Lean Food Processing

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- A fundamental goal of lean processing is to move the product smoothly and quickly through all of the process steps.
- Lean thinking provides the structure to organize and improve processes that align with food quality and safety goals, while lean tools expose wasteful steps in processing and provide methods to eliminate them.
- Lean teamwork will support the good manufacturing practice goals for teamwork, cleanliness, and organization.

While it is true that consumers today are much more diet conscious, the term "lean" food processing does not mean the reduction of calories or fat content but rather, in this article, it will refer to streamlining the production of food itself. The time has come to start applying the process-slimming techniques of "lean thinking" to the food processing industry. The manufacturing world has been trying for years to catch up to the Japanese model of the Toyota Production System, which is commonly considered the basis of lean operations. In fact, lean thinking has been spreading beyond traditional manufacturing firms (4). In recent years, it has moved into the service industry and proven its application to any sequence of processing steps in any enterprise. According to APICS, The Association for Operations Management, lean production is:

"A philosophy of production that emphasizes the minimization of the amount of all the resources (including time) used in the various activities of the enterprise. It involves identifying and eliminating nonvalue-adding activities in design, production, supply chain management, and dealing with customers. Lean producers employ teams of multiskilled workers at all levels of the organization and use highly flexible, increasingly automated machines to produce volumes of products in potentially enormous variety. It contains a set of principles and practices to reduce cost through the relentless removal of waste and through the simplification of all manufacturing and support processes" (1).

The food industry has some major concerns in the areas of quality and safety. In a recent presentation on food safety, two of the eight reasons cited for applying Hazard Analysis and Critical Control Points (HACCP) were to organize processes to produce safe food and to organize staff to promote teamwork and efficiency (8). These two goals fit precisely into the target zone of lean thinking and the associated lean tools.

The organization of processes is effected in lean processing by a tool called a value stream map (VSM). The value stream is the path that the product or service follows from raw material to the consumer. It can be developed for an entire supply chain or a single product, passing through a set of operations in a single processing plant. It is scalable and was first used at the supply chain level and later perfected for the enterprise environment (2,4).

Creating a Value Stream Map

The VSM is not simply a flowchart of the steps to make a product. It also includes the flow of information from the customer through the enterprise to the supplier. This reverse flow of information provides the triggering mechanisms for the action taken by the supplier and the enterprise itself. Not only does this tool organize the process elements but it collects data for each element in the process such as cycle time and staffing. This data is then used to assess the performance, value, and interaction of each element. Combining the information flow with the process steps and their information exposes how the enterprise controls and paces the process. Creating a VSM for the current state of the enterprise is the starting point for improvement (Fig. 1).

A key part of VSM analysis is the development of a timeline that allows a separation of the process elements into those that add value and those that do not. For example, holding something in inventory does not add value. Mixing, cooking, and packaging add value to the product. By examining the path of a product through the string of processes and evaluating each step, it becomes clear at which point value is added or where the product is simply stored or handled without value being added to it. Each cluster of productive activities that add value is surrounded by nonvalue-adding steps. The timeline is built by creating a line at the bottom of the map representing the sequence of steps. The time for each uninterrupted value-adding process is noted in its area below the line. The time for a nonvalue-adding process is noted in its area above the line. Totaling all the nonvalue-adding times (above the line) and value-adding times (below the line) separately is generally an eye opener. It is alarming how much time is being spent with no value being returned. These can then be quickly attacked. Ratios of nonvalue to value can be 20 to 1, 40 to 1, or more. This indicates a large potential for improvement. Companies that are in the 4 to 1 range are in relatively good condition.

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Remove Nonvalue-Adding Steps

Once the elements are organized, the real work of lean processing can begin. A quick rule of thumb is that any elements that do not add value should be targeted for elimination. Those that add value should be perfected to optimize their efficiency. One important note is to consider value as seen through the eyes of a consumer. The acid test is to ask the following: Would the customer be willing to pay for what is being done? For example, the customer may not know that a toasting process is performed on a grain but they value the resulting enhanced flavor. That represents added value that the customer would be willing to pay for. Typically, nonvalue-adding steps are also places where inventory stays for a period of time and where no processing is being done. The storage of a food product can expose it to more than just the waste of money tied up in the product. It can be degraded, contaminated, attacked by pests, or simply age. A fundamental goal of lean processing is to flow the product smoothly and quickly through all of the processing steps.

