



A Practitioner's Guide To
Lean Manufacturing

Plant Layouts &
Cellular Manufacturing Edition

Vincent A. Amaro, Jr.

Evolver™ - A Practitioner's Guide To Lean Manufacturing - Plant Layouts And Cellular Manufacturing Edition. Copyright © 2006 by Lean Manufacturing Consulting, Inc. and Vincent A. Amaro Jr. Printed and bound in the United States. First Printing 2007

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About The Author



Vincent A. Amaro, Jr. is the founder and President of Lean Manufacturing Consulting, Inc. Mr. Amaro has dedicated his career to the development of world class manufacturing operations using Evolver™ lean manufacturing techniques, which have provided numerous firms a competitive advantage in today's global marketplace. Mr. Amaro has over 25 years of experience in manufacturing, including extensive experience as a machinist.

Mr. Amaro began his career in manufacturing while serving a tool and die apprenticeship during the early 1980's. During his career, he has worked for a variety of firms ranging from aerospace to medical devices and has held several positions including experimental machinist, tool and die maker, mold maker, tool designer, manufacturing engineer, process engineer, Plant Manager, and Vice President of Operations.

Having worked his way up from the shop floor, Mr. Amaro has the ability to quickly recognize and solve problems, as well as the ability to earn the respect of the rank and file employees. The combination of in-depth manufacturing knowledge and real "hands-on" experience differentiates him from other executives at his level.

During his career, Mr. Amaro has successfully completed hundreds of lean projects of various sizes and complexities. He is a dynamic leader who is an expert in the implementation of lean manufacturing and the turn around of failing product lines resulting in millions of dollars in savings. Mr. Amaro holds a Bachelor's degree in Business Management and an MBA in Global Business Management.

Functional Layout

Functional Department

A functional department is best described as a department that is designated to perform a specific centralized function or operation. Functional department examples include: the lathe department, the mill department, the inspection department, the stockroom department, the accounting department, the human resources department, etc. Poor functional layouts exist when steps within a manufacturing process are not arranged with product flow in mind.

Flow

Flow in a lean application is best described as how (good or bad) parts travel through the production process. Good production flow is similar to an automotive freeway where traffic travels (flows) in a smooth manner without interruption. Using the same analogy, poor production flow is similar to driving a car in congested city traffic where it starts and stops, does not move smoothly, and lacks a direct path. In other words, a layout with poor production flow is not smooth, nor is it the shortest distance between two points.

Functional Layout

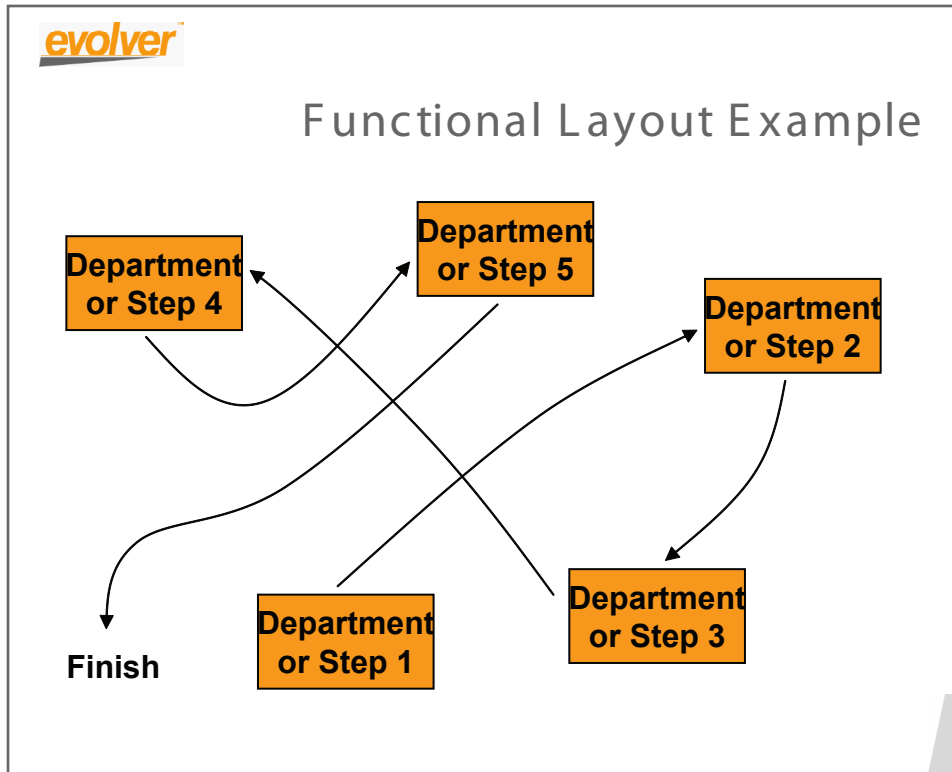
A functional layout is a factory layout that meets the following conditions:

- Its operations or steps are separated into functional departments.
- The arrangement of the functional departments throughout the factory does not take into consideration the actual product or part being produced. In other words, the functional departments are arranged in a manner which contributes to excessive transportation waste and poor production flow.

Other problems associated with functional

layouts include poor communication between operators, as well as problems with the detection and isolation of defects. When you have a manufacturing process with functional departments scattered throughout the facility, the long distance between the various steps tends to hinder communication between the operators and the interdependent departments. This lack of communication often contributes to a whole host of other problems in the manufacturing process.

For example, I once performed a time study on a fabrication process. The material was cut incorrectly due to of a faulty cutting fixture. The welders who received the incorrectly cut material filled the gaps with weld, which wastes both time (labor) and materials (welding wire). Due to the heavy globs of weld, employees in the grinding and deburr departments wasted both time (labor) and materials (sanding belts and discs) grinding down the globs of weld. All of this unnecessary waste of labor and materials occurred because the employees from the various departments never communicated since their departments were physically far apart from each other. In fact, the distance between these departments was so far apart that the leads in each department also failed to communicate!



Functional Layout (Example)

Department

In this slide the term “department” is used to describe a functional department. For example, the lathe department, the mill department, the inspection department, etc.

Step

A step is a sequence in a production process. Within each step, you may have multiple operations occurring, either simultaneously or consecutively. For example, within one step we may perform both a drill and tapping operation.

Operation

An operation is the type of work (mill, lathe, drilling, tapping) being performed within a step.

The term “department or step” is used in this slide to illustrate how a part moves within a manufacturing process. Although the words department and step are different terms, the problems associated with poorly arranged departments or steps are very similar. Keep this in mind.

This is an example of a functional layout. There are five (departments or steps) in this example. The arrows depict the “flow” or the direction a part travels through the manufacturing process. Notice how the various departments or steps are not arranged in any logical order resulting in transportation waste. This is an example of poor production flow. If this type of layout resembles your facility, consider changing it immediately to a product layout which is described on the following page.



Beginning Your Present Layout

- Every item on the shop floor needs to be drawn (i.e., machinery, cabinets, toolboxes, material carts, aisles, doors, etc.).
- Accuracy is important! Measure equipment as accurately as possible. Shortcuts here may cause you problems later!
- Tools required – Use tape measures and a measuring wheel. Avoid laser tools unless you have proven them to be accurate.
- If you own drafting software, use it.

Beginning Your Present Layout

Begin by accurately drawing every item on the shop floor. This includes machinery, cabinets, trashcans, employee toolboxes, material carts, aisles, doors, etc. If it is on the floor, draw it!

Draw the equipment as accurately as possible. Avoid the temptation of drawing “boxes” instead of drawing an accurate footprint of a machine. Yes, it takes a little longer to draw the equipment correctly; however, it is a small investment that pays large dividends for years to come. Your new layouts will be easier to create and easier for others to read. The entire Evolver™ program focuses on reducing costs and eliminating non-value added activities. With this in mind, I would not advise you to do something that actually takes more time if it was not necessary.

Tools Required

Normally, when I begin a layout, I utilize the following tools:

- Two 30 foot tape measures or two 25 foot tape measures. I personally prefer the 30 foot tape measures as the extra five feet may save some time. Use these tape measures for laying out the building parameter or an area designated for lean improvement.
- One 15 foot tape measure for measuring equipment. The 15 foot tape is lighter and easier to maneuver when measuring machines and other equipment on the shop floor. (Note: A 12 foot tape measure also works fine for this task.)
- One 100 foot tape measure (the type that winds up manually). Normally, I only use the 100 foot tape measure for measuring aisles. You could also use the 100 foot tape

measure if you are measuring an empty building or an area without equipment.

