Lean Manufacturing

- An operational system that maximizes Value Added, reduces Essential Support and eliminates Waste in all processes throughout the Value Stream.
  - What is Value-added?
  - What is Essential Support?
  - What is waste?
    - Overproduction
    - Inventory
    - Waiting
    - Motion
    - Correction
    - Over processing
    - Transportation

Rules to Consider

- All work shall be highly specified as to content, timing, sequence, and outcome.
- All work shall have a direct path for products and services.
- All improvements shall be conducted using a scientific method at the lowest possible level of the organization. Micro/Macro implications.

Rules for smaller lot production

- Processes must be stabilized as much as possible. (Man, machine, materials, methods)
- Quality must be continually improved upon and source inspection implemented.
- Standardized work shall be created and based on repeatable human movements.

Rules for Implementation

- Create the culture.
  - Management structures/org structure
    - Upper Management on the floor DAILY, Production team, Quality, Engineering, Sales
  - Involve the floor: it is imperative
  - Have a plan– (rule of no surprises)
  - Train- spend the energy and time to retain good employees.
  - Reward profitability **and** small victories

Rules of Implementation

- Information Gathering– the necessary evil.
  - Metrics and benchmarks: throughput, manning, overtime, productivity (man hour per net ton), uptime, scrap/re-work, motion studies, inventory levels, changeover.
  - Why?
    - Know where you are. Take credit for what you have done financially to improve based on your implementation.
    - It is not enough to just "know" it's different.
    - The Devil is in the details. Find the way to get them.

Rules of Implementation

- Where do we start?
  - Inspect/Pack/finish Blast
  - Clean/finish
  - Heat Treat
  - Shakeout/Blast
  - Pouring
  - Mold/Core
  - Raw

Rules of Implementation

- Start at the end– why?
- Move furniture and balance work to the standards. Cannot just move furniture.
- Create simple visual systems- PIGs, lanes, hands-on Kanban
- Create the direct paths for products and services through software and manual means.
- Standard Changeover and flexibility
- Involve Management on a daily basis
  - Scrap/rework/start-up meetings

Pack/Inspect

- In line blast/ inspect/upgrade
- Requires direct path to HT
- Pack at the end of the process
- Visuals provided/ offal measured and reviewed daily.
- In line inspections/rework shall negate as much as possible; the defects found in final… not that final finds the defects.
- Partial boxes and the handling formalized

Clean and Finish

- **Decide** that C/F is not your bottleneck.
  - If you can pour it: you can get it through.
- Cellular concepts to C/F: upstream impact
- Inventory Control benefits: time vs. quantity: based on throughput information.
- Difference between A “shift’s worth” vs. “what we get when we get it… and work on it when we can”.

Scheduling

- One place shall hold the sequence.
- Core/Mold/Pour Value stream
- Value of information gathered to construct heats.
- Flexibility of the c/f cells to accommodate the needs while still honoring the “direct path”.

Pouring

- Heats constructed at Core/Mold.
- Flexibility with furnaces and tunnels/cooling areas- direct path.
- Shakeout/blast to feed the C/F cells.
- Test bars/engineering samples entered into the schedule.

Changeover

- Standard Changeover methods shall be established: content, time, sequence, and outcome.
- The less time spent in Changeover, the more time spent producing.
- Essential support in this?
  - Need for Quick change “carts”/tooling.
  - Inventory methods for cores/molds/time!
- Put it away ready for the next run.
  - Would you put dirty dishes in the cupboard?

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- Nothing will happen if you think you are “special”.
- Anything can happen if you prove you are “special”.
- Customer satisfaction
  - How is this measured by you?
    - Lead times?
    - Price?
    - Service?
- Why can you not satisfy all of that and yourselves?

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- Increasing profitability = increasing price or reducing costs.
- Cost = Time
  - Cost not at the expense of people specifically.
  - Time as the benefit (or weight) of processes that provide both value and waste from the time of order to the time of shipping.
  - What is your Manufacturing Lead Time from order to shipping? What do you expect as the norm for yourselves? What would you want that to look like in the future for both you and your customers?

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Question:

How much of your Manufacturing Lead Time do you think "value" is added as a percentage of TOTAL time?

For example: of a 10 week lead time: how much time is value added per part? (product is actually changed to customer specs)… Core, mold, pour, shake-out, blast, torch, arc, grind and Heat treat? What is the percentage of Value added in regard to the total lead time?

Less than 1% of total manufacturing lead time is the norm.

Lean Foundry

Eagle Alloy, Muskegon MI. 10 years later

Manufacturing Lead Time:

- 7 weeks to 3 weeks.
- 57% reduction in Lead time
- Can they get product out in less than a week? Yes. Even with upgrade.
- What could this flexibility in scheduling afford you?

Productivity as measured by man-hours per net ton:

- 65.4 in 2001/ 50.2 now.
- 23% improvement **overall** throughout the entire foundry over 10 years.
- Monetary implications of such.

Heats poured:

- 500 Tons per month shipped/386 heats per month in 2001
- 800 tons per month/614 heats per month in 2011.
- 858 heats per month poured today.
- Same space and time. 222% improvement since 2001.

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Eagle Alloy, Muskegon MI, 10 years later

Quality: 4.01% scrap in 2001: 2.6% scrap now.

65% reduction.

- Single piece flow in the c/f department allows in process inspection and immediate attention.
- Final Inspectors audit at the end of the cell.

On time Delivery: now 95% or better

- Current sales are 124% more than 2001 and expect to be almost triple that by year end 2012:
- They are maintaining lead times.