As lean analysis progresses, areas will be identified within the current state as presented on the map for improvement. These will become targets for projects ranging from continuous improvement, commonly called Kaizen, or statistical analysis and improvement found in the Six Sigma discipline.

Common Flow Impediments

Anything that impedes the product flow can be considered waste. The common seven wastes to avoid in lean processing are listed below.

Overproduction. Any time a product is processed in excess of demand is overproduction. This could be the result of poor projections, improper batch sizes, or just trying to make large "economic" lots. A recent client had no way to make small sample batches of product so they had to cook a production batch and discard substantial quantities. A project was then started to bring on line a smaller capacity cooker to fill this need.

Waiting. This is the most prevalent waste. It appears in all industries and is an obvious waste of time but has far reaching consequences beyond just time. Product is often sitting in front of or after a process with no place to go. This often is symptomatic of a disconnect in scheduling or pacing between operations. It seems harmless enough just to have some product not moving. In reality, it is product that was paid for as raw material, may even have labor added, and by not being sold, has been delayed from turning into cash. If it is in the production space, it also has an even greater danger of degradation, contamination, etc., than inventory stored in a storeroom, refrigerator, or container since it may be in a less controlled processing environment. Walking along the actual process steps can reveal products waiting, signaling a discontinuity or constraint in the flow and providing a target for improvement.

Excessive Transportation. Product that is moved repeatedly or over great distances in the processing wastes both effort and time. One of the lean concepts is to work in compact cells rather than to move product in and out of process-oriented departments. This lean style allows for less product movements and the associated risks to damage or degrade the product, time wastes, and manpower use. For example, even though the cooking and processing was relatively compact for one processor, the storage before, during, and after processing was spread all over the plant complex. A diagram of the routing revealed miles of travel for the product. This became a focus for rearrangement activities and improved scheduling.

Inappropriate Processing. This ranges from selecting the wrong or more expensive process (with no value to the customer) to not choosing or performing the process correctly. This can result in damaged or defective product, wasted resources, excess inventory, or even shortages. This is a spot where asking "why?" a number of times can get to the root cause. The process calls for asking, Why did this occur (or not occur)? Once that cause is revealed, the process is repeated by asking the same question about that cause itself. The theory of the "5 why" technique is that by the fifth level the root cause is exposed.

Unnecessary Inventories. Inventory is a very insidious way to create waste. It has been used in many industries to cover up the true problem areas. Because businesses had large stocks of inventory, they found it necessary to invent systems to manage them. This was the birth of the requirements planning systems (e.g., material requirements planning, enterprise resource planning, distribution requirements planning, etc.). Inventory should only exist where it serves the need to buffer a constraint in the processing sequence. A constraint is a spot in the process where production is limited by the capability of that step more than any other in the sequence. Only one of these can exist at a given time. Any improvement before the constraint point in the process will generate more inventories before the constraint that will be unable to pass through the constraint. Any improvement after the constraint point will drain inventory that does get through the constraint and create shortages. In any enterprise, it is likely that there will be some stock at the raw material stage, before the constrained process, and at the finished goods stage (Fig. 2). The actual business model will dictate how much, if any, inventory should exist at these points. It will then take a process review to improve the constraint itself to determine what is really needed to manage or improve it.

Unnecessary Motion. As opposed to the excess transportation above where product is moved, this is where the person is moving. The operation is causing the operator to move too much when performing the tasks required. Fixing this became the rage in the early 1900s with the emergence of "efficiency experts." The core concept is to make it as easy as possible for

