Techtips

by Roger Kern

Techtips is a collection of useful ideas, techniques, and procedures designed to further EDM knowledge.

Overcut and Orbit Fundamentals

In this issue's column we will examine the fundamental rules of overcut and orbit as they relate to Sinker EDM operations, with an eye toward utilizing our enhanced understanding to exploit them to our advantage, and to avoid the numerous pitfalls that await the unwary EDMer.

Overcut Rules
(Without orbit):

• Overcut radiates outward from the material of the electrode creating a uniform gap between the electrode geometry and the generated workpiece geometry.
• External sharp corners become either internal radii or spheres with a radius equal to the overcut.
• Internal sharp corners become external internal sharp corners.
• The centerlines of the electrode and workpiece radii are common.
• External electrode radii become internal radii, increasing toward the workpiece by the amount of the overcut.
• Internal electrode radii become external radii, decreasing toward the workpiece by the amount of the overcut.

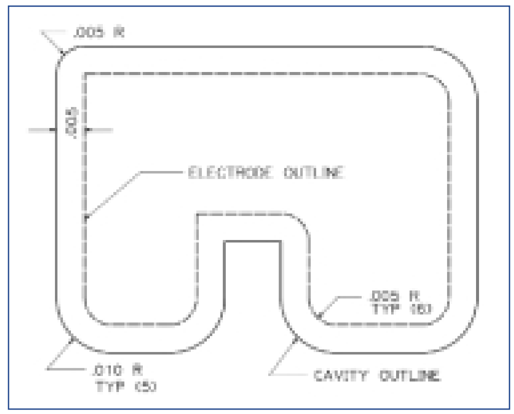

Figure #1

***Figure #1** depicts the top view of a male electrode outline and its resulting cavity. I have arbitrarily chosen the overcut as .005". The electrode has one external sharp corner, one internal sharp corner, five .005" external radii, and one .005" internal radius.*

Following the rules listed above, we note the following with respect to the generated cavity:
• The electrode external sharp corner generates a .005" radius internal corner on the workpiece.
• The electrode internal sharp corner generates a sharp external corner on the workpiece.
• The five electrode external .005" radii generate five .010" radius internal corners on the workpiece.
• The electrode internal .005" radius generates a *sharp external corner* on the workpiece.

This last fact often surprises EDMers, but it is entirely logical if we follow the rule that centerlines remain the same and note that the overcut is driving the cavity surface toward the centerline, *thereby reducing the radius (in this case to zero)*.

It is important to note that these rules also apply to geometry that is soley defined in the X-Y plane when the gap between the electrode and workpiece in the X-Y plane is produced by a combination of spark gap and orbit in the X-Y plane.

The fact that internal radii of the electrode are effectively reduced by the combined effect of overcut & orbit can often be very beneficial for those that make electrodes in a wire machine, since limits on the internal corners produced by the wire can be mitigated by orbiting the electrode.

❑ Example #1: The Ratchet Wheel

However, the rules of overcut can also burn (no pun intended) the unwary EDMer. Let's look at ***Figure #2****, which is a 72 tooth ratchet which is dimensioned as having a 1.0000 diameter over the tips of the teeth.* Let's assume were are required to burn a cavity to mold this part. For purposes of this exercise, we'll ignore shrinkage and assume an overcut & orbit allowance of .005" per side. As shown in ***Figure #3***, we lay out the cavity in the CAD system, offset the path by .005" per side, and generate a shadowgraph chart for grinding the electrode. We grind the electrode to the chart and burn the cavity, finishing with a final combined overcut + orbit of .005" per side.

Whoa! Measuring the molded part we are undersize by almost .020"! The overcut + orbit left us with a ratchet tip with a .005" radius, falling far short of the dimensioned cavity outline, due to the small included angle of the ratchet tooth. This is exactly what the rule would have predicted. We did everything right, but still blew the job because our ratchet requires a certain amount of engagement with the pawl. Cavities with internal sharp corner dimensions (especially those with small included angles) can be very tricky when made by EDM.

So far we have only looked at prismatic cavities. The situation becomes a lot more complex when the form of the cavity becomes three dimensional and we use a combination of overcut and 2-dimensional orbit, since we have to now abide by additional rules:

Additional Rules:

• All of the original rules apply to the dimensions contained within the orbit plane. (Typically X-Y)

• For planes perpendicular to the orbit plane, the electrode corners and radii will generate cavity radii with *a total gap of only the final finish spark gap*.

