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Designing and installing a powder coating system

by Nick Liberto

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Finishers decide to install powder coating lines for a number of reasons: to improve compliance with environmental regulations, to withstand market pressure when competitors turn to powder, or to replace a worn-out liquid line. No matter what the reason, making the move from liquid finishing to powder coating is a complex, multi-step process. This article presents a formula—used for installing more than 100 powder coating lines—that simplifies the process of making a successful switch to powder.

If you are leaning in the direction of changing from your current finishing technology to powder or of adding a powder coating line to your existing operation, you need to assess how well powder coating will work for you in terms of performance and economics.

Performance. Finishers considering powder need to decide if powder suits the nature of the parts they coat and meets their finish requirements.

Nature of parts. Parts with many Faraday cage areas or internal obstructions will be difficult to coat with powder. They usually can be powder coated, but finishing costs and system complexity often increase. Parts constructed of nonconductive materials (plastic) are difficult to powder coat. Materials (solder joints and lead) and assemblies (seals, bearings, and gaskets) that can't withstand high curing temperatures are not good candidates either. Powders that cure at low temperatures can help, however. A part with a heavy mass may take an unrealistic time to attain cure metal temperature or to cool off. An infrared oven or boost section can speed part heating, and cool-down tunnels and water quench systems can reduce cooling time.

Finish requirements. It's important to be sure that powder will meet your requirements for appearance (in terms of orange peel, gloss, or clarity, for example) and after-cure properties (such as film thickness, salt-spray resistance, or ability to be silk-screened).

Economics. The first step in deciding if powder is economically feasible involves determining if it makes more sense to use your existing ovens, washer, and conveyor or to buy new equipment. The next step is calculating the cost of buying and installing the new application and recovery system. The final step is figuring out the expected return on investment (ROI) for the conversion.

Existing or new equipment? Justifying a switch to powder is easier when you're thinking of replacing a worn line entirely or of building a new plant. It's harder when you're considering upgrading an existing line with a powder application and recovery system. Your existing equipment may not work successfully in a powder coating process unless you repair or replace it. If you decide to buy new equipment, examine the cost and the floor space requirements. If you decide that you must run the existing system during the installation of the powder system, develop a workable plan to accomplish this. [Editor's note: For a fuller discussion of the economics of switching to powder when equipment requires repairing or replacing, see "Powder coating—too expensive?" elsewhere in this issue.]

System purchase and installation. Powder application and recovery system vendors will give you budgetary (estimate) price quotes, which you can use to determine system costs. You must figure the costs associated with installation also. These include the costs of constructing and modifying buildings, bringing new utilities to the line, dismantling the old system, and installing and starting up the new one.

Return on investment. The final step in determining if powder is feasible for your operation is an analysis of the expected conversion costs and expected savings. Some examples of anticipated savings are reduced cost for applied material, labor, and energy. This comparison, usually called the ROI calculation, will give you an indication of how long it will take the system to pay for itself and begin to make a profit. Here is a formula for calculating ROI:

$$\frac{\text{Equipment cost} + \text{installation cost}}{\text{Annual operating savings (costs)}} = \text{ROI (years)}$$

Organize the project team

If you have decided to purchase and install a powder coating system, you need to pull together a project team, select a team leader, and establish lines of communication. The project team consists of in-house personnel and an independent consultant. The team will determine the project's success to a large extent, so choose wisely.

Select in-house team members from these departments: sales and marketing, manufacturing, engineering, and finance. Choose a consulting firm with experience in powder coating. The firm's experience means it can help your company avoid costly design and installation mistakes. The company must not represent or have any affiliations with equipment or material suppliers or have outside interests that conflict with its project responsibilities.

The project leader is responsible for giving team members copies of meeting notes, correspondence, and other pertinent data and for funneling information from one member to another. The leader must know where the project stands at all times and be able to answer any question about the project.

