Surface Finishing

Surface finishing is an important step in the operations sequence for the production of any high quality part. Plan to spend time on this activity and seek advice from the teaching staff regarding which processes will best support your design goals and which techniques will maximize productivity and quality. It is almost always a good idea to practice finishing techniques on a "test part" before committing your workpiece to the process. This will help eliminate mistakes on the workpiece and provide a way to evaluate the result of the set of finishing processes you have chosen. Have fun. These processes let you create the luster and color and texture that add so much to your product.

1. Mechanical Surface Refining Processes

A. Abrasive Blasting

Abrasive blasting involves directing a high-pressure stream of air and free abrasive particles at the surface of a workpiece. "Starblast" has a coarse, angular grain shape, and is very effective for removing rust and welding scale from steel workpieces. It is generally too coarse for use on aluminum or plastics. Use Starblast at full line pressure (about 100 psi). Glass beads are finer in size and smooth in shape. They produce a non-directional, matte surface on aluminum. It is important to use the lowest air pressure that will pick up the media when glass bead blasting (usually about 40 psi). If the pressure is too high the glass beads will break on contact with the workpiece and because they are re-circulated the fractured (angular shaped) beads will make the surface too coarse. It is important to remove any wax, oil or grease from the surface before abrasive blasting so that those contaminants don't become driven into the surface by the blasting (preventing subsequent plating, painting, anodizing or patina from adhering).

B. Buffing

Buffing is normally done with power. A cloth buffing wheel is coated with very fine abrasive (tripoli, rouge, etc.) which is applied from a wax stick to the rotating perimeter of the wheel. The workpiece is then placed in contact with the edge of the buffing wheel and moved so that the entire surface to be buffed is covered. The result is a highly lustrous surface. Buffing technique is critical. There is a significant hazard that the buffing wheel will catch the workpiece, pull it out of the operator's hand, and throw it violently on the floor. This can result in injury to the operator and serious damage to the workpiece. Seek advice and a demonstration for a TA before attempting buffing.

C. Filing

Filing is done to establish geometry and refine surface finish. It is generally a higher material removal rate process than sanding. Files come in a wide variety of shapes and degrees of coarseness. Common shapes include round, flat, square, 3 square (trianular) and half-round. Coarseness ranges from "coarse" (very heavy

cuts) to "bastard" (medium cut) to "smooth" (fine cuts). Files come in large (10 or 12") and small sizes with the smallest being "jewelers" and "needle files". There are also riffler files that can be used in concave surfaces. Filing technique is important and includes 1) use a sharp file, 2) use a "file card" to keep the gullets between file teeth free of debris, and 3) bear down on the file only during the forward stroke. "Draw filing" and "chalking" the file are techniques to achieve smooth surfaces. Jewelers and needle files are very easy to break. Filing is more successful when the workpiece can be held in a vise or by some other means that leave both hands free to manipulate the file.

D. Sanding

Sanding is done to make a surface more consistent, smoother, or to remove machining marks, or to establish "grain" (directionality). Use "wet or dry" sandpaper (liquid resistant sheets with silicon carbide abrasive) for best results. Grit sizes range from 60 (and lower) which is very coarse to 600 (and higher) which is very fine. Use light oil, kerosene or water as a sanding fluid. Sanding can be done by hand or by power. Some power techniques can be destructive to the work. Sanding techniques include contour block sanding, straight edge reference sanding, and cross sanding, and power sanding on the lathe. Ask a TA for advice. A good rule of thumb: if you are sanding for more than 5 minutes without making much progress, move to a coarser (lower number) grit. Then work up to progressively finer grits. The use of dremel tools or die grinders to do power sanding often reduces good geometry and potentially smooth surfaces to chaos. Usually hand sanding or lathe power-sanding result in much better quality results.