- A measuring wheel for performing a quick accuracy check. (Important Note: Avoid the temptation of using the measuring wheel as a shortcut. I only use the wheel when I have an extremely long distance and a perfectly straight line for the wheel to travel. If you are going to use the wheel, use it correctly and with accuracy. When taking a measurement, try to walk in a straight line. Also, take notice of your handle position. I prefer to start the measurement and stop the measurement with the handle at 90 degrees (vertical). I do this because moving the handle changes the measurement reading. Yes, it's only a few inches, but I prefer to be as accurate as possible. Do it right the first time!
- Black magic markers - I use black magic markers to write on the floor. For example, let's assume that you are measuring a distance of about 45 feet. Measure off the first 30 feet with your tape measure. Then make a small mark on the floor with the marker. From there you can use the mark on the floor to measure the remaining 15 feet of distance. Then simply add up the two measurements. This approach is great when you cannot run a measuring wheel in a straight line due to equipment or other obstructions on the factory floor.

method or merely your own personal preference, that's okay too.

Create layers for the following:

1. Create a layer for the building or area perimeter. This is where you will draw your building or area.
2. Create a layer for your present layout. I always keep a copy of the present layout, even after the changes are made because it allows me to refer to how things were previously arranged. I simply turn the layout off and on as required. You never know when you might need to look at the old layout. Having a layer for the present layout also helps with the new layout because you can switch back and forth to check aisle spacing, machine spacing, etc.
3. Create a layer for your new layout. This is where you will draw your new layout. Having a layer for the new layout allows you to start with a clean uncluttered drawing.

Drafting Software

If you have drafting software, use it. It is faster and more accurate than using a piece of paper, plus it allows you to establish layers in your drawing.

Layer Suggestion (Drafting Software)

The following is just a suggestion. This is my personal preference and what has worked well for me in the past. If you have a more effective



Walking The Existing Process Present Layout

- Walk the manufacturing process that you are trying to improve (follow the path that the parts travel).
- Measure the total distance traveled with the measuring wheel. (Note: You can also measure the individual distance of each manufacturing step. Then, you can add your individual distances to obtain your total distance traveled.)
- Using your layout, create a spaghetti diagram as you walk the process to illustrate the movement of the product through the facility.
- Create a description of every step of the process.

Walking the Existing Process - Present Layout

The purpose of walking the process is to gather information about how a part or family of parts travel through the manufacturing process. The information gathered while walking the process is somewhat different than the information gathered during a time study.

In a detailed time study, we are interested in collecting detailed information regarding a manufacturing process or a step within a process for the purpose of collecting and improving run times, removing waste, looking for cost reductions, error-proofing, etc.

When you walk a process for the purpose of creating a new layout, we are interested in collecting information about how a part or family of parts travel through the manufacturing process for the purpose of improving the layout or creating a cell.

Examples include:

- How are the parts transported (cart, pallet, bins, etc.)?
- How heavy are the parts? Do you need special handling equipment for the parts?
- How heavy is the tooling? Where is the tooling located? Do you need special lifting equipment for the tooling?
- If you are using best-batch-flow, what are the optimum batch sizes?
- How wide do your aisles need to be?
- How much space is required around each machine?
- What are the power requirements for each machine?

(Note: The topics of equipment and people considerations are discussed in greater detail in the upcoming segment.)

The logo for 'evolver' is written in a lowercase, sans-serif font. The 'e' is orange, and the rest of the letters are black. There is a small trademark symbol (TM) to the upper right of the 'r'.

Designing A New Layout People Considerations

- Who will be impacted by your move?
- Have you included them in your decision making process?
- Is there an approval process required for the move? If so, complete this first.

Designing a New Layout - People Considerations

Before you begin, deeply consider who will be impacted by your move. You need to consider everyone! This includes, but is not limited to: the rank and file employees, maintenance staff, shop floor supervisors, middle and upper management, office employees and even those in different departments. There is nothing worse than spending days working on a layout only to discover someone has created a “roadblock” and your new plan needs to be altered. What is even worse is discovering a roadblock in the middle of a move! Take your time and consider everyone.

