How to set up your system for a new part
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I recently helped a customer with some equipment and setup problems. Their system had been in operation for 9 months. They couldn't meet their coating specifications, and too much scrap powder was being collected in the recovery system. After I corrected some of the equipment problems, I started to perform trial runs to set the system up for their parts.

During this process, the customer commented: “We have already done that. I thought you were the expert in powder coating and could get the results we want without the hassle of trial-and-error testing.” I replied that I had left my magic wand in my office for this visit and assured him that I would bring it next time.

At the end of the visit I had increased their production by 100 percent and reduced their scrap powder by more than 80 percent. Their product was within their coating specification but still not perfect. I suggested that they continue trial-and-error testing during their production runs to control film thickness better. I also instructed them on the proper procedure to set their system up for a part. The advice I gave them is the subject of this column.

Part setup in a powder coating system is done by running a series of tests prior to running production batches. You can reduce the number of tests that need to be run by taking an orderly, scientific approach to part setup. The number of test runs needed will also be reduced if your coating specifications are not strict. If you don't take a scientific approach, however, and if your coating specifications are strict, be prepared to spend considerable time performing test runs. There are no substitutes for time and patience in this endeavor.

Coating variables
The first step in understanding the setup process and in establishing an orderly, scientific approach is to recognize the coating variables that your system can control. Not all systems can control all variables; be sure you know your system's capabilities. The following is a list of variables that you may be able to control:

- Number of guns
- Placement and type of powder pattern
- Position of guns (target distance from gun tip to part)
- Output of powder from each gun
- Speed of powder from each gun
- Electrostatic voltage from each gun
- Reciprocator or oscillator stroke length and speed
- Conveyor line speed
- Density of parts on conveyor
- Hanging trueness (plumb) of parts
- Part temperature during coating
- Powder level in feed hopper
- Part ground
- Compressed air quality
- Environmental conditions (room temperature and humidity)
- Condition of part (bent, dented, containing trapped water, and so on)
- Powder formulation (resin, fillers, pigments, percent of reclaim)
- Booth airflow and draft speed
- Readiness of equipment for production coating
- Part design (material part is made of, quality of welds, and presence of Faraday cages)

The effects of each variable, or of combinations of variables, on system setup can be significant. If you consider the possible combinations of variables that this list contains, you will begin to grasp the scope of what is involved in setting up a powder system to coat a specific part.
**Scientific method**

A scientific method is an orderly approach to solving a problem. In this case, it means that you must determine and follow a course of action for setting up a system and document the results. Following is an example of a scientific method for system setup. The steps should be performed in the order given.

1. To assure equipment readiness, clean and check all guns and pumps, and check the powder booth, voltage supplies, hoppers, and other application equipment. Check and correct the booth airflow, draft patterns, and velocities. By doing this now, you can predict repeatable results when running production batches.

2. Try to control as many of the variables as you can so that you can eliminate them as problem sources. For instance, you can eliminate room environmental conditions as a variable by providing environmental control of some kind (air conditioning, humidity control, heating). You may be able to control the following variables on your system:
   - Density of parts on the conveyor
   - Hanging trueness of parts
   - Part ground
   - Compressed air quality
   - Condition of the part

   You may be able to control another variable, part design, by considering how the product can be fabricated to permit easier hanging, powder coating, draining, curing, drying, and so forth. Some Faraday cages can be eliminated if, for instance, the part is designed to be formed or assembled after the powder coating has been applied. If designing the product to facilitate the powder coating process is not possible, you must decide if powder coating is an appropriate finish for the part.

3. Determine the best way to hang the part, taking into account part size, design, and complexity. Hang the parts from the conveyor with the best possible trueness and part density per hook. Use clean hangers to transmit proper ground to the part. Position the part on the hanger to allow the powder spray pattern access to primary or difficult-to-coat areas. (For additional details on hanger design, refer to "Hanger design and maintenance" in *Powder Coating*, June 1991.)

