Stamping Out Chaos Simulation©

Dr. Shahrukh Irani
Hoerbiger Corporation of America
1212 Milby Street
Houston, TX 77023

Background

This simulation is a down-sized version of the original half-day *JobshopLean Simulation*©. It was developed to introduce the core principles and strategies for FLean (Flexible and Lean) to a large group within at most two hours! Lean is about eliminating waste. Flexibility is about being adaptable to produce a high variety of products with different routings. FLean = Flexibility + Lean because high-mix low-volume manufacturers must be quality-conscious, cost-effective and capable of short delivery times for every order they receive to produce any product in their product mix!

Description of the Manufacturing Facility

The stamping jobshop consists of six stamping presses. Each press is capable of stamping only one of the six letters – W, E, T, A, H, C. In addition, there is a department "R-S" which is a combination of two departments ("R" = Receiving of raw materials; "S" = Shipping of finished products). Ideally, we would keep "R" and "S" separate but I combined the two departments only to simplify running the game without any assistance. ☺

Description of the Product Mix

The stamping jobshop must produce the following kit of 14 different stamped parts:

1. **Wheat**
2. **Chat**
3. **Hate**
4. **Each**
5. **What**
6. **Teach**

7. **Whet**
8. **Chew**
9. **Cheat**
10. **Thaw**
11. **Etch**
12. **Watch**
13. **Heat**
14. **Ache**

Goal of the Simulation

The objective is to minimize the time it takes to complete the entire kit of 14 parts before it can be shipped to the Assembly department. This is just to keep the game simple! Thereby, it is not important to minimize the total time it takes to produce one or other part. Rather, all that we care about is the time it takes to complete whichever is the last part in the kit that we complete in order that the kit can be sent for assembly as soon as possible. In academic parlance, we seek to minimize the Schedule Makespan.

Setting Up for the Simulation

- Would 14 volunteers from the audience please step forward? I need each of them to be one of the 14 different parts.
- Would 6 more volunteers from the audience please step forward? I need each of them to be one of the 6 presses. Each will receive an inkpad and a stamp for one of the six letters – W, E, A, T, C, H. When a part is presented to you that needs your letter to be stamped, please oblige that part. I promised you that we would be simulating a stamping jobshop! Right? ☺
- Finally, would 1 more volunteer from the audience please step forward? I need him/her to be the R-S department. He/she will release the parts into the system and, when any part is completed, record the time when it was completed. Those are work as bean counters or expeditors are ideal for this job! ☺

Running the Simulation

- *Instructions for those who role play the Parts:*
  - Each part will start at the location "R-S", and walk at normal speed to get stamped at each of the presses specified in its production sequence. After all the letters it needs have been stamped, the part must return to the location "R-S" and have its time of completion recorded on it.
  - At any press, parts must queue up one behind the other on a FIFO (First In First Out) basis i.e. whoever arrives first gets stamped first. No pushing and shoving, let alone fisticuffs. Please!
  - DO NOT MOVE TO THE NEXT MACHINE AFTER YOU HAVE BEEN STAMPED AT THE CURRENT MACHINE. Please wait for **either** the Water Strider to come by and move you to the next machine in your route (in the case of the Current State simulation) **or** for the current machine's operator to move you to the next machine in your route (in the case of the Future State simulation).
- *Instructions for those who role play the Presses:*
  - Process parts in the order that they arrive i.e. FIFO (First In First Out).
  - Separate parts waiting to be processed from those that have been processed. For example, parts that arrive for processing wait on your right, and parts that you stamp you move them to your left, where they will wait until the Water Strider comes by to move them to the next machine in their route.

FLean Best Practices in this Simulation

- *Performance Metric:* It is important to choose a performance metric that is aligned with on-time delivery, WIP reduction, etc. rather than machine utilization. Especially in this case where all the parts being made go into a single final assembly!
- *Facility Layout:* One of the many challenges of being FLean is to design a facility layout that "fits" the variety of routings in the product mix. Especially when this mix can be expected to change over time!
  - *Continuous Flow:* One-piece flow between machines is a-given in an assembly line! Consecutive machines are (naturally!) adjacent to each other. But, this could be a challenge in the typical high-mix low-volume manufacturing facility which, more often than not, has a functional layout. In this layout, there is considerable distance separating

any two machines used consecutively by any part. So, unless the facility is organized into manufacturing cells, the inter-machine travel distances will simply not be small enough for single-piece flow, or even use of transfer batches!

- *Material Handling + Expediting:* The Water Strider is a cross-trained employee that does the work of both a Material Handler and an Expeditor. Think about it! A material handler is the one person on the shopfloor who has the best situational awareness of which order is where. So, with the appropriate training and authorization, he/she could ensure on-time deliveries!

- *Visual Management:* Managing with visual cues is one of the hallmarks of any well-designed and well-managed shopfloor (or office too!). Plus, if the facility layout and communication flows allow it, when machine queues are visible, the operator of the consuming machnie can signal the operator of the supplying machine when and how much work to send. Or even stop running their machine and walk over to help them process the jobs in queue at his/her machine!
- *Pull Scheduling by Time-phased Release of Orders:* Time-phasing the release of orders into the system to prevent build-up of queues at bottleneck machines (which leads to WIP which leads to high order completion times)
- *Bottleneck Management by Planned Sequencing of Orders:* If you release back-to-back parts with identical routings, they will all "hit" the same machine at the same time. Which will cause congestion at those machines but machine utilization will be high due to common setups and a full queue of orders!
- *Flexible Automation:* It is a common practice to replace 2-3 existing machines in a facility with a single flexible machine. This eliminates non-value adding delays (such as setups and material handling delays) and reduces the difficulty of finding well-trained employees in a labor-constrained industry sector. But be cautious about which machines you choose to combine as it could lead to some undesirable workload and queuing problems, especially if both machines occur consecutively in many routings and are heavily used in the current system!
- *Machine Utilization vs. Setup Reduction:* Would it be advantageous to kit these parts – CHEAT, WHEAT, HEAT – and route them as a "bundle" through the shop? That way they visit C (where

only CHEAT gets processed), then W (where only WHEAT gets processed) and then all three parts would get processed at each of the remaining machines (H→E→A→T).

- *Flexible Labor:* Could the operator from an under-loaded machine walk over to assist the operator at an over-loaded machine? Yes and No. For one, again the machines would need to be co-located into a manufacturing cell for the travel distances to be small. But, as is often the case in stamping, molding and forging facilities, there is only one die. In this simulation, there is only one stamp for each letter! Unless additional dies were made, an under-loaded press could not be located near an overloaded press so both machines could share the workload for the overloaded machine! ☹

In Conclusion

This simulation was developed to provide insights into some of the synergies and differences between best practices for a Lean assembly line compared to best practices for a Lean jobshop. Some Lean practices can be quickly implemented even in a small or medium-size high-mix low-volume (HMLV) manufacturing company. That is because they are universal and already in widespread use across industry. But several FLean practices are unique to high-mix low-volume manufacturing facilities. We need "poster children" companies to implement them just as Toyota has shown the way on what works best for low-mix high-volume repetitive assembly.