Select the vendors

The project team must now choose which companies it is confident will provide the system that will most closely meet your company's requirements at a price you can afford. Team members must realize that the new powder coating system is a *process*, not hardware. If they buy and install the system as if it were just hardware—without giving thought to process—you'll end up with an expensive pile of parts. By following these steps, you will define the finishing process needed at your company and also simplify vendor selection.

Write a performance specification. The specification communicates the company's requirements for a powder coating process. Incorporate all information that is pertinent to setting process parameters. Some examples follow:

Production rates. Based on a 5-year marketing plan, break down all parts and their production quantities.

After-cure properties. Outline the coating performance needed to meet the company's requirements. Include specifications for all applicable performance and appearance requirements and any special after-finishing processes (silk screening or post forming, for example).

Utilities. List the existing plant utilities such as natural gas, water, compressed air, sewer, and waste water treatment. If existing utilities are inadequate for a vendor's equipment requirements, you will need to bring in new utilities.

Plant floor space available. If you know the size of the area where the new system will be installed, include this information in the specification.

Existing system information. If components of the existing system (ovens, washer, conveyor) will be used in the powder coating process, include information about them. Examples of useful information are the dimension from the top of the rail to the top of the part, washer stages and durations, and oven times and temperatures.

Part profile. If you will use the existing part profile, add it to your specifications. If you know the new part profile, include it also.

Colors. Include the colors you will coat your products with and the number of colors you will use.

Communicate the specification to vendors. Send the specification to vendors you want to consider. Include powder suppliers, chemical suppliers, system houses, and powder equipment suppliers.

Perform application tests. Provide parts, powder, water samples, and color chips to the vendors you are considering using. Witness the application tests when possible. Use test results to confirm that vendors are capable of meeting your process specifications. Eliminate vendors who have not performed to your expectations.

Update performance specifications. During testing, you may discover that some of the process parameters you requested are not practical or cost effective. Use test information to refine process parameters and update performance specifications.

Obtain quotations. Use the revised specifications to get equipment and material quotes.

Review quotations. Review quotations for compliance with your performance specifications. Analyze the quotes, comparing the price and features offered by each vendor. You may want to use a spreadsheet for vendor analysis (see Table 1).

Make vendor selection. After reviewing the vendor analysis carefully, select the suppliers you will work with. Base your selection on the following criteria: (1) compliance with the performance specification; (2) confidence in the vendor's ability to provide what is quot-