❑ Example #2: Cube with Radii

Let's look at the cavity block in ***Figure #4*** for a molded 2.0000" cube that has .250" radii on all edges. Again, only for purposes of this illustration, we will assume an overcut of .050" per side and an orbit of .200" per side. The values have been exaggerated for dramatic effect.

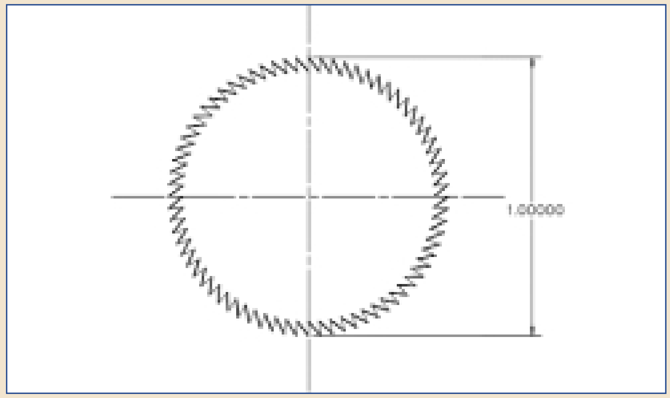

Figure #2

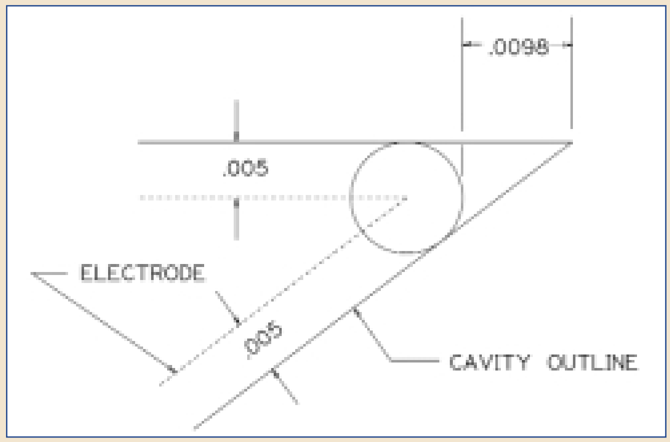

Figure #3

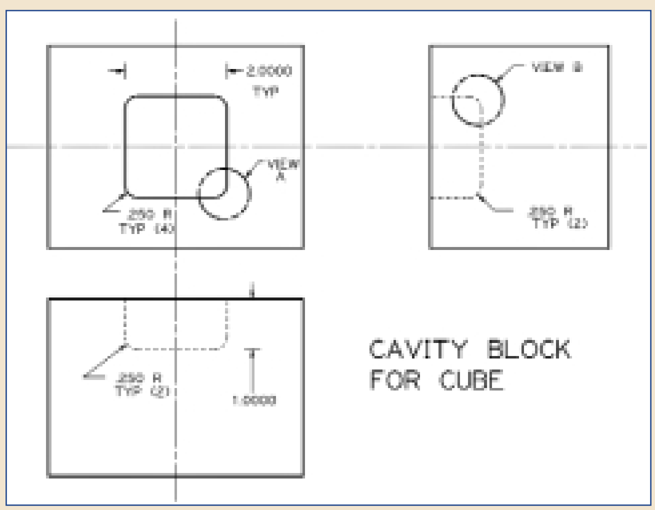

Figure #4

Now let's look at the enlarged views **A** and **B** in ***Figure #5*** to plan our electrode.

View A is a top view looking at the cavity and electrode geometries in the plane of the orbit, X-Y. Note that the electrode will need to have sharp corners if we are to meet the .250" R cavity specification with our chosen overcut & orbit.

View B is a right hand view looking at the cavity and electrode geometries in the Y-Z plane, perpendicular to the plane of the orbit. The electrode in this view and the corresponding front view will need to have .200" radii to meet the .250" R cavity specifications, because the orbit does not alter the geometry in these views.

Even though the cavity has (8) identical .250" radii, the electrode will have (4) sharp edges in the top view and (4) .200" R on the edges in the other views!

The situation becomes even more complex with a true three-dimensional form.

