An Introduction to the Economics of Metal Finishing

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The past decades have seen continual improvements and advances in the art and science of surface finishing. Less progress, however, has been made in understanding the economics of surface finishing, particularly in a disciplined, rigorous, scientific manner.

Those involved in surface finishing on a daily basis cannot escape the fact that surface finishing is an economic activity. In other words, substantially all the surface finishing done (as well as the technical underpinnings developed) is done for the purpose *of creating a profit*.

While the **intent** of surface finishing is to generate a profit, the financial results are not always as intended. Imperfect understanding of the economics of surface finishing leads to the unintended result summarized by *Rochester's First Law of the Economics of Surface Finishing:*

Most surface finishers make money on only half of the jobs they process.

Economic considerations underlying the various surface finishing processes - particularly understanding of surface area data - compound the unintended results of the First Law as described by the *Corollary to Rochester's First Law of the Economics of Surface Finishing:*

Most surface finishers don't know which parts they finish are profitable, and which are not.

Many readers might be skeptical at this point. Let me give a few illustrations:

• An 8d common nail has over twice the surface area as a 3/8″ × 2″ hex head machine screw and therefore costs **twice as much** to plate (given the same plating thickness).

• A 5/16″ lockwasher has nearly three times the surface area as a 3/8″ × 2″ hex head machine screw and therefore costs **three times as much** to plate (given the same plating thickness).

I submit (and the discerning reader may agree or disagree) that platers don't normally price 8d common nails at twice the price of 3/8″ × 2″ hex head machine screws, and they don't normally price 5/16″ lockwashers at three times the price of 3/8″ × 2″ hex head machine screws. But that is the ratio of costs.

The direct costs of surface finishing are proportional to the surface area of the parts being plated.

Are Cost and Price Related?

In an ideal world, the price directly reflects the cost, but the plating business is not an ideal world, and, while the price often reflects the cost, often it does not.

The rational costing/pricing model is that each item is priced at total cost plus a percentage for profit. Factors that interfere with the rational costing/pricing model include:

- Adherence to outdated costing/pricing models
- Costing/pricing based on promised volumes rather than actual volumes
- Processing problems for which costs may or may not be recovered by pricing (*e.g.*, especially, cleaning)
- Aggressive pursuit of sales with little regard for profit (top-line myopia)
- Seeking and accepting uneconomic business in order to maintain production, particularly in declining economic environments
- Lack of understanding of the economics of particular part types, especially with respect to comprehension of throughput factors (*e.g.*, pounds per barrel, racks per hour, etc.)
- Customers' perceived quality issues and complaint history
- Customers' perceived ability to pay, and the promptness with which invoices are paid
- Acceptance of "loss leaders" in order to maintain profitable business
- Strategic and tactical business pricing decisions
- Recovery of inflationary costs or lack thereof
- Possession and control of deflationary cost benefits
- "Buying" business
- Competition

These and many other "issues" - sometimes fully rational if non-quantitative - but sometimes not - are part of the essential fabric of metal finishing costing and pricing.

The most common means of determining pricing is for the plater to establish how much money the line needs to generate per hour of production, and work backwards to the number of barrels (barrel plating), racks (rack painting) or baskets (dip-spin painting). From those numbers, the surface finisher calculates the price on a "per pound" or "per piece" basis.

Surface finishers often face the problem of costing and pricing "fluff" or "popcorn" - parts with a low bulk density that have low throughput in pounds per hour. The obvious solution is that these items have a higher per pound price to compensate for the low throughput.

And consider just some of the cost categories associated with running such a business:

- Equipment depreciation
- Cost of space
- Utilities
- Maintenance labor and parts
- Overhead - advertising, general and administrative, sales costs (expenses)
- Direct labor
- Indirect labor
- Direct Costs
- Indirect Costs - of which waste treatment is generally the most significant
- General and Administrative (G&A)
- Sales Expense

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non-ferrous metals such as these to soak for long periods of time in the solvent. When continuously degreasing these metals, make a daily effort at removing any metal fines that may be present.

3. Excessive heat

At least 1.5 inches of liquid should always be above the heating elements exposed to solvent. If the solvent is exposed to high temperatures, thermal decomposition can produce acidity. If the solvent contains a large amount of light oil, a fire may result. The solvent sump should have a shutdown system, based on sump temperature. Thermostats should shut off heat at 195°F (91°C) for TCE. Frequent inspection of all temperature controls and visual confirmation of solvent level is highly recommended.

Avoid installing vapor degreasers near any operation that may combine solvent and excessive heat and or UV radiation (welding, ovens, furnaces etc.). Stray solvent not captured by the ventilation system may decompose on these hot surfaces, or may decompose upon exposure to strong UV rays.