II. Surface Coating Processes

A. Anodizing (Purchased Service)

Anodizing is the electrolytic treatment of aluminum that forms a very thin coating of aluminum oxide on the surface of the workpiece. The oxide coating is of an open cell structure which is naturally gray (roughly aluminum color) but can be dyed a wide range of colors. The coating is very hard (aluminum oxide is a very hard ceramic material), and does not conduct electricity. Anodizing is either "conventional" or "hard". Hard coating comes in a very limited set of colors, involves developing a thick enough coating (on the order of 0.002-0.004 inches) that it will change interference and thread fits, and is both very durable and offers excellent corrosion resistance in salt water applications. Conventional anodizing creates a film thickness which is so thin (the etch step removes a little material and the film creation step adds back about the same amount for a very small net change in size) that it will not change interference or thread fits. Conventional anodizing makes the surface much more scratch resistant and durable than natural aluminum and offers a very wide range of possible colors. Anodizing appearance (color and reflectivity) is very specific to the alloy of aluminum being anodized. If you want good color match, all parts being anodized must be done at the same time and on the same alloy. Don't buff parts to be anodized or they will come

back "splotchy". Don't anodize cast or welded parts. Anodizing will be a different color in the weld zone than on the rest of the part because the filler rod used during welding is never the same alloy as the workpieces. The porosity in our cast aluminum will trap the acid used to etch the surface and will weep out later staining the surface. A good alternative for aluminum weldments or castings would be powder coating.

B. Electroplating (Purchased Service)

Plating adds a thin coating of metal to the surface of the workpiece. The workpiece must be electrically conductive (there are also vacuum metallizing processes for plastic workpieces). Plating materials include chrome, nickel, silver and gold. Colors range from black to chrome. Surface reflectivity can be very glossy or semi-matte. Typically the coating is very scratch resistant. The workpiece must generally be delivered with the surface finished to the same degree of luster and refinement that is desired in the plated part. This means that a great deal more time would be spent preparing a surface for chrome plating than for powder coating. It is possible but expensive to electroplate aluminum. This process is normally used on steel, brass, or copper.

C. Patina

Patination is an ancient process of chemically coloring workpieces (often statuary or jewelry). Traditionally this is done on bronze castings to create color and reflectivity conditions that add visual strength to the part. There are also products that will produce a patina on steel. The Rodin sculptures at Stanford are wonderful examples of very high quality patination. These surfaces tend to look more organic and varied than anodized, plated or painted surfaces. There are a nearly infinite number of chemical recipes to achieve all kinds of effects on various materials. The simplest and most reliable is "liver of sulfur" which converts the copper in bronze to copper sulfide causing the surface of the casting (only the surface) to become brown or black depending on the concentration of the solution and the temperature of the surface to which it is applied. Patination often includes applying a multiplicity of wax coats over the chemically altered surface. Liver of sulfur is made by mixing 2 ounces of liver of sulfur (crushed to a powder), 1/2 ounce of aqua ammonia (specific gravity = 0.89), and 1 gallon of distilled water. Cleaning of the metal surface is critical to the successful adhesion of the patina. "Most metal coloring failures are due to incomplete or improper cleaning." A good reference is Untracht, Metal Techniques for Craftsmen .

D. Powder Coating (Purchased Surfaces)

Powder coating creates a thin (about 0.002 of an inch per coat), even coating of plastic on the part. The resulting surface can be very glossy, matte, or hammertone. A very wide range of colors is available. Powders can be optimized for food safety, scratch resistance, resistance to fading in sunlight, etc. Common power coating resins include epoxy, polyurethane, polyester, and acrylic. The process involves thermal fusion of a thin layer of plastic powder that is attracted to the surface of the workpiece by electrostatic charge. This means that the

workpiece must be able to withstand the heat of fusion (typically about 400ºF). Powder coating is suitable for steel, and aluminum and is a better alternative than anodizing aluminum castings or weldments. Soft soldered metal assemblies, plastic parts, and bondo filler will be ruined by the fusion temperature.

revision history :

Ver 1.0	????	????	original text
Ver 1.2	10/01	Katherine Kuchenbecker	minor re-formatting and revisions