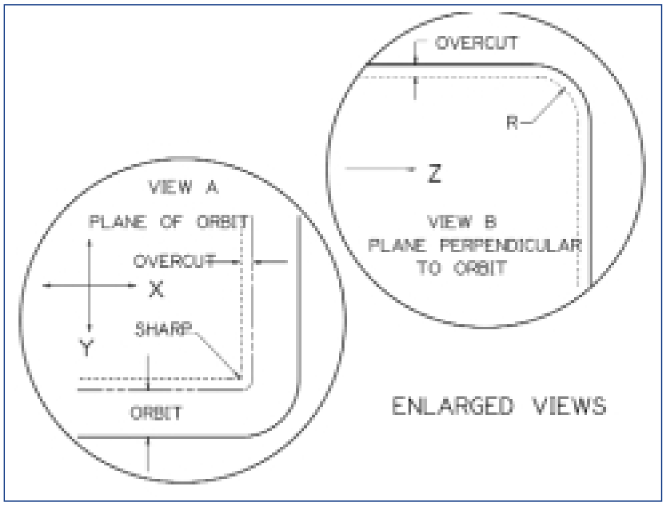

Figure #5

❑ Example #3: The Cylinder

Consider the molded cylinder depicted in ***Figure #6 which will be molded in the cavity block depicted in Figure #7***. What differentiates this example from the previous one is that the shape is no longer prismatic, with the geometry in the Y-Z plane being circular.

Now let's study a cross-section of the cavity shown in ***Figure #8***. Let's assume we will be orbiting in the X-Y plane. This time, I have avoided assigning any hard numbers to the cavity, overcut, and orbit. For purposes of the illustration, the final orbit is shown as being four times larger than the final overcut (The low power setting used for finishing).

Please examine Figure #8 carefully and note the following:

At final orbit and depth, the centerline of the electrode is offset both from the center of the cavity and the parting line by the amount of the orbit.

There will be flat at the bottom of the cavity equal to two times the final orbit.