4. Certain oils

Some chlorinated oils are unstable at temperatures above 150°F (65°C), breaking down to produce acids. Also, newer cutting and machining lubricants may contain additives that are incompatible with TCE or any chlorinated solvent.

5. Excessive oil-solvent concentration

High oil/grease content in the solvent sump can cause solvent decomposition, insufficient vapor generation and sludge/scale formation. The higher boiling temperature may thermally break down the solvent as well. Maximum recommended still temperatures are typically around 193°F (89°C) for TCE, which corresponds to around 25 to 30% oil.

6. Mixed degreasing solvents

If various chlorinated solvents are blended, the stabilizers may be at the wrong concentration or may be inadequate for stabilizing the solvent mixture. The end result is decomposition of the mixed solvent, producing acids. Also, the varying boiling temperatures of various solvents may produce decomposition. For example perchloroethylene (PCE) boils at about 250°F (121°C). If mixed with TCE, which decomposes at this temperature, acid is produced by thermal decomposition of the TCE.

7. Introduction of acidic matter

Some brazing and soldering fluxes contain acidic compounds. When introduced into a vapor degreaser, these compounds may overwhelm the stabilizer(s) in the TCE or, in small amounts, they may lower the acid acceptance value of the solvent.

Preventive action

Some operations change the solvent in the vapor degreaser frequently enough to avoid acidic conditions. According to the *Electroplating Engineering Handbook* (3rd edition): "With modern well-stabilized solvents, the need for chemical control is virtually eliminated."

However, when the bulk of the workload is aluminum and or other light metals, and when the above indicated conditions for producing acidity can not be readily controlled or prevented, a periodic acid acceptance test can verify that the solvent is sufficiently stabilized.

Most solvent suppliers provide kits or procedures to determine the acid acceptance value, but their procedures will vary. The simplest test is described in the above mentioned handbook. Vigorously mix equal portions of distilled neutral water and test solvent under a fume hood. Allow the solvent and water to separate. Next, measure the pH of the water portion. A reading of 6 to 8 is normal, while 5 to 9 is on the edge and any pH less than 5 confirms an acidic condition. Other procedures involve acid-base titrations which can provide acid acceptance values in equivalent sodium hydroxide concentrations.

According to one major solvent supplier (Dow Chemical), acid acceptance values should normally be above 0.1 wt% sodium hydroxide (NaOH). When it drops to 0.08 wt% NaOH, it should be monitored daily. Below 0.04 wt%, NaOH, corrective action should be taken.

Corrective action may involve adjusting the stabilizer concentration in the solvent or blending the affected solvent with fresh solvent. Vapor degreasers containing solvent with very high acidity need to be specially treated. The following guidance for cleaning such an acidic vapor degreaser comes from Reference 1:

1. Turn off heat.
2. Add soda ash to sump in a solution of one pound of soda ash (sodium carbonate) dissolved in five gallons of water (no solids!), and agitate as much as possible while the solvent is cooling.
3. When the solvent is cool, remove it from the degreaser.
4. Following approved confined space procedures and wearing all recommended safety gear, remove as much sludge as possible from inside and outside of the degreaser.
5. Fill the degreaser with water to a depth of 4 to 6 inches above the heating elements, and add soda ash at the rate of one pound per five gallons of water in the sump.
6. Heat the soda ash solution and boil if possible. Wash all parts of the degreaser that were in contact with the acid solvent.
7. Drain the degreaser and dry completely.
8. Add fresh solvent.
9. Determine the cause of acid generation and take action to prevent future occurrences. *P&SF*

References

1. Roderick P. Murphy, *How a Vapor Degreaser Works*, Degreasing Devices Co., Southbridge, MA, 2000; http://www.degreasingdevices.com/ebook.htm.

2. *Trichloroethylene Stabilization and Maintenance*, Detrex Technical Bulletin, Detrex Corporation, Southfield, MI.

3. *Electroplating Engineering Handbook*, 3rd Edition, A.K. Graham, Ed., and 4th Edition, L.J. Durney, Ed., Van Nostrand Reinhold, New York, NY, 1984.

4. *Economical & Efficient Degreasing with Chlorinated Solvents from Dow*, Form No. 100-6096-485, Dow Chemical Corporation, Midland, MI, 1985, 49 pp.

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For an organization with a number of different plating processes, it is reasonable to set up each process or line as a separate profit center with indirect costs allocated according to some reasonable model. Models such as these are effective and widely used.

Generally though, surface finishers do not take into account the surface area of the parts they are plating, despite the fact that they are in the surface finishing business, and, generally speaking, within a given process, the costs are proportional to the surface area and the plating thickness. Articles in future issues will discuss surface area - how it is calculated and how it can be used profitably by the practicing surface finisher. *P&SF*