Sometimes a move may require an approval from management. If so, you may want to consider obtaining the approval first. Hint: I personally prefer to create a “rough draft”

layout which often helps management visualize what you are trying to accomplish. It is easier to obtain approval when they can see the end results. Remember, money is the operative language for management. In addition to your rough draft, advise management of the projected savings. Always be conservative with this number! It is perfectly fine to exceed your original savings estimate; however, falling short will destroy your credibility in a hurry.



Designing A New Layout Equipment Considerations - Part 2

- Does anyone else use this equipment? If so, how will they be impacted by your move?
- Permit considerations – Check with your local authorities for permit requirements prior to moving equipment.
- Other considerations:
 - Machine maintenance accessibility (leave at least 5 feet behind and on the sides of a C.N.C. machine as you may need forklift access for a repair).
 - Machine loading and unloading.
 - Machine noise, odors, and dust.
 - Flow of raw materials and finished goods.
 - Personal toolboxes. (Did you leave enough room for employee toolboxes in your layout?)

Designing a New Layout - Equipment Considerations (Part 2)

Does Anyone Else Use The Equipment?

If you have equipment that is used by others within the facility, you need to consider them. Even if the particular piece of equipment belongs to your department and is occasionally borrowed by others, provide them some consideration. Talk to them first and obtain their feedback. Even if a compromise can not be reached, at a minimum, they will know that you considered their needs. This is not about politics. It is about earning respect and respecting the needs of others.

Permit Considerations

Some pieces of equipment may require a permit. When in doubt, check with your local authorities for permit requirements prior to

moving or installing any equipment.

Machine Maintenance Accessibility

Once again, this is a good time to talk to your maintenance department. They can tell you exactly how much space is required to service the equipment. In general, C.N.C. equipment requires a minimum of 5 feet behind and on the sides of the machine.

C.N.C. Chip Conveyers – Before you begin, find out how the chip conveyers are removed and how the coolant is drained from the machines. Make sure that you have enough clearance to service the equipment!

Power Requirements

Whenever you purchase a piece of equipment

or move a piece of equipment, you need to know the power requirements. Save yourself the embarrassment. Research your electrical requirements before you begin your drawing.

I once witnessed a manager attempt to save money by ordering a new C.N.C. machine with 220V three-phase instead of 480V three-phase. When the machine arrived, the maintenance team quickly discovered that there was no 220V power available where the machine was to be located. Now to operate the machine, a transformer was required. In addition to the cost of the transformer, additional labor was required to wire the transformer and get power to the machine. This entire fiasco could have been avoided by doing some research.

Machine Loading And Unloading

It is also important to know how a machine is loaded and unloaded. How large are the parts? Are the parts heavy enough to require special lifting equipment? How heavy is the tooling? Are the parts stored on carts? If so, how large are the carts? If you are batch processing, what is the size of your batch?

Machine Noises And Odors

I once located a machine that made a lot of noise outside a large office. To say that the employees were not happy with me would be an understatement! We were able to reduce the noise by adding an additional layer of drywall to the office walls. However, even with the extra layer of drywall, the equipment could still be heard.

Be mindful that some equipment and operations smell, such as conventional E.D.M. machines, abrasive cut-off saws, welding, composite and adhesive operations, C.N.C. machines with spoiled coolant, etc. Most people in the factory are used to it. However,

when this equipment is located near an office, office employees tend to become upset. Again, deeply consider your surroundings before moving the equipment.

Dust And Airborne Particulate

Research OSHA's website for the appropriate method of handling this type of problem.

Flow Of Materials And Finished Goods

Before starting your layout, make sure that you understand both the flow of raw materials and the flow of finished goods. The intent here is to establish the best flow possible.

Personal Toolboxes

Do not forget to consider personal toolboxes when you design your layout. I usually make sure that I have enough room for at least one roll away toolbox at each workstation or machine. When you have two or more shifts, you may need to create an area for storing roll-away toolboxes at the end of the shift.

Machinery Special Requirements

Some equipment is very sensitive to vibrations from forklifts and other large pieces of equipment. This is especially true with sensitive inspection equipment and equipment performing close tolerance operations.

Another sensitivity consideration is room temperature. In addition to the temperature requirements of the machinery, changes in temperature may impact some close tolerance operations.

Some pieces of equipment require special "concrete pads" cut into the factory floor. The pads may be required for weight and/or isolation from outside vibrations.