Applying lean manufacturing techniques to powder coating operations

To understand the potential impact, it’s necessary to understand what each of the three principles represents. Pull systems use signals to instruct upstream processes to replenish parts that are consumed downstream. Takt time is the available time divided by the number of finished units required in that time period. Takt time might also be referred to as the “drumbeat” of the plant. One-piece flow involves processing one part at a time, rather than in batches.

What does this mean for the production floor? It means that if three operations are required to make a part, lean thinking dictates that all three operations be completed for the first part before an operation is started on the second part.

The Relation to Powder Coating

For the benefits of pull systems and takt time to be realized, color changes must be fast, and first-time application of powder coating must be of consistently high quality.

Fabricators who powder coat can expect the number of color changes to increase dramatically when they implement pull systems. With pull systems, demand dictates what color is applied next. If color change time is not minimized, significant loss of capacity results.

Ideally, all plant operations would produce consistently at the designated takt time. However, on a powder line, product flow is interrupted whenever color changes are needed or when parts are rejected because of finish flaws. Because most powder coat

POWDER COATING in lean times
Applying lean manufacturing techniques to powder coating operations

By Dan Beachum

In an effort to improve the flow, management, and efficiency of their manufacturing systems, many fabricators have adopted lean manufacturing principles, modeled after the Toyota Production System. In this type of production environment, customer demand drives daily production schedules, and inventory is minimized.

Companies that have implemented lean practices have realized substantial improvements in the productivity of both workers and equipment. They have also achieved higher product quality and more on-time deliveries, reduced lead-times, and increased profitability.

Fabricators who powder coat or who are considering a powder coating line should realize that powder coating is compatible with these same lean principles. In fact, the three principles of lean manufacturing—pull systems, takt time, and one-piece flow—can have enormous impact on a powder coating operation.

Powder coating booths can be specially designed to fit into a lean manufacturing environment. In many cases, because fabricators are attempting to make the most of their floor space, the lines are smaller in size than traditional powder coating systems.

For the benefits of pull systems and takt time to be realized, color changes must be fast, and first-time application of powder coating must be of consistently high quality.

Fabricators who powder coat can expect the number of color changes to increase dramatically when they implement pull systems. With pull systems, demand dictates what color is applied next. If color change time is not minimized, significant loss of capacity results.

Ideally, all plant operations would produce consistently at the designated takt time. However, on a powder line, product flow is interrupted whenever color changes are needed or when parts are rejected because of finish flaws. Because most powder coat
lines do not change colors instantly or produce 100 percent perfect parts on the first run, parts are stockpiled between the finishing department and the operation that follows to avert part shortages downstream.

Supporting the goal of one-piece flow requires a different approach to fixture. Many companies have discovered that the common practice of batch loading by part groups or families is incompatible with lean ideology. Instead, it's advantageous to load all the parts required to assemble one unit on a single rack. As the rack comes off the line, all parts are available for assembly.

Finally, minimizing the overall size of the powder coating system is critical within a lean environment. Traditionally, companies have increased their capacities to meet sales growth with plant expansions and added equipment. Lean, on the other hand, uses continuous improvement concepts to increase capacities, while simultaneously seeking to reduce the footprint of production.

A Lean Powder Line Design

Here are some of the most important factors to consider when designing a powder line for lean manufacturing.

Color Change. The more frequent the color change, the less practical are standard roll-on/roll-off booths. Preparing an offline booth for the next booth in "reclaim" mode can take an hour or two. Rolling the first booth offline and moving the other booth into the painting position takes five minutes or more, depending on the length of the booth and line speed.

One option for faster color changes is multiple application booths, coupled with an overhead power and free (OP&F) conveyor. In this arrangement, a common conveyor leads to an application room housing two or more powder booths. Just inside the room, the conveyor branches into multiple spurs, each routed to a single booth. With an OP&F conveyor, the upper rail hosts the drive chain and the bottom chain contains the load carrier, which can be engaged or disengaged from the drive chain. Color changes are made by specifying the load carrier number and desired booth using the operator interface.

Programmable logic controllers typically manage and track part location, verify the color to be applied, and direct the carrier load to the appropriate booth. So, while one booth is operating, another is color changing and being prepared for the next job.

Disadvantages of this option include inherent system complexity, more elaborate controls, and higher capital costs for conveyors and related systems. This strategy also creates a bigger equipment footprint.

An alternative for achieving quick color changes is a multiple-booth, 100 percent spray-to-waste system. Rather than several spray booths and reclaim, two separate booths—one automatic and one manual—are used. With this arrangement, the emphasis is on high transfer efficiency rather than reclaiming. Using two separate booths instead of a single, larger one enables the sequencing of color changes and greater efficiency in evacuating suspended powder particles, both of which are important. This application technique is more consistent because 100 percent virgin powder is used. Powder that has not undergone the mechanical stresses imparted by reclaim equipment will inevitably produce a higher-quality finish.

In a basic spray-to-waste color change, four tasks take place: empty the booth of work, purge the previous color from hoses and guns, connect the next hopper, and burp the guns a second time. The advantage of multiple booths, especially small ones, is that it's possible to perform each task in each booth quickly.

For larger powder coating operations, powder feeding centers are available. The advantage of coupling automatic guns to a powder feeding center is that all guns can be purged simultaneously.

If short color runs are common, a manual booth makes sense. Color changes can be achieved in about 30 seconds in this configuration.