TABLE 1

Sample vendor analysis for a powder coating system

Comparison item	Vendor #1	Vendor #2	Vendor #3
General			
Washer	L-shaped; floor-mounted	L-shaped; floor-mounted	L-shaped; elevated
Dry-off oven	Elevated	Floor-mounted	Floor-mounted
Cure oven	Elevated	Floor-mounted	Elevated
Conveyor	4" I beam; 458 chain	3" I beam; 348 chain	3" I beam; 348 chain
Environmental room	Standard panels	Fiberglass panels	Painted steel panels
Cooling tunnel	None	2	1 (common to both ovens)
Washer			
Prewash stage	2 risers; 125 gpm; 320 gal	Not shown	2 risers; 11 gpm
Cleaner stage	14 risers; 850 gpm; 2,150 gal	14 risers; 780 gpm; 2,400 gal	13 risers; 745 gpm; 2,410 gal
Rinse stage	8 risers; 500 gpm; 1,250 gal	8 risers; 450 gpm; 1,400 gal	7 risers; 400 gpm; 1,020 gal
Conditioner stage	2 risers; 125 gpm; 1,320 gal	None	2 risers fed from rinse
Zinc phosphate stage	14 risers; 750 gpm; 1,900 gal	14 risers; 650 gpm; 2,000 gal	13 risers; 620 gpm; 2,020 gal
Rinse stage	8 risers; 450 gpm; 1,150 gal	8 risers; 375 gpm; 1,100 gal	7 risers; 355 gpm; 840 gal
Sealer stage	8 risers; 450 gpm; 1,150 gal	8 risers; 375 gpm; 1,100 gal	7 risers; 285 gpm; 1,220 gal
Rinse stage	8 risers; 450 gpm; 1,150 gal	8 risers; 275 gpm; 800 gal	7 risers; 285 gpm; 720 gal
Drains	10'	9'	10'
Washer vestibules	6'6"	13' (entry); 12' (exit)	8' (entry); 10' (exit)
Washer housing	10-12 gauge; ladders w/platform	3/16"; slanted roof; no platform	10 gauge; elevated; platform
Washer tanks	1/4" mild steel; 2" insulation	1/4" mild steel; 1" insulation	1/4" mild steel; 2" insulation
Zinc phosphate tank	1/16"-ss sloped bottom; pit	3/16"-ss sloped bottom; pit	3/16"-ss sloped bottom; no pit
Washer vents	1,360 cfm	1,200 cfm	2,600 cfm
Washer piping	CPVC; QD nozzles	CPVC; QD nozzles	CPVC; QD nozzles
Dry-off oven			
Dry-off design	Elevated; 4" insul.; 300°F	Floor-mtd.; 4" insul.; 350°F	Floor-mtd.; 3" insul.; 250°F
Dry-off exhaust	1,274 cfm	2,500 cfm	3,840 cfm
Dry-off recirculation	25,500 cfm	45,000 cfm	12,600 cfm
Dry-off burner	2,000,000 Btu	3,000,000 Btu	2,000,000 Btu
Dry-off heat seal	Bottom entry; natural	1,600 cfm	4@ 2,000 cfm each
Cure oven			
Cure design	Elevated; 4" insul.; 425°F	Floor-mtd.; 4" insul.; 450°F	Elevated; 4" insul.; 500°F
Cure exhaust	6,033 cfm	6,800 cfm	3,300 cfm
Cure recirculation	90,440 cfm	50,000 cfm	2@ 25,350 cfm each
Cure burner	5,200,000 Btu	5,000,000 Btu	4,500,000 Btu
Cure heat seal	Bottom entry; natural	1,650 cfm	Bottom entry; natural
Cure duct location	Top feed; bottom return	Top feed; top return	Bottom feed; top return
Environmental room			
HVAC duct work	Yes	Yes	Yes
Wall construction	Steel panels; sealed floor	Fiberglass panels; vacuum	Prepainted metal
Access doors	2 personnel; 1 overhead	2 windows; 2 prsnl.; 1 overhd.	2 personnel; 1 overhead
Conveyor			
Type	4" I beam; 458 chain	3" I beam; 348 chain	3" I beam; 348 chain
Length	1,480'	1,150'; supports extra	1,330'; ss in phos. stage
Take-up type	Mechanical	Air	Air
Number of drives	1	1	2
Sludge tower			
	800-gal tank; mild steel	Extra cost	355-gal tank; ss
Summary			
Appliance experience	Lowest	Middle	Highest
Appliance reputation	Lowest	Middle	Highest
Price rank	Best	2nd best	3rd best
Layout	Middle	Worst	Best
Price			
Equipment	\$587,329	\$713,282	\$621,078
Installation	188,621	81,500	271,770
Total	\$775,950	\$794,782	\$892,848

ed; (3) reference check of the vendor's past customers; and (4) promised delivery date and price of equipment or material.

Write the contract

The contract should do more than provide work for lawyers. Your project team and lawyers must write it to protect your company's interests. Cover these points in the contract:

Performance specification. Include the performance specification to drive home the point that you are buying a process, not just hardware. Various components of the hardware mentioned in the vendor's quotation should be referenced to the process and specifications.

Project schedule. Everyone involved in the project should agree on a realistic project schedule and commit to delivery dates that correspond to it. Use Gantt or PERT (Performance Evaluation Review Technique) charts to show the relationship between important project activities and delivery dates. Use critical path and other project management techniques to track project details. Figure 1 shows a Gantt chart used to track a simple powder coating project.

