The process of production painting can become an all-consuming job with two paramount objectives:

- The line can never stop
- The product must be moving out the door

Interestingly enough, after the process is established, a certain amount of complacency sets in. This is where all your reliable, trustworthy people are doing their jobs, and they all know what to do. Things start up in the mornings and run pretty well all day. Schedules are being met, and no screaming, desk-pounding executive assails your well-being. All is well... life is good!

This is the time to fix those hissing little air leaks, check triggering precision on automatic guns, and look for lost motion and sloppy gun handling by hand sprayers. You might try to find out how much is being spent on paint booth arrester pads, or look at the overall painting efficiency. Do you really know how much of that $90/gallon paint you are applying ends up in the trash? This brochure may help you get some answers.

When a volume of paint is purchased, two things are obtained: solids and volatiles. The confusing part is that the solids are not really solid and at best you can only smell the volatiles. Material Safety and Data Sheets (MSDS) that accompany all paints are a good source of information on paint characteristics. These sheets usually list such things as weight/gallon, VOCs in pounds per gallon, specific gravity, flash point, boiling range, volume and weight solids.

Solids are that portion of the paint that will dry or cure to a solid film. They include the resin fillers and pigments remaining when the paint is dry or cured. The balance of the paint consists of solvents that evaporate during spraying, air drying or curing.

A gallon of paint is usually divided between solids and volatiles. Thus, a paint that is 40 percent solids has 60 percent volatiles. But it isn’t quite that simple. The solids in a gallon of paint are found most easily by heating them until all the volatiles are gone, and then comparing the weight of the remaining solids with the original weight. This will quantify how much of the original weight is solids or percent solids by weight.

The most useful expression of solids content is by volume, because in the application of the paint, we deal with consumption and application in parts or square feet/gallon. This “volume” solids allow determination of how many of the 231 cubic inches in the gallon are useful film formers and how many will disappear. Application method aside, one gallon of 100% solids paint applied at 100% efficiency will cover 1604 sq. ft. of surface to a depth of 1 mil (.001").

Converting weight solids to volume solids is termed “bulking.” It involves equating the specific gravity of various formulated paint components with the fact that one gallon of water (specific gravity 1.000) weighs 8.33 lbs. An in-depth analysis appears in a companion brochure called What is Paint?
Most paints are thinned, or reduced in viscosity before being applied. This allows compensation for weather conditions, surface requirements, and the use of different types of spraying equipment. The volume solids listed on MSDS then, are no longer accurate. The new value can be determined by using Table 1 on the following page.

Paint-volume solids range from as low as 10 percent for some wood sealers to as high as 100 percent for radiation curable coatings. The definitions of “low” and “high” solids are somewhat indistinct, but the dividing line of approximately 60 percent is usually accepted.

**TABLE 1**

<table>
<thead>
<tr>
<th>Determining Volume Solids of Reduced Material</th>
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<tbody>
<tr>
<td>$S_C = \frac{V_U \times S_U}{V_U + T}$</td>
</tr>
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</table>

Where:  
$V_U = \text{Volume Uncut Paint}$  
$S_U = \% \text{ Solids Uncut Paint}$  
$T = \text{Volume Added Paint}$  
$S_C = \% \text{ Solids Cut Paint}$

If in production, where some gauge of efficiency is to be determined, measurement of paint volume consumed is necessary. Several methods are available, but Table 3 identifies a fairly accurate technique that requires no special equipment or skills.

**TABLE 2**

<table>
<thead>
<tr>
<th>Determining Coverage &amp; Mileage</th>
</tr>
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<tbody>
<tr>
<td>$C = \frac{1604 \times S \times E}{I \times A}$</td>
</tr>
</tbody>
</table>

Where:  
$C = \text{Sq. Ft. per Gallon}$  
$S = \% \text{ Solids Uncut}$  
$E = \text{Transfer Efficiency}$  
$I = \text{Dry Film Mils}$  
$A = \text{Part Area Sq. Ft.}$

**MILEAGE**

With your car, it's often worthwhile to know how far you can go on a gallon of gas. With paint, the mileage is usually expressed as pieces painted per gallon.

Coverage refers to the square footage that can be painted. Mileage and coverage are determined using three variables: volume solids, film thickness and application efficiency. An example is where the 231 cubic inches of paint solids noted earlier, are spread to a thickness of 2 mils (.002`). The coverage drops from 1604 to 802 square feet. If thickness is increased to 3 mils (.003`) coverage drops to 535 square feet.

No application process is 100% efficient. Some paint is always lost due to overspray, drips and excessive film build. Some comparative averages for different application devices are:

- Air atomized gun: 30%
- Airless: 40%
- HVLP: 48%
- Electrostatic hand gun: 64%
- Electrostatic automatic: 80-90%
- Dip & flow coating: 85%

At the start of any test run (the longer the better), measure the fluid level in inches from the top of the drum, bucket, pail or pressure-pot liner. At the end of the run, remeasure and note that the difference between the two measurements becomes item “H” in the formula in Table 3.

Assume, for example, that the inside diameter of the paint container is 13 inches. If the beginning fluid level was 5 inches and the end level is 11 inches, “H” would then carry a value of 6. Substituting in Table 3:

$U = .0034 \times D^2 \times H$

Assume that during our hypothetical test run, 420 pieces were painted with the 3.45 gallons of paint. The parts per reduced gallon then, becomes 122. Armed with some costs and the paint-kitchen formula, we can arrive at a per piece cost to paint.
The paint-kitchen recipe calls for the reduction of each gallon of paint with 16 ounces of xylene at $12.50/gallon. The reduction costs $1.56. With the reduction plus the paint at $90/gallon, there is a $91.56 investment. The investment, however, is for 1.125 gallons, not one. With proportioning, we find that the reduced gallon actually costs $81.37. Piece cost for paint then is $0.667. This, of course, doesn’t factor in labor or other costs such as gas and electric for ovens, compressors, pumps, lighting, booth and air replacement fans, or scrap from defects.

It is possible, with these simple calculations, to manipulate the information in Table 2 and establish actual transfer efficiencies of the painting equipment or paint system. An average total film build can be established. The paint areas to be painted can be figured in square feet. Flow checks at each station can give total gallons consumed. These values can be backed into Table 2 for a comparison of efficiency. We know, after all, with application and solids at 100%, we get 1604 square feet per gallon per mil.