Floor Space Minimization. To streamline a powder coating system, look to the "big boxes," the cleaning and pretreatment stages and ovens.

In a traditional clean and pretreatment operation, a three-stage (clean, rinse, and dry in place) or a five-stage (alkaline, clean, rinse, phosphate, and rinse) setup is used. However, a dry-in-place, polymer-based chemistry technology is emerging that replaces traditional phosphates and could signal a change in cleaning strategy.

For many applications, especially simple parts, this dry-in-place technique produces excellent adhesion and corrosion protection. It also occupies a smaller footprint compared to traditional cleaning operations. Typically, the dry-in-place pretreatment application requires only a couple of risers with misting nozzles. Post-rinsing isn't required, and parts move directly into the dryer.

With conventional iron phosphate pretreatment systems, a dwell time of 60 seconds is needed in the iron phosphate tank. With dry-in-place systems, about 10 seconds is needed.

A common space-saving technique is to mount ovens on the roof or on a mezzanine. Many companies elevate sections of process lines to allow parts to enter the oven from below, so heat escape is minimized.

For this to work, there must be a significant change in elevation (a decline out of the washer, then incline into the oven, for instance). This adds time to the finishing cycle time and introduces a space consideration of a different kind:
Parts must have sufficient space between them to prevent contact with each other when the racks are climbing or descending. The size and complexity of the parts to be coated ultimately determine just how much space must be allotted per part per rack.

Curing. A typical powder coating system requires a 20-minute dwell time inside the oven, a specification that cures a variety of parts and geometries effectively and together. This dwell time is what most powder chemistries require to achieve proper color and gloss.

The disadvantage is that at normal conveyor speeds, 20 minutes of dwell time means a big oven is needed.

An alternative is a combination oven that exposes parts to two or three minutes of intense infrared heat and then 10 to 12 minutes of conventional convection heat. Because the oven uses both infrared and convection technologies, it is not limited to flat parts, which is usually the case with ovens that rely solely on infrared curing.

But the combination oven does have trouble with highly complex shapes, which confound the infrared curing technology because the entire surface has to be exposed clearly to the infrared beams.

Another oven option is high-velocity convection, which circulates high volumes of air through small orifices. Air is impinged onto the part, quickly raising the substrate temperature. The powder’s blocking agents, which help protect against premature curing, come off the powder, and a faster cure occurs.

Unfortunately, high-velocity systems are not as forgiving as conventional systems. Color and gloss, for example, can become distorted if a line stops.

Cooling Tunnels. In a typical line layout, eight to 10 minutes of conveyor space (the time it takes a conveyor to move a part from Point A to Point B) is provided after the dryoff and curing oven for parts cooling.

An alternative to the traditional cooling tunnel is a tunnel that pulls outside air into the chamber at one end and expels hot air at the opposite end. Such forced-cooling tunnels cut cooling times in half.

The Lean Mantra

The central tenets of lean thinking are to shorten the order-to-delivery cycle time, invest in simpler systems, and reduce work-in-process inventories, all without compromising quality. Fabricators who follow these principles and invest the resources needed to become lean realize significant savings that are quickly reflected on the bottom line.

This goes for fabricators who powder coat as well. Thanks to technological advancements and creative equipment layout, the benefits of lean manufacturing are now open to all.

Dan Beachum is the manager of Walgren Company’s Organic Finishing Group, 3677 Sysco Court S.E., Grand Rapids, MI 49512, 616-942-8910 or 800-831-5555, danb@walgren.com, www.walgren.com.

For many applications, especially simple parts, this dry-in-place technique produces excellent adhesion and corrosion protection.
Walgren Company offers a unique set of skills and experience, and proven solutions to the specialized needs of production powder. For more than 30 years, we have focused our energy and resources on challenging projects for automotive, off-highway and aerospace applications. Walgren is your best source for new, turnkey powder coating systems, and upgrades and retrofits to enhance productivity and reduce costs.

Walgren has set the standard for parts handling efficiency in powder coating operations. We have solid credentials, with major OEMs and contract shops, in all major parts handling methods: split rail, hoist, power and free, and monorail, and combination (“hybrid”) systems.

Walgren provides comprehensive waste treatment for multiple finishing processes, and will handle all cleaner/rinse chemistries: acid, alkali, zinc-based, chromate and phosphate. Many systems include filter pressing; all are engineered to minimize sludge volumes and disposal.

Walgren can design your powder coating system in SolidWorks to create highly detailed 3D models, rather than flat 2D drawings.

Walgren provides controls design, implementation, and training. Controls include simple relay devices to the most sophisticated PC/PLC-based systems. We specialize in data collection and traceability at the part, batch or load-bar level, and frequently interface controls with ERP (shop floor/material planning) systems.

Independent Self-Diagnostics for major powder coating modules are provided on Walgren lines.

WALGREN COMPANY
3677 Sysco Court SE • Grand Rapids, MI 49512 • Phone: 616-942-8910 • 800-831-5555 • Fax: 616-942-8915 • www.walgren.com

Industry’s #1 Choice for • Chromic, sulfuric, phosphoric or hardcoat anodizing equipment • Zinc, copper, nickel, chrome, tin and electrolytic nickel plating systems
• Cleaning, etching, zinc and iron phosphate pretreatment systems • Wastewater treatment and air emission control • Chemical recovery • Automation controls and reporting
• Comprehensive, safe and ergonomically designed material handling • Specialty powder coating systems for long sections and aluminum extrusions

QS-9000 TE Certified