4. Determine the part temperature at the time of powder application. All parts should be close to room temperature or under 100°F to assure that the applied powder film thickness will be held at the lower end of the acceptable range. Parts with a high mass will sometimes retain heat from the dry-off oven, while those of lower mass will be under 100°F. A higher part temperature may be desirable if a coating thickness greater than 4 mils is required or if the part contains Faraday cages that are difficult to coat.

5. Position a rack of parts within the powder booth. Position the guns to obtain the best target distance (between 6 to 12 inches). This can be done by moving the gun motion device or the gun mounting bars.

6. Determine if a gun motion device is necessary to coat the part. Remember that this device will allow you to coat the part with fewer guns. This will increase system efficiency by reducing the amount of powder that is sprayed, recovered, and scrapped. Determine what the stroke length and speed of the device should be for the part and conveyor line speed you are using. (For information on calculating stroke length and speed, see "Gun motion changes follow production changes" elsewhere in this issue.)

7. Estimate the number of guns that will be required to coat the part. You can do this by imagining the gun motion device's stroke length and the spray pattern size. Determine the best type of spray pattern (round or fan-shaped, for example) to coat difficult areas of the part. Keep in mind that the shape of the spray pattern is as important as gun position. Position the guns and adjust their spray patterns so that all areas of the part are coated; pay particular attention to critical areas such as primary areas and Faraday cages.

8. Adjust the conveyor to a speed that will allow the part to be hung efficiently and safely and still meet the production rate required.

9. Check the level of powder in the feed hopper. Make sure it is full when you start running tests, and check it often as testing progresses. As the hopper level gets lower, powder density decreases. This can cause gun spurs and inconsistent powder feed at the gun, creating poor test results.

10. Adjust the voltage supply to the highest possible setting. Examine the part after coating to determine if the setting should be reduced for better coverage of Faraday cages. Be aware that in reducing the voltage, you will dramatically lower the transfer efficiency to all the other areas of the part. Other system adjustments will also counteract the Faraday cage effect, and you should make them in conjunction with reducing the voltage. By doing this, you may not need to reduce voltage as much as you would otherwise have to. The other parts of the system to adjust are powder output, gun position, spray pattern direction, line speed, and part preheat temperature. In addition, if you can adjust the voltage supply to the guns individually, you can reduce the voltage to the gun(s) that coats the problem area(s) while maintaining the highest possible voltage to the other guns. Not all systems permit this, however.

11. Turn on only the guns that you have determined are required to cover the part that you are testing. Adjust the powder output to the lowest setting or to the setting that was used to coat a similar part. Adjust powder speed so that powder penetrates recesses as required and is fed consistently. To determine if powder feed is consistent, examine the output and pattern of powder from each gun. There should be no surging, and the spray pattern should be even. Develop a gun numbering system that will tell you which area of the part is being coated by which gun. Turn on the gun motion device, if it is to be used, and start the first trial run.

12. The first trial run should include at least one rack of parts (be aware that these parts may be unusable after the
test). After the parts are coated, evaluate your system setup by answering these questions:

- Can the parts be hung safely and efficiently at this conveyor speed?
- Is the production rate attainable at the test line speed?
- Is the part temperature before coating as expected?
- Is the cured film the required thickness?
- Are Faraday cages coated as expected?
- On which areas of the part does coating need improvement? Which gun numbers need to be adjusted?
- Is manual touch-up required?

Your answers will tell you what steps you need to take to coat the part better. After you have determined where improvements need to be made, make the minimum amount of changes to get the improvements you want. Document the changes you make.

13. Run additional tests, and evaluate the results according to the instructions in Step 12, until the coating parameters are met for this part. After each trial run, take notes to document the variables that were changed from the original settings. This way, you can determine what you must do to get back to a previous setting if the results of the current test are worse than the results of the previous one.

14. Record the final settings for all the variables needed to coat the part. Use these to start each production batch run when coating the part. Remember that some variables are sometimes difficult to control (for example, room environment without air conditioning or changes in powder formulation). You may have to adjust the settings for some variables on a daily basis to get the results you require.