Responsibilities. Carefully assign all responsibilities (both internal and vendor). Pay particular attention to the "by others" statements in the vendor quotes (this refers to tasks a vendor indicates are to be performed by others—not by people from the vendor's company). Do you agree with the vendor's assessment that others should perform these tasks? If not, state your position clearly in the contract. Make sure these responsibilities are assigned: (1) equipment installation; (2) utility drop and hook-up preparation; (3) building modification; (4) environmental powder room construction; (5) system start-up; and (6) employee training.

Communicate!

Project success is rooted in good communication. Project-team members must communicate with each other; the

project leader must communicate to the vendors and they to the leader. Problems will be cleared up quickly and questions answered only when all departments affected by the project are involved and when tasks are clearly spelled out. The following will aid you in achieving these goals:

Appoint a core project team. This team is made up of a project manager, representatives from the engineering and maintenance departments, and vendor contacts. The project manager may be a company employee (possibly from the engineering department) or someone who answers to your company exclusively. All people involved with the project will communicate with this person directly. The project manager is responsible for making sure the project is on time, on budget, and done according to the contract.

Schedule review meetings. The project manager should schedule regular review meetings, which all core project team members should commit to attend. The meetings' purpose is to discuss problems in project design and installation as they arise and to keep the project on schedule.

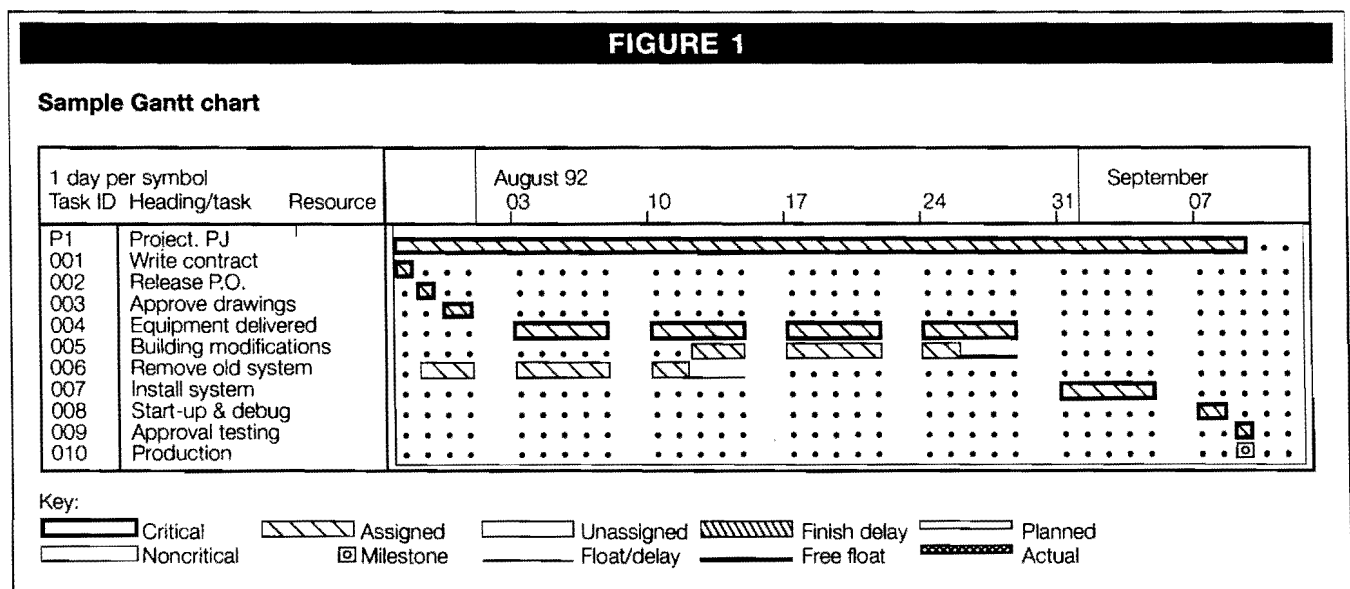
Update delivery schedule. The project delivery and installation schedule is a dynamic document. It must be updated regularly so it always reflects the true status of the project. To do this, the project manager determines the critical path of activities that affect the project completion date and monitors them closely for delays. Project management tools like Gantt and PERT charts provide graphic representations of this information.

