of finishes. Scheduling our orders in extrusion to deliver the optimal mix for our anodizing operation was completed this year and has provided an increase in productivity as well as open capacity for our anodizing line.

6. The Culture of Continuous Improvement and Lean Manufacturing Sustainment

This is probably the most difficult step we’ve identified with lean manufacturing, and from what we have gleaned from other companies, we’re not alone. Continually auditing and driving continuous improvement will help maintain the momentum needed to develop a culture of continuous improvement and lean sustainment. Our company has developed a variety of tools to aid in this effort.

a. Employee Engagement – example; each team member has a goal to submit 12 waste stoppers per year or one per month. This drives employee engagement and is the basis for small or larger kaizen improvements. It’s easy to measure and great incentives are tied to meeting the goal.

b. Standardized Work – develop a standardized checklist for leaders, managers, engineers to audit improvements and processes, and require that data and/or numbers be logged rather than check marks.

c. Creative Incentives for performance, ideas, participation

d. New Hire’s – the foundation of any culture is its people. Employee entrance is huge. Can temporary or staffing agencies select new employees better than you? Doubtful!

e. Culture of change – Employees need to be willing to embrace change, because the “status quo” is the opposite of “continuous improvement”. An open atmosphere of communication has to be present. If team members are afraid or can’t voice their opinions and concerns, then growth is stifled and it’s difficult to improve.

f. Measuring – if it can’t be measured, it’s not happening. If it’s not reported, it’s extremely difficult to change or improve.

There are many more tools not listed that help create a culture of Continuous Improvement. The list above has yielded great success to our culture, which we feel is the most valuable asset we have, and has provided the continual success we’ve realized as a company since the beginning of our lean journey!