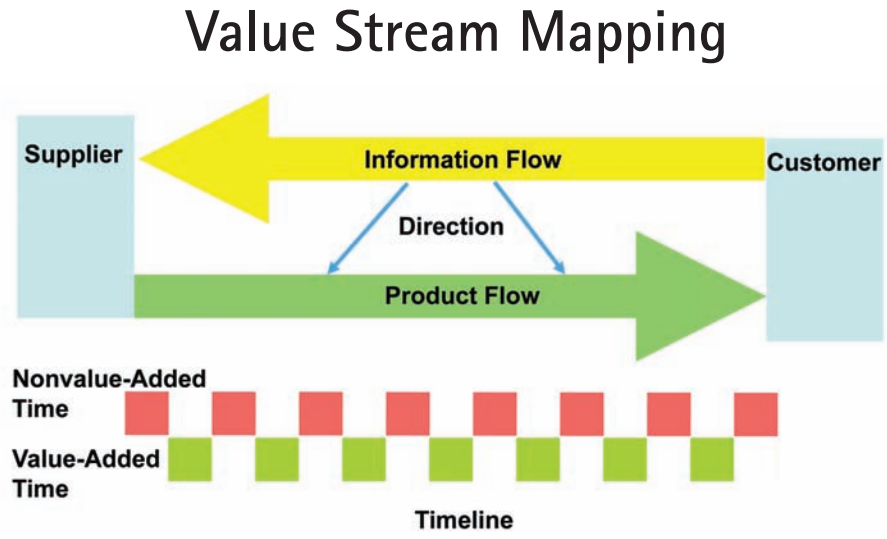

Fig. 1. Elements of a value stream map.

the employee to execute the movements in order to perform a task. This begins with how the product arrives at the work station and where it is positioned for the employee to process. It ends with how the employee finishes and moves it to the following step. The assembly line model, and its variations, is well understood in industry. It is, however, under applied in many processes. Benefits of 25% improvement are not uncommon in simply rearranging the work flow at a step.

Defects. Making a bad or nonconforming product is the easiest waste to understand. How it is created may be more difficult to spot. Optimum performance in lean processing relies on quality. It benefits from processes being in statistical control. Process variation and unexpected failures make flow and operational performance unmanageable. All of the work-arounds, sorting of good from bad, and delays are pure waste. Once the value-adding processes are identified, these are the steps to subject to an improvement plan, such as Six Sigma, to ensure the output is defect free.

The Lean Team

Clearly, VSM and waste removal does not happen in a vacuum. It is a participation sport and requires the involvement of the entire workforce. The direction of lean operations and the resources to perform lean projects must come from the top of the organization. But, the best place to educate, engage, and focus the initial program is at the operator level. The second part of an HACCP citation is to organize staff in a way that promotes teamwork and efficiency. This is precisely what a lean team does.

Each work station or group of work stations in the process becomes a cell. That cell is a dedicated and trained group of employees with the specific goal of making the area for which they are responsible the best performer it can be. In many cases, this is a cultural shift. Employees may have never been asked to think about efficiency and process improvement. They may be timid or fearful of putting themselves out of work. It takes coaching from supervision to support lean training by taking the suggestions from the team seriously and having the useful solutions implemented immediately. There must also be a management commitment that ensures process improvements will not result in layoffs. If a reduction in team members is needed, it should only result in a transfer or promotion—never in a layoff. One way to absorb excess staff is to implement a lean project office where the best lean talent from a successful cell is promoted to work with other teams to help them succeed at lean processing.

The development of a lean culture within the organization is key to ongoing success. Everyone needs to be asking a series of questions:

- Would the customer be willing to pay for this?
- How can the process be improved?
- How can we achieve the perfect product every time we operate?
- How can we make our individual and group tasks easier and less time consuming?
- How can the process be mistake-proofed?
- How can the distance the product travels be reduced?
- How can we better arrange the work cell?
- Is the work cell keeping pace with the other operations and the pace of customer demand?
- Is there any inventory in the area that is not being worked on?
- Is there a constraint in the area and if so what can be done to improve the process?