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Eagle Alloy, Muskegon MI, 10 years later

Changeover in molding: 1 hour to 30 minutes:
50% reduction.

Utilization of floor space: more than double the production in a space they thought they filled up.

Training: Allowed to develop "training cells" for new employees for two weeks, equipment, safety, and standard work.

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Eagle Alloy: Muskegon MI, 10 years later

Scheduling: Only schedule at one place. Cores and follow FIFO after that. No core work also scheduled in to balance out the work.

Vertical Integration: were afforded to bring more Heat Treat in house (new ovens), new facility being built for sand reclamation and expansion to house patterns and support functions. New tunnels being built and all existing tunnels moving 15 feet westward-ho as it makes more sense for the flow.

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Pacific Steel: the beginning–

January 20, 2011 through March 18, 2011, a total of 24 different part numbers from 15 different part families, with an average unit weight of 37 pounds, were processed and prepared for heat treat in the "Pilot" Cell.

- The C/F Cell accounted for 272 net tons or about 47% of the total weight of A-line castings for the period in question.
- The Cell's average daily output for two shifts was nearly 12,000 net pounds per day while utilizing an average of 3.49 team members per shift .
- This compares to the traditional linear process which averaged 11,000 net pounds per day utilizing 19 team members during the benchmark period in September 2010.

Productivity in the Cell increased by over 141 net pounds per manhour: **201% improvement in productivity**.

The cost savings for the labor component of this new configuration are approximately **67%** or **$1,635 per shift** for an **annual cost savings of $824,206. For one cell's worth of productivity improvement.**

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Pacific Steel: the beginning

- Cell Clean and Finish Time:
  - The cell now processes this casting in 3 minutes 12 seconds with an aggregate queue time of 9 minutes 40 seconds. (in to torch and out ground). Please refer to illustration. Every 3 minutes, a finished part is in the tub.
  - The difference being the "Pilot" Cell pulls WIP using FIFO and no other castings are introduced to the cell until a batch is complete vs. the linear model which allows castings to "leap frog" ahead based on the type of metal. Overall, PSC is realizing shorter lead times and improved throughput to the downstream process.
  - In the above example there is a **94% reduction in lead time.**

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Pacific Steel: the beginning

- In Process Inventory – This data was collected the week of April 11 - 15 and is a direct comparison of the linear vs. cellular models.
  - Statistics show that the cellular model has an Average WIP level of 339 net pounds which is 2% of the WIP level measured or a **98% reduction in WIP.**
- Floor Space Reduction –On Average the "Pilot" Cell processed approximately 1,000 net pounds more in 256 square feet than the *combined* C&F room operation of September, 2010, which had a footprint of roughly 4,000 square feet.
  - This is a **94% improvement in facilities utilization**

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Pacific Steel: the beginning

Quality

- As a result of the hourly production goals applied to the Cell, there has been a greater visibility of part specific quality issues. These issues have been historically overlooked or not considered to be an issue.
  - **Part # :** Identified issue with shrink, Cavity 1 resulting in scrap
    - o Cause: Sucker Core failure. Possible breakage.
  - **Part # :** Identified issue with Cavity 1, pinhole, resulting in over-processing
    - o Cavity 1 pinhole required about 142seconds of grinding vs. 22 seconds of grinding in Cavity 2.
  - **Part # :** Identified issue with shrink in contact pad of small riser

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Pacific Steel: the beginning

Qualitative

- Team work and ownership of the process was virtually non-existent prior to the implementation of the Cell.
- Team members are **self-managing** the work in the Cell, and overall communication between operators has increased due to their close proximity. Cross-shift communication and "passdown" has also improved.
- Supervisors have expressed that they "would *love* to have more Cells".

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Pacific Steel: the beginning

Qualitative/Quantifiable

- The team rejects unacceptable quality from the time castings are blasted through the cell itself. Issues are communicated promptly to supervisor which triggers the formation of a corrective/preventative action team.
- Information systems are in place (e.g. Production Log Database) to provide reporting that did not exist before such as on production delay occurrences, output, and utilization.
- Achievable "expectations" have been set using the Production Log and PIGs (Process and Inspection Guidelines), and are observing greater "accountability" against these expectations.

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Pacific Steel: the beginning

- Challenges
  - Hot Castings –mitigated the heat issue by installing a cooling fan and providing operators with different gloves. Glove inserts have been issued and are being tested prior to official adoption.
  - No WIP – Cell team operators do not fully understand the concept of one-piece flow and will need to receive additional training to drive this concept home and realize the full potential of the "Pilot" Cell.
  - Dirty Castings from the Blast –informally trained blast operators on acceptable surface inspections for forwarding castings to downstream operations. It would be beneficial to incorporate a reference placard next to the blast with explicit procedures and guidelines.
  - Materials Replenishment – encountered issues replenishing arc rods and grinding wheels early on. A staging area has been designated for these materials and a kanban system has been put in place to ensure timely replenishment of critical materials.

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- Biggest Challenges:
  - Culture:
    - Embrace the "old school" to lead the "new school".
    - Bring in outside eyes for a fresh perspective.
  - Expectations and goals and standards
    - Setting them/ measuring regularly on an hourly basis/monthly basis/quarterly basis
  - Union issues
  - Profitability sharing programs

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Draw the line; decide where you need it to be based on customer demand; construct accordingly.

Share the wealth from everyone's hard work based on profitability.

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- Conclusion with this thought:

"You create what you want."
John Workman

- Questions