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Lean Factory Design Basics

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Before you build a new factory or redesign your existing facility, give consideration to the following concepts to aid with product flow.

General plant layout

Primary consideration has to be given to a single direction of flow. This means that the material only moves in one direction during its journey through the plant. Raw material is moved to the machine or assembly, placed in the machine or assembly and exits on the other side/end to be fed to the next operation. Aisles need not be square, or a standard width. Material delivery often dictates the size of aisles, yet if you have Point of Use storage and smaller batches that do not require equipment to move them, then the width of an aisle is smaller and certainly variable. Machine orientation should facilitate "one-man-two" access where one operator can attend multiple machines with minimal walking. Typically, machines are organized in rows or a group, which means the operators are required to move around the machines to access them for parts removal, status updates, and counting. Eliminate as many internal doors, walls, fences, different buildings as is practical. Product should flow, ideally, without interruption, through the entire process. Walls, doors, fences, separate buildings inhibit this flow. One plant I worked in arranged them in a "C" shape which allowed one operator to stand back 5 paces and watch 6 machines running. If attention was needed, the operator could see that, versus walking around to each machine because the row of machines hid the others from view.

Flexibility should be your number-one design criteria. Put equipment, where practical, on wheels (with wheel locks) for ease of re-arrangement. Build flexibility into your re-arrangement on the first move utilizing flexible power drops, flexible air connections, light equipment on lockable wheels, and equipment on skids. Remember, with continuous improvement comes continuous change. As your business continues to become Lean, expect and plan to adjust/change your layout multiple times. The critical idea is to make "change" as easy and inexpensive as possible.

A Lean facility should make every effort to accommodate support personnel as close to the shop floor as space will permit. Traditional plants typically put supervisors, engineers, planners, and buyers in offices away from the shop floor. This configuration contributes to issues of communication, poor visual control, and the invisible "wall" that separates the shop floor people from the "management". Co-locating these critical services in teams by value stream on the shop floor to support the daily operations is a preferred configuration. Obviously, this raises some serious cultural issues, but again, change is required to ensure a sustainable Lean environment.

Smaller is better

Big equipment is expensive to buy, install and maintain, and is not flexible in terms of movement or volume changes. Look at buying equipment that is closely matched to demand, and if more capacity is required, buy another machine or work overtime. Smaller equipment also is better suited to cell design, as the smaller equipment can be incorporated into the process to reduce non-value added movement, handling, etc.

Shipping/ Receiving

There are many opinions for the location of shipping/receiving functions. Some say that receiving should be on one end of the building with shipping at the opposite end to enhance a single direction of flow. Another view says they should be in the same location or side-by side to better utilize manpower, construction costs associated with doors/ ramps and security issues. I am inclined to separate the two areas, simply because it reduces confusion.

If possible, construct the entire plant at dock height. In a lean environment, we want cost effective material delivery directly to the point of use on the shop floor. We also want easy shipment / loading. If a plant that is all at truck dock height does not limit where you install truck doors, then there is considerably more flexibility in plant layout.

The layout in both areas is important to facilitate material processing movement. In receiving, the biggest problem is usually what to do with material that has either a quality problem or does not match the purchase order, and therefore takes up space while waiting for disposition. If you have a mindset that says something like "all incoming materials will clear the dock in 1 hour or less", your process does not require any storage areas. In shipping, shipping frequency will set the tone for process design. Compare hourly shipments vs. weekly shipments in terms of manpower utilization, space requirements, and material handling.

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Electrical, Air, Water, Computer, Phones

All connections should be made via an overhead distribution with flexible lines and an extra loop of wire/hose is preferred. The key reason is that if you have to move equipment one foot to the right to accommodate another piece of equipment, we don't need to hire riggers to disconnect and connect. Use of power-poles or "power centers" that are fixed to the floor fall into the inflexibility category and are to be avoided as well. Yes, there may be a slight cost issue, but this is short-term view. The long-term advantages are found in the flexibility of machine and resource mobility. The business volumes, products, processes will change and that will require the ability to move equipment, materials, support equipment quickly. That is achieved by unplugging with Twist-locks, quick-connect fitting, and snap-in connectors that do not require outside contractors. Air lines (and air compressors) should be of sufficient diameter to provide proper volume of air to the machines. Improper air pressure results in incorrect torque on bolts driven by air ratchet tools, or poor functioning ejection pins.