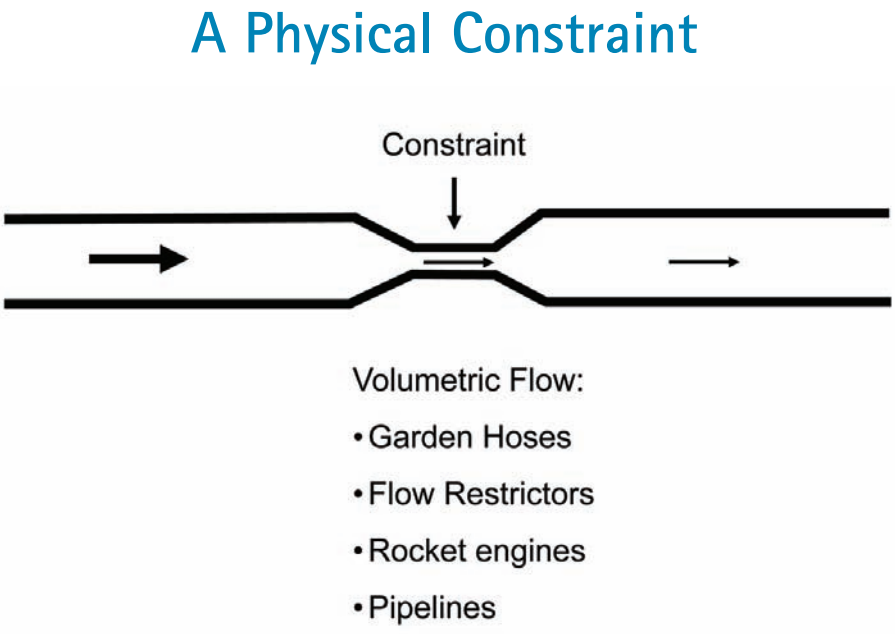

Fig. 2. A physical constraint.

The "5S" Tool

Lean processing comes with a tool kit for this kind of first-level team improvement. It is called "5S." This should be done in the area of the participants and only with the approval of the process owner. Once the team has been educated on lean processing and the program goals, it is time to get them started in the lean world by conducting some 5S exercises. The 5 Ss are descriptive words, in Japanese and English, starting with "S" that describe lean tasks. There are slight variations in the exact words but the core concepts are the same. The 5S program should be a front-line tool in compliance with good manufacturing practice (GMP) requirements. The following list outlines the content for each of the 5 Ss and is in the general order in which they should be conducted.

1. Sort. Separate needed from unneeded items in the work cell. Leave only the bare essentials. Remove unneeded and excess items from the work area. The team must answer the questions: Is it needed, in what quantities, and where should it be located?

2. Set in order. Establish a place for everything and put everything in its place. Place parts, tools, and instructional manuals close to the point of use for easy access and to reduce the individual motion. Use color codes, shadow boards, and labeling to quickly identify items. These include cleaning, cooking, handling, and measuring devices.

3. Shine. Operators clean their own equipment and working areas and perform basic preventive maintenance. Everything is clean, sanitary, and in a constant state of readiness. Investigate the causes of any dirtiness or potential contamination and implement corrective action.

4. Standardize. Assign responsibility for activities regarding maintaining the first three 5S conditions. Integrate documented procedures in GMP, ISO, and other procedural standards for 5S maintenance

tasks incorporated into regular assigned work duties. If the formalization process is not done, improvements made in the first three steps do not last but revert to prior conditions. This will be especially true when the organization is under stress.

5. Sustain. Several conditions are necessary to sustain a 5S environment as well as a lean program. Start with awareness through education and training. Provide the necessary time to perform lean tasks in the work schedule. Structure how and when 5S tasks are to be performed. Have management provide leadership, resources, and acknowledgment for program success. That acknowledgment can take the form of rewards and recognition. Finally, keep the program interesting, satisfying, and exciting to keep people engaged.

The Tools of Lean Thinking

These foundations now enable the use of lean tools to provide a transparent workplace where the order is visual and control is evident to management as well as the team members in the cell. Everyone is then equipped to understand what is happening. There are provisions for posting skill levels, training achievements, maintenance schedules, methods, and metrics. These allow meeting the GMP requirements and serve as a foundation for continuous improvement. Neither the GMPs nor lean environment are tolerant of errors so the focus is on doing things right the first time. These generally require a well-documented standard practice that is rigorously adhered to.

Most food products do not have indefinite shelf life. The concept of just-in-time production and timing should not be foreign to a food enterprise. The reasons for moving products along at a rapid pace may be slightly different. Spoilage and waste are considerations on the food industry's side, while minimal inventory and flow are the goals for lean processing. There is a concept called "takt time" (the maximum time per unit allowed to produce a product in order to meet demand) in lean processing. This is based on the rate of demand and serves to develop a production rate that matches demand. That is the starting point for just-in-time activities. Material is moved through the enterprise based on a pull system. Demand from the customer pulls the product from the enterprise, and then each process is synchronized to deliver the replacement for the product pulled. There are a lot more details to implementing pull, just-in-time, and takt. They marry well with keeping the product fresh and flowing to the consumer.

There is a synergistic relationship between the basic requirements of food processing and the tools of lean thinking. Double-digit improvements are not uncommon. After applying the disciplines of lean thinking to a food processor, the results should provide excellent compliance with industry and business requirements. The enterprise will operate with improved organization and continuous improvement will result. This two-for-one-special should be ample motivation for any food business to embark on a lean program, helping to maintain and improve quality, reduce costs significantly, and improve customer service and satisfaction.

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