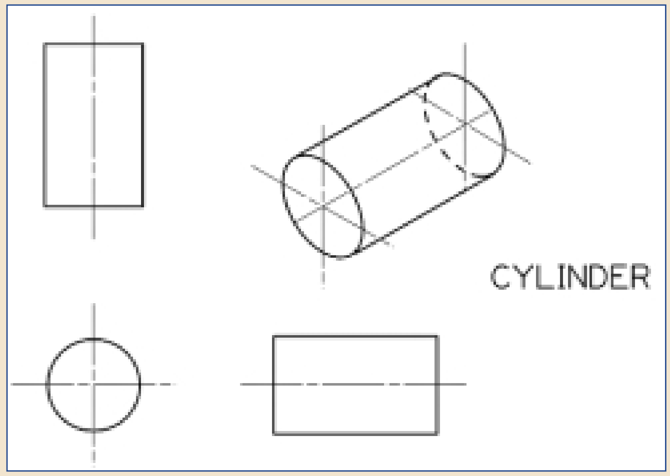

Figure #6

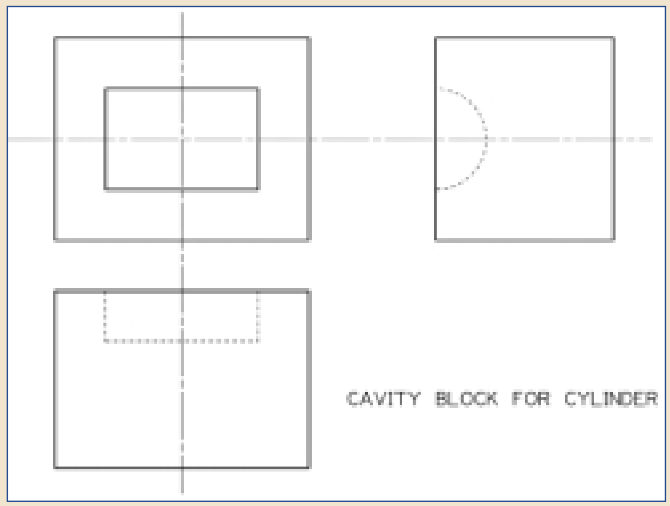

Figure #7

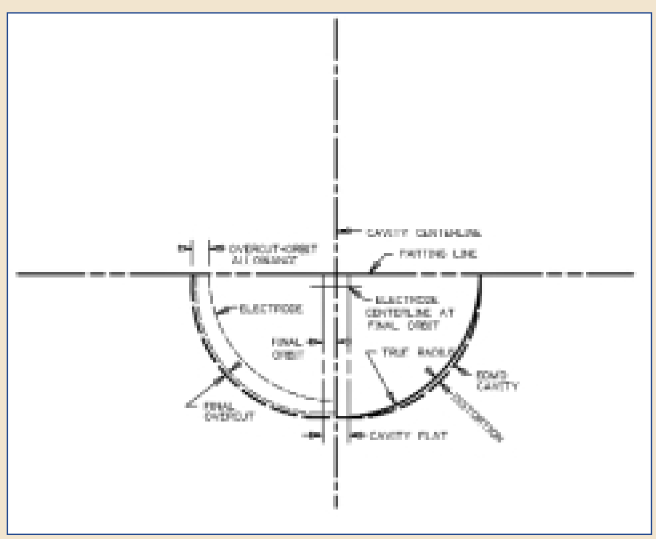

Figure #8

Even though the cavity has the correct dimensions at the centerline and the parting line, the form of the cylinder is distorted. The resulting molded part will be oversized if measured on the diagonal.

In addition to the two geometry defects just illustrated, the generated corner radius at the intersection of the cylindrical surface and the ends will vary from a radius equal to the sum of the final overcut and the final orbit at the parting line, to a radius equal to the final overcut at the bottom of the cavity.

It should be noted that if the cavity was a sphere instead of a cylinder, similar geometry distortion would occur. The sphere would measure correctly only at the parting line and along the Z axis, have a circular flat on its centerline at the bottom of the cavity, and it would measure oversize when checked along any diagonal diameter.

There are a number of alternative strategies that can be considered to avoid the pitfalls of orbiting as illustrated in the preceding example:

Don't use orbit at all. This option will solve all of the distortion problems. However it would require both a rougher and one or more finishers, and result in dramatically increased burn times.

Orbit in the Y-Z plane instead of the X-Y plane. While this option will eliminate the geometry distortion issues, it will not allow us to clean up the roughing finish on the ends of the cylinder, since we are orbiting only in the Y-Z plane.

Use a spherical orbit. This will solve all of the geometry issues, while allowing us to take full advantage of the efficiencies of orbiting — including making only one size electrode that is uniformly smaller than the cavity, high speed low wear roughing, improved flushing, and fine final finish.

Spherical Orbiting

Let's briefly examine spherical orbiting.

The spherical orbit pattern is an option found on many advanced CNC sinkers. Spherical orbit patterns are not possible with mechanical orbiters or many of the available electronic spindle-mounted orbiters.

When properly applied, a spherical orbit pattern reduces the X-Y circular orbit amount as the depth increases, until the orbit is zero when the depth of the electrode reaches the depth of the cavity less the final overcut. That is, the orbit in the X-Y plane is diminished in such a manner that when viewed in the X-Z and Y-Z planes the diminished orbit pattern generates a radius equal to the amount of the orbit. See ***Figure #9***.

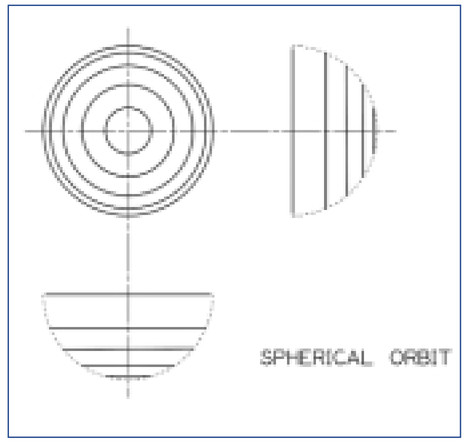

Figure #9

For most burns with some form of 3-D geometry at the bottom of the cavity, typically a uniform radius along the intersection of the side walls and the bottom, the following procedure is often employed:

Plunge burn at roughing settings with little or no 2-D orbit until the level of the 3-D portion of the geometry is reached.

Engage spherical orbit pattern and proceed by reducing power and increasing orbit until the final orbit and finish power settings are reached.

It has been said that each leap in EDM technology gives us a multi-fold increase in productivity and quality at the expense of a multi-fold increase in the possibilities to spoil the job.

Hopefully this admittedly tedious exercise will unleash the power of the former and help you avoid the latter.

Any suggestions for future topics are welcome.
Tell us what you would like to read about.
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