Rest Rooms/Lockers

Look at placing multiple bathroom facilities with easy access to the shop floor. This reduces non-value added walk and wait time. Lockers need to be placed outside the manufacturing area, so that only properly dressed employees can access the floor. It also prevents bringing unauthorized items onto the floor.

Point of Use Tool Storage

Multiple sets of tools need to be available at each workstation or machine. Businesses make the mistake of keeping tools in a locked toolbox or central storage in the mistaken belief they are controlling costs, yet the time lost at the machines by operators searching for tools is huge. Point of use storage of tools and materials is critical to resource utilization, so space on the floor has to be planned.

Store any low-cost tools where they are needed. Put racks on the equipment to hold the screwdriver, wrench, and hammer within reach of the operator. Investing a few hundred dollars in additional tools, combined with clearly defined locations for their storage, will save thousands of dollars annually in lost productivity. Tool supply companies can furnish "vending machines" that can be placed throughout the shop floor and are stocked with commonly used tools and supplies, generally on consignment. Operators/supervisors are provided with credit-card type keys that record when, what, and by whom, each part has been used.

Die Storage

Wherever possible, open vertical storage of high usage dies is required by the machines. This minimizes set-up time (finding a forklift/hoist, locating/installing lift eyes, bringing the die to the machine). Do not put dies in a mechanized vertical storage unit, as this limits access, as well as creates the risk of the storage unit breaking down with no way to get the dies out. Dies should have fixed lift eyes (if they are used) permanently installed to eliminate hunting, installing, and removing the eyes. Some type of pull system is required to alert the die room that a die is need of major repair. Quick or easy repairs should be done on the shop floor (to eliminate non-value added transport and wait time to the tool room), either by the operators (once they have been trained) or by the tool & die people.

Total Productive/Preventative/ Predictive Maintenance (TPM)

TPM should be performed on all equipment as part of the relocation of equipment. Level 1 TPM (cleaning, tightening, lubrication) should be done by the operators via a checklist. Preventative maintenance that replaces bearing, filters, motors, etc should be done at pre-planned intervals, backed up by the appropriate spare parts on-hand. Finally, a predictive maintenance effort is the periodic evaluation of the equipment to prevent running to failure (temperature readings on bearings, noise levels, lubrication analysis).

Ensure maintenance people are available on the off-shifts. This will help with reducing downtime, machine failure, and missed shipments. How many times have you come into work expecting a shipment to be ready, only to be told that the machine broke down, so they waited till a maintenance person came in on the first shift? By having access to idled equipment on weekends or nights, an excellent preventative maintenance program is possible.

Cellular Manufacturing

Arrange equipment so that product can flow easily in small batches (one piece if possible) from operation to operation. Minimize storage – if it is being stored, it is not flowing. Avoid conveyors wherever possible. U-shaped cells are typically favored and provide a number of advantages. The product begins and ends on the same aisle, communication is improved, and work-in-process inventory is minimized. A U-shape minimizes travel distance. One operator can "walk" the product through the cell if and when needed. The cells should also be scaleable as volume increases/decreases.

However, U-shaped cells are not always possible, but smaller machine groupings that achieve many of the same effects/ benefits are possible. Thus, the business should have some type of cellular thinking as part of its Lean plant design.

Summary

A Lean facility should be laid out to incorporate 1-piece flow wherever possible. Flexibility to absorb future changes should be paramount in the design phase. Flexibility includes overhead distribution of power, air, water, etc. and moveable, small pieces of equipment. Be sure to provide space for point of use storage of materials and tools. Finally, plan on using cellular manufacturing to reduce non-value added time in your process.