Install the system

Equipment installation differs from equipment delivery and involves separate steps, which should be incorporated in the overall project schedule:

Prepare site. Prepare the installation site before the equipment is delivered. Level the floors, complete building modification or construction, and relocate or dismantle existing equipment.

FIGURE 1



Group equipment together. Ready a staging area near the installation site to hold the equipment as it is delivered. Equipment from different suppliers usually arrives at different times and on partially loaded trucks. Grouping the equipment before installation will assure that nothing gets lost.

Inventory the equipment. Have your project manager present to inventory equipment as it is delivered, before installation begins. Replace missing hardware and broken components before they are needed for installation. Nothing stops an installation faster than missing or broken parts.

Prepare utility drops. Before installation begins, work out the location of utility drops with the equipment vendors and get the drops ready. Once installation is under way, system components will cover the drops, making it impossible to install them later.

Enclose an area for powder application and storage. Plan the application area so it has adequate room to store the amount of powder the system will use in a 24-hour period. Enclose the application area to prevent powder contamination from the rest of the plant; provide temperature and humidity control as needed. Also, plan an area for long-term powder storage.

Start up the system

If your design and installation plan was sound, start-up should be an exciting time and not a dreaded event. Some helpful hints for system start-up follow:

Testing reduces start-up time. Highly automated systems will take longer to debug than manual systems. No matter how simple or complex the system, however, having a good system design and doing some equipment testing before start-up will shorten start-up time greatly.

Bring in maintenance and operational personnel. Have maintenance and operational personnel available for system start-up. They can observe how to troubleshoot the system when the vendor is solving start-up problems.

Have test parts and powder available. To prevent delays during start-up, have test parts and the powder you will use during production on hand. You will probably have to scrap the parts after coating, so do not plan to use them for production.

Take a systematic approach. You'll save time if you take a systematic, logical approach to system start-up. [Editor's note: For a guide to system start-up, see "How to set up your system for a new part," *Powder Coating*, August 1991.]

Train employees

A project is not successful unless employees know how to use and maintain the new system safely and efficiently. Training typically is available at three times: (1)

Before system installation, take advantage of any training that vendors sponsor at their facilities. (2) During system installation, have maintenance and operational personnel present. They will gain knowledge by seeing the system components being assembled and by learning how they work before production begins. (3) After the equipment is installed and debugged, equipment suppliers should provide on-site training to team members and other pertinent employees. This should be part of their contracted services.

Start production

Initial production of coated parts is an exciting time, but excitement should be tempered with sound judgment. Planning is the key for success. Here are some suggestions:

Get help from suppliers. Sometimes all the problems are not apparent during start-up and have to be flushed out during production. It is helpful to have the equipment and material suppliers present for the first few production days to help solve problems.

Run different parts in quick succession. Run all types of parts through the system as soon as possible. If your production parts are seasonal, or if new product changes are coming, run samples of these parts when production begins so you can detect problems.

Plan for rejects. Have a plan for handling the rejects the system will generate during start-up and initial production cycles. Do not depend on using the first parts coated for production or you will be disappointed; there is always a learning curve before you can run the system properly. Make the reject plan flexible enough to allow parts to be reworked or scrapped.

Keep an open mind. Be willing to be innovative and creative in trying out methods for successfully coating the parts. Make your ideas known to the equipment supplier during start-up. You know your product better than the supplier does, and months after the suppliers have completed the project, you will be coating the parts better and more efficiently than they ever could.

Conclusion

If the design of the powder coating system is well suited to your requirements, and if a plan to install the system is implemented properly, then installing and starting a powder coating line can be pleasurable. Good luck and welcome to the world of powder coating! **PC**

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